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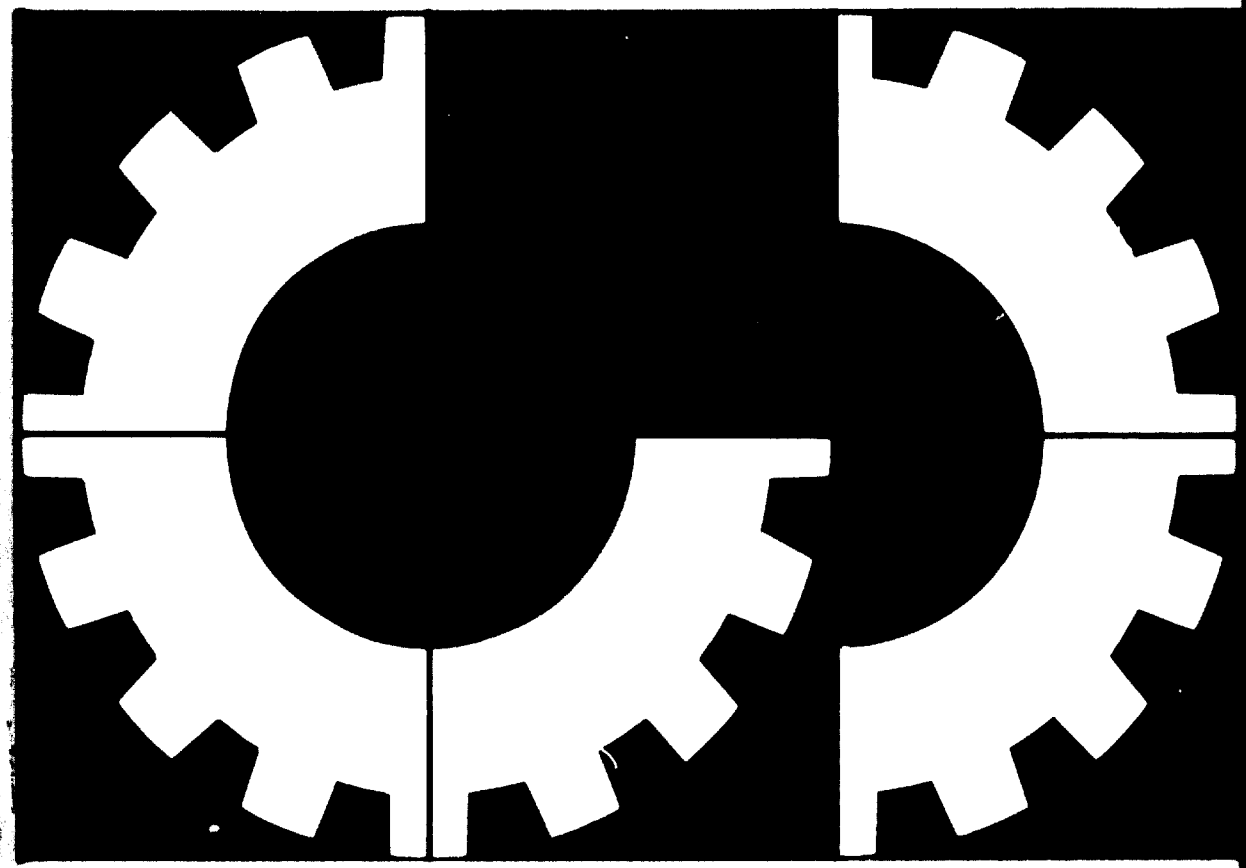
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

MACHINE TOOLS IN LATIN AMERICA



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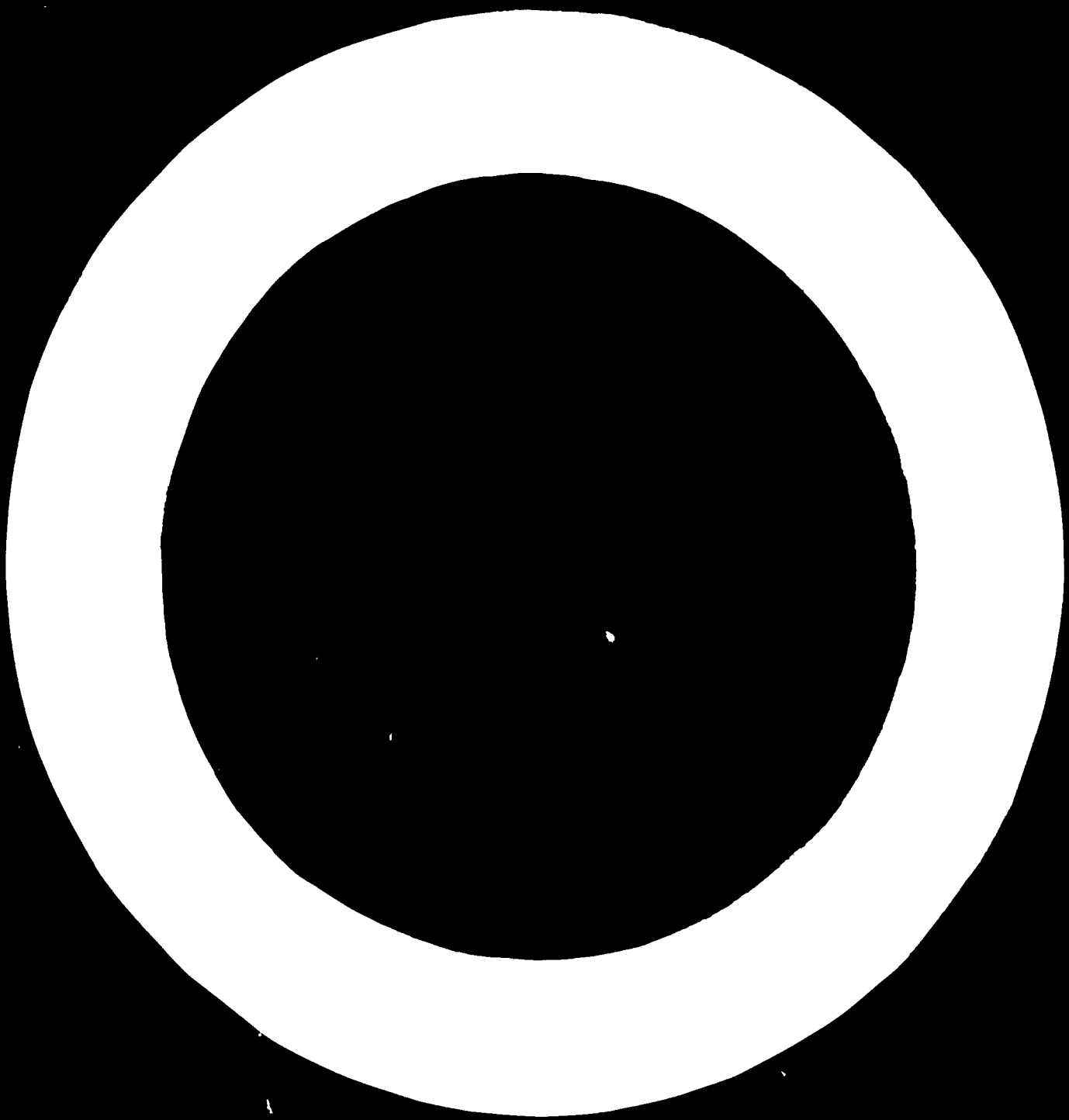

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
VIENNA

MACHINE TOOLS IN LATIN AMERICA

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Preface

At an Interregional Symposium on the Development of Metalworking Industries in Developing Countries held in Moscow in 1966 under the auspices of the United Nations, it was decided that a series of regional seminars would be held to examine the specific problems faced by the various regions in developing their metalworking industries. Special attention was to be given to the machine tool sector, which was recognized as being the key to the development of the metalworking industries. Accordingly, a series of regional seminars on the machine tool industry was planned by the United Nations Industrial Development Organization (UNIDO).

The first seminar—on Machine Tools for Europe and the Middle East—was held in Bulgaria in 1971. A Seminar on Machine Tools for Latin American Countries, held at Buenos Aires, Argentina, from 16 to 25 October 1972 and at São Paulo, Brazil, from 26 to 27 October 1972, was the second in the series.

The purpose of the Latin American Seminar was to analyse, through papers, films, discussions and factory visits, the technical and economic problems involved in the selection, utilization, maintenance and repair of machine tools, as well as in the establishment and development of the machine tool building industries in countries of the region. Papers were presented by leading experts in their field, by UNIDO, and by other participants in the Seminar. The presentation of each paper was followed by detailed discussions on the application of the subject-matter in the countries of the region in general and in the countries represented at the Seminar in particular, consideration being given to the special conditions prevailing in those countries.

The programme included visits to major factories of the metalworking and machine tool industries in Argentina (Buenos Aires and Córdoba) and Brazil (São Paulo, Jundiaí, and Santa Barbara). The visits were organized by the Governments and industrial chambers and federations of the host countries, so that the group might study the utilization and manufacture of machine tools under workshop conditions.

A visit was also made to the premises of the National Institute for Industrial Technology (INTI) at Buenos Aires, where valuable information was obtained about the Institute's activities supporting the technological development of the metalworking industry in Argentina. INTI has established research and development laboratories in the fields of physics (electricity, electronics, basic metrology etc.), chemistry (organic, inorganic, chromatography etc.) and material analysis (destructive and non-destructive testing, industrial treatment for metal, plastics, paper etc.). The findings of these laboratories are at the disposal of manufacturing enterprises in Argentina.

Part one of this publication is the report of the Seminar in Latin America. Part two is a study on the machine tool industry in general. It was prepared by the secretariat of UNIDO and is based on papers presented at the Latin American Seminar, the proceedings of other regional seminars, and United Nations publications on the machine tool industry.

EXPLANATORY NOTES

The following definitions are used:

"Billion" means thousand million.
"Dollar" ($) means the United States dollar.
"Ton" (t) means metric ton.

In tables, a dash (–) indicates that the amount is nil or negligible; three dots (. . .) means that the data are not available.

The following abbreviations are used:

GDP gross domestic product
GNP gross national product

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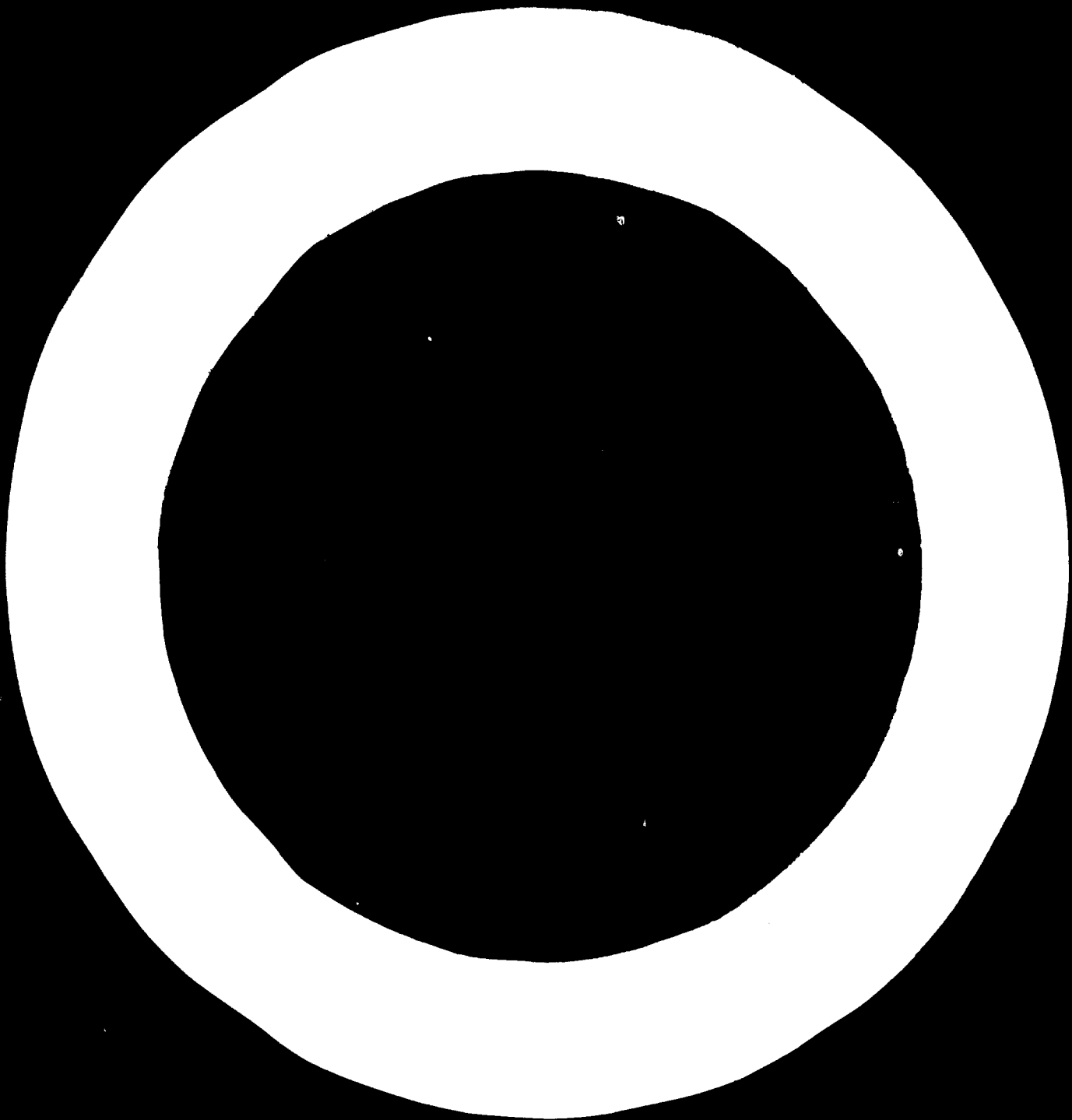
Report of a Seminar on Machine Tools for Latin American Countries

held at

Buenos Aires, Argentina (16–25 October 1972)
and
São Paulo, Brazil (26–27 October 1972)



I. ORGANIZATION OF THE SEMINAR

The Seminar was held under the auspices of the United Nations Industrial Development Organization (UNIDO) in co-operation with the Government of Argentina–through the National Institute for Industrial Technology (INTI) and the Chamber of Manufacturers of Machine Tools of Argentina (CAFMHA)–and the Government of Brazil–through the Conselho de Desenvolvimiento Industrial, Rio de Janeiro and the Federation of Industrialists of the State of São Paulo (FIESP).

It was attended by 94 representatives from 20 countries. They included representatives of UNIDO, the Economic Commission for Latin America (ECLA) and the European Committee for the Co-operation of Machine Tool Industries (CECIMO).

M. E. Báncora (Argentina) was elected Chairman; A. Henriques da Silva (Brazil) Vice-Chairman; and K. C. Berger (Federal Republic of Germany) Rapporteur of the Seminar. A drafting committee consisting of M. E. Báncora, K. C. Berger, J. W. Delucchi, R. Gabriel, E. C. J. Sabatté and A. Henriques da Silva was appointed to prepare the report of the Seminar. N. N. Krainov, Industrial Development Officer, Engineering Industries Section of UNIDO was Director of the Seminar.

At the opening session, addresses were made by N. N. Krainov, by E. J. Parellada, Minister for Industry and Mining of Argentina, and by S. M. del Carril, President of the National Institute of Industrial Technology (INTI) of Argentina.

Mr. Krainov, in his address, said that industrial progress in many developing countries was hampered by the lack of machine tools. Those countries should, however, strive to produce their own tools. During the initial stages of a country's industrial development, machine tools would naturally have to be imported, but as its industrialization advanced, the country should try to supply its own needs. Apart from the obvious economic disadvantages of importing equipment, the purchase of inappropriate or too-sophisticated machine tools often resulted in its under-utilization. In any case, the manufacture of certain machine tools and accessories–dies, jigs, moulds and fixtures for example–was a labour-intensive operation and, as such, ideal for developing countries.

Describing machine tools as "the key to over-all development", Mr. Parellada stressed the need for the countries of Latin America to co-operate in the development of their metalworking industries. Although each country might have a different social or economic system, the problems to be faced in the development of the industry were common to all of them. He also felt that machine tool manufacture in the developing countries themselves provided much scope for the imaginative and creative efforts of indigenous technicians, who could design tools, or adapt existing designs, to suit local needs.

Mr. del Carril paid a tribute to UNIDO for the excellent technical assistance it had provided his organization in the past. He also was of the opinion that the countries of the region should co-operate with one another and co-ordinate their efforts in building up their machine tool industries.

Investment promotion programme

Concurrently with the Seminar, an investment promotion programme was organized to provide an opportunity for the promotion of specific industrial projects related to machine tools in countries of the region.

Before the meeting, and in the course of it, participants from Latin America submitted a number of projects they wished to promote, and for which they would require industrial co-operation.

Of 37 specific projects identified, 22 were for the establishment of new factories; 7 were for the expansion and modernization of existing facilities; 8 were for other types of industrial co-operation, including information and expertise.

UNIDO arranged, upon request, meetings among parties interested in discussing prospects for co-operation on these projects and on other matters of mutual interest.

Most of the participants in the Seminar - representatives of the Latin American countries, representatives of industrial organizations and companies from the region, and industrialists from other regions—availed themselves of the opportunity for confidential discussions provided by these meetings.

The participants felt that the direct contacts established and business talks initiated during these promotional activities were very useful; those promising success would be followed up after the meeting.

A limited number of copies of the list of participants and observers at the Seminar are obtainable on request from the Engineering Industries Section, Industrial Technology Division, UNIDO, quoting symbol ID/WG.113/18/Rev.1.

II. FINDINGS OF THE SEMINAR

The participants in the Seminar drew a number of conclusions from the country study statements, the report of the UNIDO field mission and the discussions that followed the presentation of papers at the Seminar. These conclusions are set out below.

Stages of development

The importance of machine tools to the expansion of industry becomes apparent when it is considered that machine tools—or machinery produced with the use of machine tools—are used in the manufacture of most other products. The availability and proper utilization of machine tools also determines the potentiality of the metalworking industry.

The developing countries of the Latin American region may be classified into three groups, according to the degree of development of their metalworking industries and particularly of the machine tool sector:

(a) Countries with developed metalworking industries and established machine tool sectors, such as Argentina;

(b) Countries with developed metalworking industries and developing machine tool sectors, such as Chile;

(c) Countries with limited metalworking industries but no machine tool sectors, such as Bolivia.

The problems of developing countries vary at different stages of the development of their metalworking industries. It is not feasible, therefore, to submit one formula for assistance for all of them.

For the countries of the first group the problems are complex and difficult to solve. They include:

(a) Training in the use of advanced machine tool technology, e.g. numerical control;

(b) The planning and organization of export promotion schemes;

(c) The setting of high standards for quality and their application throughout the industry;

(d) More general participation in the international flow of technological information.

Countries in the second group need assistance in the following activities:

(a) Market research to define machine tool requirements, by type and quantity;

(b) The setting of standards for quality control, material testing, design, manufacturing processes etc., in order to improve existing production techniques;

(c) The acquisition of information on the importation of sophisticated machine tools;

(d) The establishment of contacts with foreign machine tool firms, with a view to negotiating licensing and know-how agreements and undertaking joint ventures.

The main problem of the third group of countries is the development of its metalworking industry. They need help in:

(a) The analysis and utilization of existing and potential resources;

(b) The proper selection and utilization of machine tools;

(c) The training of personnel;

(d) The maintenance, repair and rebuilding of the machine tool park, prior to establishing prerequisites for the manufacture of simple machine tools.

Obviously, some of the recommendations made for one group might well be applied to the others.

Limited local markets

A careful investigation should be made to discover whether a domestic market exists and, if it does, whether it is accessible. As newly established machine tool industries usually find it difficult to compete with imported products, some form of government protection may be necessary in the beginning. This protection should decrease at a predetermined rate, however; otherwise it may lead to stagnation and inefficiency, thereby damaging the metalworking industry of the country as a whole.

Access to larger markets may be had through regional trade and industrial complementation agreements, a policy that is currently being pursued in the Latin American region to good effect.

III. SUGGESTIONS FOR FUTURE ACTION

A number of suggestions for future action were formulated by participants in the Seminar.

It was suggested that the countries of the region:

(a) Create a consortium of machine tool manufacturers on a regional or subregional basis, which would assist individual enterprises in the fields of research and design, marketing and distribution, quality control etc. (This consortium was proposed specifically for the members of the Andean Group[1]);

(b) Study the possibility of applying some simple forms of numerical or other electronic control to existing machine tools;

(c) Improve facilities for the exchange of experience in licensing and other agreements on co-operation;

(d) Improve their market research and general marketing activity to enable individual companies to plan their production in accordance with actual market requirements;

(e) Exchange fellowships, in order that the less developed countries might benefit from the practical experience of the more industrialized ones.

It was suggested that the industrialized countries:

(a) Consider the developing countries as partners, bearing in mind that the importance of the developing countries as markets and suppliers increases with their industrialization;

(b) Develop schemes for co-operation by every possible means, e.g. by supplying know-how, by licensing, by entering into agreements, and by participating in joint ventures to promote industrialization;

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[1] On 26 May 1969, at Bogotá, the representatives of the Governments of Bolivia, Chile, Colombia, Ecuador and Peru signed an Agreement on Subregional Integration designed to promote the balanced and harmonious development of the five countries by means of economic integration. This Agreement came into being in response to the requirements of the less developed countries in the Latin American Free Trade Association (LAFTA) for a joint effort to promote the adoption of practical formulas permitting the maximum acceleration of development. The Cartagena Agreement was conceived within the general framework of the Montevideo Treaty, and consequently one of its purposes is to establish favourable conditions for the conversion of LAFTA into a common market.

In order to achieve the objectives provided for in the Agreement, the following measures are envisaged:

(a) Harmonization of the economic and social policies of the member countries;

(b) Liberalization of tariffs on subregional trade;

(c) Setting up a mechanism for the joint programming of industrial activities, in regard to products specified in a reserve list;

(d) Establishing a common external tariff within a period not exceeding ten years;

(e) Giving preferential treatment to Bolivia and Ecuador.

(c) Co-operate with UNIDO in providing the assistance required;

(d) Accept fellowships from the countries of the region.

It was suggested that UNIDO:

(a) Provide the technical assistance requested by the developing countries in the course of the Seminar (see below);

(b) Co-ordinate requests for co-operation from both developed and developing countries and assist in negotiations up to the point where agreement has been reached between the partners;

(c) Promote technical assistance generally in the countries of the region;

(d) Support the Economic Commission for Latin America (ECLA) in its activities in the region.

IV. REQUESTS FOR TECHNICAL ASSISTANCE FROM UNIDO

In the course of the Seminar attention was called to various needs for technical assistance from UNIDO, as indicated below.

Argentina

Expert in numerical control to assist the Government to introduce numerically controlled machine tools in the country's metalworking industries.

Bolivia

Expert in the evaluation of the metalworking industry, to assess the country's stock of machine tools and its utilization with a view to co-ordinating the operations of existing and future machine tool parks.

Expert in forging plants and foundries, to carry out a feasibility study on the establishment of a central forging plant and foundry.

Brazil

Expert in tools, dies, jigs and fixtures, to assist in the development of their production locally.

Expert in capital goods market research, to assist in organizing market research for the machine tool industry.

Expert in quality control and standards, to help in improving the quality of machine tools produced locally and to introduce standards where appropriate.

Expert in machine tool design, to develop the machine tool design capability of the country.

Colombia

Expert in grinding machines, to assist the Government in the selection of such machines, in accordance with its commitment to the industrial development programme of the Andean Group.

Fellowships for technological training in design, development and manufacture of machine tools.

Ecuador

Experts in *(a)* planing machines and shapers, and *(b)* hydraulic presses and related apparatus, to assist in the manufacture of this equipment, in accordance with Ecuador's commitment to the industrial development programme of the Andean Group.

Expert in carrying out feasibility studies and developing appropriate technological methods for the manufacture of hydraulic presses and other hydraulic systems.

Expert in carrying out feasibility studies and developing appropriate technological methods for the manufacture of filing and shaping machines.

Expert to help plan a technological development and information centre for the metalworking industries.

Fellowships in the following fields: steel processing; middle- and high-level management in the metalworking industries; heat treatment; metal-forming; tools, dies, jigs and fixtures manufacturing; machinery design; micromechanics or high precision metalworking; manufacture and application of hydraulic systems.

Mexico

Expert to carry out a general survey of the existing stock of machine tools, its utilization and possible development, taking into consideration the development of the metalworking and related industries.

Expert in the technology of machine tool manufacture, including the design, selection and control of materials, manufacturing processes and quality control.

Fellowships for medium- and advanced-level technicians in machine tool factories abroad, so that they might gain practical experience in the fields of machine tool manufacture and design.

Paraguay

Foundry expert, to assist the National Institute of Technology to develop a basic metalworking industry.

Expert in the selection and utilization of machine tools, to assist the Government in the expansion of the National Institute of Technology to cover new areas of the metalworking industries.

Peru

Expert in heat treatment, to help the local steel industry to meet the quota assigned to it by the Andean Group.

Expert in metrology and mechanical and electrical quality control, to help maintain a high standard of quality in the machine tools manufactured locally.

Fellowships in the following fields: press, drilling machine and general machine tool manufacturing; inspection and quality control; heat treatment; gear production.

Uruguay

Expert to help in the proper selection and utilization of machine tools, in accordance with the Government's plans for the development of the metalworking industry. This activity should lead to the establishment of a technology centre for the country's metalworking industries.

Fellowships to train at the medium and advanced technical level in the selection, application and utilization of machine tools.

Venezuela

Expert in the selection and utilization of machine tools, to analyse the actual condition of the machine tool park in the country; to formulate policies for the future development of the metalworking industry; and to assist the Government and private enterprises to implement these policies. The expert would be required on a permanent basis.

Regional

Expert to assess the possibility of establishing standards for sub-supplying industries to the machine tool manufacturers; to make an evaluation of the actual status of these industries; and to put forward recommendations for their improvement.

Expert to evaluate the national technological centres and to recommend measures that would increase their efficiency.

V. STATUS OF THE MACHINE TOOL INDUSTRY IN LATIN AMERICA AND SUMMARIES OF COUNTRY REPORTS

A. Status of the machine tool industry in Latin America

Statistical information on the industrial development of the region

Each of the components that make up a country's Gross National Product (GNP) (agriculture and fishing; mining; manufacturing; construction; electricity, gas, water; transport and communications; commerce and finance; housing; public administration and defence; and other services) relies on the use of metal products. Metal and metal processing may therefore be considered as part of the basis of industrial development. They are included in the "manufacturing industries" sector and form one of its most important parts.

The following tables show clearly that development of the economy is directly related to the manufacturing industry, which includes the machine tool industry. Table 1 shows the distribution of the GNP in the countries of Latin America from 1939 to 1969.

TABLE 1. DISTRIBUTION OF GNP IN THE COUNTRIES OF LATIN AMERICA, 1939 TO 1969

Country	*1939*	*1950*	*1960*	*1965*	*1969*	*Percentage increase 1960–1969*
	(billion dollars)[a]					
Argentina	8.5	11.6	15.7	18.9	21.6	37.4
Brazil	6.3	9.8	18.9	23.5	30.6	62.2
Mexico	5.1	9.9	17.5	24.7	31.8	81.5
Colombia	2.1	3.2	4.9	6.2	7.7	55.2
Chile	1.7	2.6	3.8	4.9	5.7	48.1
Venezuela	1.1	2.5	5.1	6.5	7.6	48.6
Uruguay	1.0	1.4	1.8	1.8	1.9	7.4
Ecuador	0.3	0.7	1.1	1.4	1.7	48.2
Paraguay	0.3	0.3	0.4	0.5	0.6	46.7
Peru	...	1.9	3.1	4.3	4.9	56.1
Guatemala	...	0.7	1.1	1.4	1.7	58.3
El Salvador	...	0.4	0.6	0.9	1.1	62.6
Panama	...	0,3	0.4	0.7	0.9	102.1
Costa Rica	...	0.2	0.5	0.7	0.9	82.0
Bolivia	...	0.5	0.5	0.7	0.9	64.2
Dominican Republic	...	0.4	0.6	0.7	0.9	34.5
Nicaragua	...	0.2	0.4	0.6	0.7	82.3
Honduras	0.2	0.3	0.4	0.5	0.6	58.4
Haiti	...	0.3	0.4	0.4	0.5	13.5
Total	30.1	47.2	77.2	99.3	122.3	57.6

Source: ECLA studies.
[a] At 1960 value.

It is interesting to note, in table 2, that, out of a total of nineteen countries, three alone accounted for about 70 per cent of the total GNP of the region in 1969 and seven for 90 per cent. The relationship of these figures to the development of the manufacturing industries can be seen in tables 3, 4 and 5.

TABLE 2. SHARE IN THE REGIONAL GNP BY COUNTRY, 1939 TO 1969

(Percentage)

Country	*1939*	*1950*	*1960*	*1965*	*1969*
Mexico	17.0	21.1	22.7	24.8	26.1
Brazil	20.9	20.8	24.4	23.7	25.0
Argentina	28.3	24.6	20.3	19.0	17.7
Colombia	7.1	6.7	6.4	6.2	6.3
Venezuela	3.6	5.2	6.6	6.6	6.2
Chile	5.9	5.5	4.9	4.9	4.6
Peru	...	4.0	4.1	4.3	4.0
Uruguay	3.3	3.0	2.3	1.9	1.6
Ecuador	1.2	1.5	1.5	1.5	1.4
Guatemala	...	1.5	1.4	1.4	1.4
El Salvador	...	0.9	0.8	0.9	0.9
Bolivia	...	1.1	0.7	0.7	0.7
Costa Rica	...	0.5	0.6	0.7	0.7
Dominican Republic	...	0.8	0.8	0.7	0.7
Panama	...	0.6	0.6	0.7	0.7
Nicaragua	...	0.5	0.5	0.6	0.6
Honduras	0.6	0.5	0.5	0.5	0.5
Paraguay	1.0	0.7	0.5	0.5	0.5
Haiti	0.7	0.5	0.4	0.4	0.4
	100.0	100.0	100.0	100.0	100.0

Source: ECLA studies.

TABLE 3. GROWTH OF THE REGIONAL GNP BY SECTOR, 1950 TO 1969

(Billion dollars)[a]

Sector	*1950*	*1960*	*1965*	*1969*
Agriculture and fishing	11.1	15.6	19.3	21.2
Mining	1.8	3.4	4.3	5.0
Manufacturing	9.4	16.9	22.4	29.1
Construction	1.7	2.6	3.1	4.4
Electricity, gas, water	0.5	1.0	1.7	2.3
Transport and communications	2.7	4.5	5.8	7.3
Commerce and finance	9.9	16.4	20.8	26 3
Housing	2.5	4.0	5.5	6.4
Public administration and defence	3.6	5.4	6.9	8.3
Other services	4.4	7.5	9.5	11.5
Total	47.6	77.3	99.3	121.8

Source: ECLA studies.

[a] At 1960 value.

TABLE 4. GROWTH OF THE REGIONAL GNP BY SECTOR, 1950 TO 1969
(1960 = 100)

Sector	*1950*	*1965*	*1969*
Agriculture and fishing	70.9	123.5	135.8
Mining	52.9	124.8	147.1
Manufacturing	55.7	132.8	172.6
Construction	64.9	116.3	165.3
Electricity, gas, water	44.2	159.9	223.9
Transport and communications	60.9	129.3	162.7
Commerce and finance	60.2	126.6	160.1
Housing	61.6	137.4	159.8
Public administration and defence	66.4	126.5	155.1
Other services	58.5	127.5	153.6
Total GNP	61.1	128.1	157.6

Source: ECLA studies.

TABLE 5. DEVELOPMENT OF THE MANUFACTURING INDUSTRY IN THE COUNTRIES OF LATIN AMERICA, 1950 TO 1969

(Billion dollars)[a]

Country	*1950*	*1960*	*1965*	*1969*
Argentina	3.42	5.07	6.58	7.62
Brazil	1.79	4.30	5.17	7.45
Mexico	1.87	3.41	4.98	7.06
Chile	0.56	0.89	1.27	1.49
Colombia	0.45	0.85	1.12	1.41
Peru	0.28	0.56	0.86	1.07
Venezuela	0.12	0.55	0.84	0.99
Uruguay	0.24	0.37	0.39	0.42
Ecuador	0.11	0.18	0.24	0.28
Guatemala	0.07	0.11	0.16	0.22
El Salvador	0.05	0.09	0.14	0.18
Costa Rica	0.04	0.08	0.12	0.17
Panama	0.02	0.06	0.10	0.15
Bolivia	0.07	0.06	0.09	0.12
Paraguay	0.06	0.07	0.09	0.12
Dominican Republic	0.04	0.09	0.08	0.11
Honduras	0.02	0.04	0.06	0.09
Nicaragua	0.02	0.04	0.06	0.09
Haiti	0.04	0.05	0.05	0.06
Total	9.27	16.87	22.40	29.10

Source: ECLA studies.
[a] At 1960 value.

Table 4 shows that in 1950 the manufacturing industry with an index of 55.7 was below average (61.1) but increased considerably in 1969.

From an examination of the figures provided in table 5, three groups of countries may be defined: the first group includes three countries (Argentina, Brazil and Mexico), which accounted for 76 per cent, or $22.13 billion, of the manufacturing industry of the region in 1969; the second group, of four countries (Chile, Colombia, Peru and Venezuela), accounted in 1969 for 17 per cent or $4.96 billion; the third group is made up of twelve countries, headed by Uruguay, which accounted for 7 per cent or $2.01 billion of the manufacturing industry of the region in 1969.

World machine tool production and development, 1966 to 1971

The following figures give an indication of the development of the machine tool industry in the world during the years 1966-1971:

	1966	*1967*	*1968*	*1969*	*1970*	*1971*
Billion dollars	5.5	5.9	6.2	6.9	7.8	7.8
Percentage increase		7	5	10	12	0

It can be seen that the figures for world machine tool production are about the same as those for the GNP of, for example, Colombia.

In 1966 the five largest machine tool producing countries, the United States of America, the Union of Soviet Socialist Republics, the Federal Republic of Germany, the United Kingdom of Great Britain and Northern Ireland, and Japan, accounted for more than 75 per cent of total output, their individual shares being 31, 15, 15, 8 and 6 per cent respectively.

In 1967, Japan had the highest growth, passing the 10 per cent mark of world production by an increase of 35 per cent over the previous year. The countries of Western Europe just maintained their position.

In 1968, the United States accounted for 28 per cent and Western Europe for 33 per cent of world production. The share of the USSR and European countries with centrally planned economies amounted to 24 per cent, while that of Japan reached 13 per cent.

In 1969, output in the United States declined to 23.5 per cent, while output in Western Europe climbed to 36 per cent. Output in the USSR and European countries with centrally planned economies increased again and reached 25 per cent of world production.

In 1970, the share of the United States in world production was 18.5 per cent, close to that of the Federal Republic of Germany, 18.9 per cent. Western Europe accounted for 39 per cent, Japan for 14.2 per cent, and the USSR for 13.7 per cent.

In 1971, the United States accounted for only 12.6 per cent, the Federal Republic of Germany increased its share to 23.4 per cent, and Western Europe was responsible for 47.8 per cent of the total.

It can be seen from table 6 that five countries, namely, the Federal Republic of Germany, the United States, Japan, the USSR and the United Kingdom accounted for 71.5 per cent of world machine tool production in 1970. The twelve countries of Western Europe that make up the European Committee for the Co-operation of Machine Tool Industries (CECIMO) accounted for about 41 per cent of world production in the same year.

The share of the countries with centrally planned economies in 1970 was about 24 per cent of the world total, while that of the developing countries was only about 2 per cent.

TABLE 6. WORLD MACHINE TOOL PRODUCTION, 1970 AND 1971

Country	1970				1971 (estimated)			
	Total	Metal-cutting (million dollars)	Metal-forming (million dollars)	Share of world production (percentage)	Total	Metal-cutting (million dollars)	Metal-forming (million dollars)	Share of world production (percentage)
Federal Republic of Germany	1,479.0	1,018.4	460.6	18.9	1,820.0	1,230.0	590.0	23.4
United States	1,443.1	992.9	450.2	18.5	980.0	662.0	318.0	12.6
Japan	1,109.4	867.4	242.0	14.2	912.0	722.0	190.0	11.7
USSR	1,073.0	803.0	270.0	13.7	1,160.0	865.0	295.0	14.9
United Kingdom	476.9	378.5	98.4	6.2	465.0	367.0	98.0	6.0
Italy	433.6	346.9	86.7	5.6	423.0	338.0	85.0	5.4
France	316.5	240.5	76.0	4.1	387.0	273.0	114.0	5.0
German Democratic Republic	252.3	185.7	66.6	3.3	260.0	193.0	67.0	3.3
Czechoslovakia	250.0	210.0	40.0	3.2	275.0	230.0	45.0	3.5
Switzerland	242.0	206.0	36.0	3.1	266.0	226.0	40.0	3.4
Poland	123.0	112.0	11.0	1.6	145.0	132.0	13.0	1.9
Spain	88.6	77.5	11.1	1.0	98.0	83.0	15.0	1.2
Sweden	66.0	43.0	23.0	0.8	79.0	51.0	28.0	1.0
China	53.0	31.0[a]	22.0[a]	0.6	58.0	43.0	15.0	0.9
Hungary	44.7	41.6[a]	3.1[a]	0.5	47.3	44.3	3.0	0.6
Canada	34.9	21.1	13.8	0.4	37.0	22.0	15.0	0.5
Belgium	33.9	16.3	17.6	0.4	37.4	17.7	19.7	0.5

Brazil	33.8	19.6	14.2	0.4	34.4	20.0	14.4	0.4
Argentina	33.4[b]	19.0[b]	14.4[b]	0.4	34.3	19.1	15.2	0.4
India	31.2	29.3	1.9	0.4	45.0	42.5	2.5	0.6
Netherlands	29.7	18.5	11.2	0.4	33.7	21.1	12.6	0.4
Yugoslavia	26.0	22.5	3.5	0.3	36.2	29.0	7.3	0.5
Austria	25.4	11.6	13.8	0.3	28.1	12.9	15.2	0.1
Bulgaria	23.0	21.0	2.0	0.3	26.9	24.6	2.3	0.3
Australia	22.5[c]	6.2[c]	16.3[c]	0.3	23.9	6.8	17.1	0.3
Romania	17.0	15.5	1.5	0.2	22.8	20.8	2.0	0.2
Denmark	14.7	9.1	5.6	0.2	15.3	10.1	5.2	0.2
South Africa	7.2	3.3[c]	3.9[c]		7.0	3.0	4.0	0.1
Mexico	5.0	2.0[a]	3.0[a]		5.0	3.0[a]	2.0[a]	0.1
Turkey	4.9	2.9[a]	2.0[a]		...	...	...	
Portugal	2.8	1.5	1.3	0.5	3.1	1.7	1.4	
Egypt	1.7	0.7[a]	1.0[a]		...	...	...	0.3
Israel	1.3	1.0[a]	0.3[a]		...	...	...	
Chile	0.9	0.5[a]	0.4[a]		...	...	...	
Other countries	1.0	0.6[a]	0.4[a]		...	...	...	
Total world	7,801.4	5,776.6	2.024.8		7,765.5	5,713.6	2,051.9	

Source: Metalworking Production, London, March 1972; and "Role of UNIDO in the promotion of machine tools in developing countries of Europe and the Middle East" (ID/WG.87/29 and Corr. 1).

[a] Rough estimate from fragmentary data.
[b] Does not always agree with data provided by national sources.
[c] Year ended 30 June.

The share of Latin America in world machine tool production

In spite of the fact that more and more developing countries have started to produce machine tools, their share in world production is still very low. For instance, in 1970 it was only about 2 per cent. The share of Latin America is only 0.9 per cent of world production or, in other words, about half of the total machine tool production of all developing countries.

Brazil, with 46.3 per cent of the regional machine tool production, is the largest producer of machine tools in Latin America. Argentina comes second, with 44.4 per cent, and Mexico third, with 6.9 per cent.

Table 7 shows the volume of production of machine tools in the countries of the region in 1970.

TABLE 7. PRODUCTION OF MACHINE TOOLS IN LATIN AMERICA, 1970

Country	*Production (million dollars)*	*Share of regional production (percentage)*	*Share of world production (percentage)*
Brazil	33.8	46.3	0.43
Argentina	32.4[a]	44.4	0.42
Mexico	5.0	6.9	0.064
Chile	0.9	1.2	0.011
Colombia	0.6	0.8	0.006
Other Latin American countries	0.3	0.4	0.003
Total	73.0	100.0	0.934

[a] Does not always agree with data provided by national sources.

In addition to the five countries listed in the table, several other countries of the region are manufacturing machine tools for their own use. This production, however, is very limited.

Imports of machine tools

It can be seen from table 6 that in 1971 five countries, namely, the Federal Republic of Germany, Japan, the USSR, the United Kingdom of Great Britain and Northern Ireland and the United States of America accounted for 68.6 per cent of world machine tool production; the three major machine tool producing countries in Latin America Argentina, Brazil and Mexico accounted for 0.9 per cent. Their consumption, however, was more than three times this amount. Table 8 shows world machine tool trade for 1970 and 1971.

Table 9 shows that while some of the demand is met from local production, both Argentina and Brazil import approximately 50 per cent of their machine tools. Mexico, one of the largest consumers of machine tools in the region, is only now beginning to manufacture them.

Table 10 shows the result of studies carried out recently by ECLA to forecast the machine tool park in the region by 1980. The studies were based on a projection of the GNP, the *per capita* income, and the economically active population, according to the latest information available. Both maximum and minimum hypotheses were established.

TABLE 8. WORLD MACHINE TOOL TRADE, 1970 AND 1971

Country	1970				1971 (estimated)			
	Exports		Imports		Exports		Imports	
	Million dollars	Share of world export (percentage)	Million dollars	Share of world import (percentage)	Million dollars	Share of world export (percentage)	Million dollars	Share of world import (percentage)
Federal Republic of Germany	800.4	30.6	212.5	9.9	920.0	32.7	210.0	9.5
United States	305.1	11.6	131.8	6.1	264.0	9.4	96.0	4.3
United Kingdom	206.2	7.9	134.2	6.2	220.0	7.8	122.0	5.5
Switzerland	198.0	7.6	51.5	2.4	218.0	7.7	40.0	1.8
German Democratic Republic	196.2	7.5	58.5	2.7	202.0	7.2	60.0	2.7
Italy	190.8	7.3	123.8	5.7	179.0	6.3	169.0	7.6
Czechoslovakia	122.0	4.6	66.0	3.1	136.0	4.8	68.0	3.1
France	116.5	4.4	193.3	8.9	133.0	4.7	224.0	10.1
Japan	90.9	3.5	160.6	7.5	100.0	3.5	132.0	6.0
USSR	86.7	3.3	145.5	6.8	96.0	3.4	196.0	8.9
Poland	46.0	1.7	97.0	4.5	57.0	2.0	90.0	4.0
Sweden	44.8	1.7	61.0	2.8	54.0	1.9	78.0	3.5
Belgium	30.5	1.2	36.5	1.7	33.1	1.2	40.3	1.8
Spain	29.5	1.1	56.2	2.6	33.0	1.2	49.0	2.2
Hungary	29.2	1.1	27.0	1.2	28.0	1.0	28.0	1.3
Netherlands	24.1	0.9	44.8	2.1	27.2	1.0	51.1	2.3
Austria	21.5	0.8	28.5	1.3	20.7	0.7	52.7	2.4
Canada	20.4	0.8	143.5	6.7	24.0	0.8	90.0	4.1
Bulgaria	16.0	0.6	31.0	1.4	18.9	0.7	36.3	1.6
Denmark	11.4	0.4	12.7	0.6	12.5	0.4	13.0	0.6

TABLE 8 *(continued)*

Country	1970				1971 (estimated)			
	Exports		Imports		Exports		Imports	
	Million dollars	Share of world export (percentage)	Million dollars	Share of world import (percentage)	Million dollars	Share of world export (percentage)	Million dollars	Share of world import (percentage)
Yugoslavia	5.5	0.2	16.5	0.8	12.0	0.4	25.5	1.1
Romania	5.5	0.2	29.0	1.3	6.5[a]	0.2	34.2[a]	1.5
Brazil	4.6	0.2	34.6	1.6	3.0	0.1	37.7	1.7
India	3.7	0.1	24.0	1.1	4.1	0.1	24.0	1.1
China	3.0	0.1	40.0	1.9	3.0	0.1	32.0	1.4
Australia	2.7[b]	0.1	27.9	1.3	2.9[b]	0.1	39.4[b]	1.8
Argentina	2.0		36.9[c]	1.7	2.1		32.0	1.4
Portugal	1.4		7.6	0.3	1.5		8.5	0.4
South Africa	0.6		43.2[d]	2.0	0.3		53.6[d]	2.4
Mexico	0.1[a]		65.0	3.0	0.1		67.0	3.0
Turkey	–		...				...	
Egypt	–		...				...	
Israel	–		...				...	–
Chile	–		...				...	
Total	2,615.3		2,140.6		2,811.9		2,199.3	

Source: Metalworking Production, London, March 1972.

[a] Rough estimate from fragmentary data.

[b] Year ended 30 June.

[c] Does not always agree with data provided by national sources.

[d] Imports to South Africa include machine tools re-exported.

TABLE 9. PRODUCTION, CONSUMPTION AND TRADE OF MACHINE TOOLS IN LATIN AMERICA, 1968 AND 1970

(Million dollars)

Country	1968				1970			
	Production	Import	Export	Consumption	Production	Import	Export	Consumption
Argentina	22.7[a]	10.0[a]	1.6[a]	31.1[a]	32.4[a]	35.4[a]	2.0[a]	65.8[a]
Brazil	28.3	47.0	2.3	73.0	33.8	33.2	4.6	62.4
Mexico	2.2	43.0		45.2	5.0	62.4		67.3
Bolivia		1.7		1.7		0.6		0.6
Colombia	0.3	4.6		4.9	0.3	12.6	–	12.9
Chile	0.4	12.4		12.8	0.4	6.7	–	7.1
Ecuador		1.0		1.0		1.1		1.1
Peru	0.1	3.2		3.3	0.1	4.0		4.1
Venezuela		11.5		11.5	–	6.1	–	6.1
Others		10.7		10.7		11.0	–	11.0
Total	54.0	145.1	3.9	195.2	72.0	173.1	6.6	238.4

Source: ECLA studies.

[a] Does not always agree with data provided by national sources.

TABLE 10. THE EXISTING MACHINE TOOL PARK IN LATIN AMERICA, AND PROJECTIONS FOR 1980

(Thousand units)

Country	Latest actual figures		Projections for 1980	
	Year	Volume	Minimum	Maximum
Argentina	1969	210.0	340.0	440.0
Brazil	1969	260.0	1,100.0	1.400.0
Mexico	1968	110.0	560.0	610.0
Andean Group	1968	60.0		
Bolivia			3.8	4.8
Colombia	1967	23.0	80.0	110.0
Chile	1968	20.7	135.0	155.0
Ecuador			12.0	15.5
Peru			40.0	49.0
Venezuela	1968	22.0	340.0	420.0
Others			140.0	150.0
Total			2,750.8	3,354.3

Source: ECLA studies.

B. Summaries of country reports

Argentina

The metalworking industry

Metalworking represents a substantial portion of total manufacturing activities in Argentina, as can be seen from the figures for 1969 and 1971:

	1969	*1971*
	(Percentage)	
Share of manufacturing product in GDP	35.26	36.45
Share of metalworking industry product in manufacturing product	31.27	32.05

Total manufacturing output grew in the period 1960–1970 by 72 per cent while metalworking activities increased their volume in the same period by 90 per cent. In 1969, the metalworking industry employed nearly 500,000.

Local demand in the field of electrical and mechanical machinery is marked by a lack of continuity. This is due in part to the important role the Government plays as consumer. Government requirements in heavy equipment so far have not been calculated.

The machine tool industry

The main production, export and import figures for machine tools in recent years, and the local share in total consumption are shown in table 11.

TABLE 11. MACHINE TOOL PRODUCTION, TRADE AND CONSUMPTION IN ARGENTINA 1966 TO 1971

Year	*Production*	*Imports*	*Exports*	*Consumption*	*Share of the regional consumption (percentage)*
		(million dollars)			
1966	11.9	12.7	1.0	22.6	50
1967	7.9	11.3	1.1	18.1	44
1968	11.8	10.5	1.6	20.7	57
1969	17.6	15.6	1.4	31.8	55
1970	21.4	33.1	2.0	52.5	41
1971	22.2	21.2	3.5	39.9	56

Sources: 1966/69 Ministry of Industry and Mining; 1970/71 Dirección General de Fabricaciones Militares (DGFM), "Direct survey".

It can be seen from the table that the local share in total regional consumption struck an exceptionally low level in 1970; however, the upward trend shown for 1971 is expected to lead to a new cycle. Total production increased in the years indicated by 112 per cent and demand increased by 81 per cent, which confirms a slow but steady increase of the local share in total regional consumption.

Structure of the machine tool industry. In 1971, some 94 establishments accounted for a total production of 13,000 tons of machine tools (excluding minor units) worth $25.2 million.

There are three main groups of machine tool manufacturers in Argentina. The first group comprises six large (more than 100 workers) and six small (46–100 workers) enterprises. Together they accounted for 59 per cent of the total weight produced, and 54 per cent of the total production value, in 1971. They use modern equipment (including NC machines), possess adequate technology and produce rather sophisticated machines, which include: copying and automatic lathes, milling and grinding machines, very heavy (up to 60 tons per unit) forming machines, and machines for production and maintenance purposes. A particularly important line is the specially designed automatic machinery (including transfers) for the automotive and consumer goods industries. These firms use their own as well as foreign designs. The major exporting firms–exporting mainly to Latin American Free Trade Association (LAFTA) countries–are included in this group.

The second group comprises 61 medium (20–45 workers) and small (5–19 workers) firms. These accounted for 39 per cent of the tonnage produced and 44 per cent of the total production value in 1971. They produce, in general, universal type machinery directed to an important sector of local and LAFTA areas. Most of them require technical and financial assistance in order to improve their productive and organizational systems, technical quality and designs. An industrial estate is currently being developed with the co-operation of an important group of these firms. This project is being assisted through a UNIDO programme of technical, administrative and marketing assistance.

The third group comprises 21 very small enterprises (less than 5 workers each). They manufacture, in general, models that would be obsolete elsewhere, using antiquated techniques and equipment. They operate with great economic difficulty and have limited resources and prospects.

Total work force. Table 12 shows the composition of the personnel employed in the machine tool industry in 1971.

TABLE 12. PERSONNEL EMPLOYED IN THE MACHINE TOOL INDUSTRY IN ARGENTINA, 1971

Size of enterprise	*Number of enterprises*	*Direct labour*	*Technicians and engineers*	*Administrative personnel*	*Total*
More than 45 employees	12	938	111	177	1,226
20–45 employees	20	540	45	63	648
5–19 employees	41	419	45	84	548
Total	73	1,897	201	324	2,422

Source: DGFM, "Direct survey".

The largest enterprise has a total of 210 employees, of which 130 are direct workers. Enterprises with less than five employees have not been included in the table.

The distribution of machine tool manufacturing enterprises in 1971 was as follows:

	Number of enterprises	*Percentage*
Capital federal (Buenos Aires)	16	17
Great Buenos Aires	45	48
San Francisco (Córdoba)	21	22
Rosario (Santa Fé)	5	6
Santa Fé (Provincia)	2	2
Córdoba (Capital)	3	3
Provincia de Buenos Aires	2	2
Total	94	100

Source: DGFM. "Direct survey".

Ancillary industries. The ancillary industries have developed considerably in the past decade. Parts and components for electrical equipment, hydraulic and pneumatic controls, fluid gates and systems are designed and produced locally. The manufacture of machine tool accessories, such as chucks and dividing heads, has also increased, but more technical assistance is needed in this area.

Local production of machine tools. Table 13 shows the distribution of the total local production of machine tools in 1971, divided into two groups, metal-cutting and metal-forming.

Exports. Machine tool exports in 1971 amounted to 15 per cent of total production, which is very high in comparison with the export figures for other metalworking industries in the country. Of the exports, 63 per cent went to the Andean Group; the remaining 37 per cent was exported to other LAFTA countries and overseas.

Exports grew from $1.4 million in 1969 to $3.5 million in 1971, and the upward trend is expected to continue.

Projected demand for 1980. Total demand projected for 1980 is 454,000 machine tools, worth $90 million. This figure is based on a projection of added value of the metalworking industries related to machine tool requirements through the productivity index and the number of machine tools per 100 employees.

Assuming an annual increase of 7 per cent in the added value, the following figures are obtained for 1980:

Total labour employed in the metalworking industries	810,000
Machine tools per 100 employees	55.4
Stock of machine tools (units)	454,000

Bolivia

The metalworking industry

The share of the metalworking industry in total manufacturing industry in Bolivia for the years 1967 and 1968 is shown in table 14.

TABLE 13. MACHINE TOOL PRODUCTION IN ARGENTINA, 1971

	Units		Weight			Value	
	Number	Share of total (percentage)	Tons	Share of total (percentage)	Number of enterprises[a]	Thousand dollars	Share of total (percentage)
Metal-cutting							
Lathes (parallel capstan automatic)	2,003	14.6	2,650	20.4	22	5,486	26.3
Milling machines (vertical, universal production)	345	2.5	526	4.1	12	1,623	7.2
Drilling machines (vertical, radial)	6,508	47.4	873	6.7	21	1,875	8.4
Boring machines (production and maintenance)	31	0.2	97	0.8	3	276	1.1
Grinding machines (plain, parallel centreless)	445	3.1	639	5.0	11	1,693	7.5
Special machines (production and transfer)	41	0.3	240	1.8	5	840	3.7
Shapers	373	2.6	434	3.4	8	653	2.9
Others (saws, broaching and honing machines, planers etc.)	738	5.3	359	2.8	19	792	3.5
Total	10,484	76.0	5,818	45.0	68	13,238	60.6
Metal-forming							
Hydraulic presses	879	6.4	1,236	9.6	15	1,971	8.7
Excentric presses	328	2.4	977	7.5	8	1,090	4.8
Shearing and punching machines	1,678	12.0	699	0.8	4	195	0.9
Brake presses and guillotines	440	3.2	4,224	37.1	8	5,665	25.0
Total	3,325	24.0	7,136	55.0	35	8,921	39.4
Total metal-cutting and metal-forming	13,809	100.0	12,954	100.0	94	22,159	100.0

Source: DGFM, "Direct survey".

[a]Several manufacturers produce more than one type of machine.

TABLE 14. THE METALWORKING INDUSTRY IN BOLIVIA, 1967 AND 1968

	1967		1968	
	Number of enterprises	*Production (million dollars)*	*Number of enterprises*	*Production (million dollars)*
Total industry	1,193	86.50	1,141	1,001.0
Total metalworking	61	2.29	52	2.73
Basic metal	9	0.15	6	0.57
Metal products and machinery	26	1.44	30	1.83
Electrical	10	0.28	5	0.26
Transport	16	0.42	11	0.07

Source: ECLA studies.

The figures show that:

(a) The total number of enterprises in the metalworking industry decreased by 15 per cent, but production increased by 20 per cent;

(b) In the basic metal industry, the number of enterprises decreased by 33 per cent, whereas production increased by 28 per cent;

(c) In metal products and machinery there was no significant change;

(d) In the electrical industry there was a strong tendency for consolidation and a slight decline in production;

(e) Transport appeared to drop, but in this area there is a lack of up-to-date production statistics. A plant for the manufacture of bus and truck bodies has been in operation since 1967.

Most industrial enterprises in Bolivia are small and burdened with the problems of shortage of capital and obsolete know-how and machinery. As they all compete in the same local market, without any degree of specialization, they are unable to lower their excessive manufacturing costs. Imports are practically unrestricted and as there is no basic Government protection for local industries, they cannot compete with international manufacturers.

The machine tool industry

Bolivia has no machine tool industry at present. However, one of its responsibilities as a member of the Andean Group is to plan a central tool manufacturing unit. The aim is to manufacture certain machines, tools and accessories that are not yet being produced in the countries of the Andean Group. Table 15 shows some of the products to be manufactured, the subregional demand for these products in 1967, the projected demands for 1972 and 1980, the estimated value of production in 1980, and the proportion of demand to be met by the subregion in that year.

The establishment of the central manufacturing unit will have a great impact on machine tool imports. Table 16 shows the number of machine tools imported in 1960 and 1970 and the import estimates for 1980. Owing to a lack of statistical information, the figures are based on data obtained from national and privately owned enterprises using machine tools in their operations.

TABLE 15. PLAN FOR A CENTRAL TOOL MANUFACTURING UNIT IN BOLIVIA

Product	Subregional demand in 1967[a]	Projected demand for 1972[b] (million dollars)	Projected demand for 1980[b] (million dollars)	Estimated value of production in 1980[b] (million dollars)	Share of demand to be met by subregion in 1980 (percentage)
Pneumatic tools	0.5	0.77	1.68	1.18	20
Tapping tools	0.9	1.47	3.8	2.66	70
Sintered plates, rods etc.	0.1	0.15	0.39	0.8	20
Radial drilling machines and tapping machines	0.25	0.69	4.52	0.9	20
Sawing machines	0.3	0.56	1.8	0.36	20

Source: Data from document JUN/PROPUESTA 26 and Decision No. 57 of the Board of the Cartagena Agreement.

[a] At 1967 prices.

[b] At 1970 prices.

TABLE 16. MACHINE TOOL IMPORTS IN BOLIVIA, 1960, 1970 AND PROJECTIONS FOR 1980

Type	Number of machine tools imported 1960	Number of machine tools imported 1970	Import estimates 1980
Milling machines	3	5	20
Drilling machines	20	30	50
Lathes	20	30	130
Grinders	7	10	20
Presses	3	4	20
Metal-sawing machines	15	20	–
Electric welding sets	28	40	90
Total	96	139	330

Source: "Report on the situation in the machine tool industry in Bolivia" (ID/WG.113/22).

It is expected that by 1980 Bolivia will be producing sufficient machine tools to cover local demand and to export–mainly to the Andean Group countries. The following table gives a projection of machine tool production and exports for 1980.

	Produced	Exported
Radial drilling machines	150	140
Metal-sawing machines (circular saws, band saws and jigsaws)	700	650

The stock of machine tools. No census of the machine tool park in Bolivia has yet been made, but table 17 shows the estimated stock of machine tools in 1960 and 1970 with projections for 1980.

TABLE 17. THE MACHINE TOOL PARK IN BOLIVIA, 1960, 1970 AND PROJECTIONS FOR 1980
(Units)

Type	*1960*	*1970*	*1980*
Milling machines	40	70	130
Drilling machines	110	250	450
Lathes	160	360	800
Grinders	30	50	120
Presses	25	60	110
Metal-sawing machines	60	100	300
Electric welding sets	130	230	600
Total	555	1,120	2,510

Source: "Report on the situation in the machine tool industry in Bolivia" (ID/WG.113/22).

Brazil

The metalworking industry

Industrial production in Brazil in 1970 was valued at $9.3 billion, of which the metalworking industry accounted for $5.25 billion or 66 per cent. The importance of the metalworking industry to the Brazilian economy is apparent from the figures given in tables 18 and 19. Table 18 shows the position of the metalworking industry in relation to the GNP in 1970. The importance of the transport equipment, which accounted for 42 per cent of the total metalworking industry, is clearly seen from this table. Table 19 shows the projected development of the metalworking industry from 1968 to 1980. The volume of production of the machine tool industry in 1968, $28.3 million, accounted for only:

0.5 per cent of the metalworking industry;

0.38 per cent of total industrial output;

0.087 per cent of the total GNP.

TABLE 18. THE METALWORKING INDUSTRY IN BRAZIL IN RELATION TO GNP, 1970

	Amount (billion dollars)	*Proportion of GNP (percentage)*	*Proportion of metalworking industry (percentage)*
GNP	32.5	100.0	
Industrial production	9.3	28.0	
Metalworking industry	5.25	16.2	100.0
Metal products	0.94		18.0
Non-electrical machinery	0.84		15.5
Electrical machinery and equipment	1.23		23.5
Transport equipment	2.19		42.0
Other	0.05		1.0

Source: ECLA studies.

TABLE 19. PROJECTED DEVELOPMENT OF THE METALWORKING INDUSTRY IN BRAZIL, 1968 TO 1980

	Production (percentage)	*Locally added value (percentage)*	*Increase of added value (percentage)*	*Machine tool park (thousand units)*	*Labour (thousands)*
			Metal products		
1968	100	100	100	...	...
1971	134	61	131.8	69.6	165.7
1975	198	60	188.5	91.6	218.1
1980	170	59	257.4	122.7	263.1
			Non-electrical machinery		
1968	100	100	100	...	...
1971	144	61	142.7	70.7	152.0
1975	212	59	202.1	92.3	198.5
1980	285	56	275.2	131.3	255.3
			Electrical machinery and equipment		
1968	100	100	100	...	...
1971	136	57	134.7	75.0	167.1
1975	192	56	185.7	96.5	208.0
1980	285	56	275.2	131.3	255.3
			Transport equipment		
1968	100	100	100	...	...
1971	137	47	137	90.9	227.3
1975	192	48	205	114.9	294.6
1980	285	48	302	147.2	368.0

Source: Institute for Economic and Social Planning (IPEA) studies.

The metalworking industry is expected to have an approximate growth rate of 300 per cent to 1980; metal products will have the lowest share in this sector.

The locally added value will increase at a steady rate and the transport industry will continue to maintain its key role. The electrical industry is expected to be the most machine tool intensive industry, with 51.4 machines per 100 workers in 1980, while the transport industry will be the least machine tool intensive, with 40 machines per 100 workers. (The machine tools used in the transport industry are much more sophisticated and represent a much heavier investment than those used in the electrical industry.)

The role of the State of São Paulo. Most of Brazil's metalworking industry is concentrated in the State of São Paulo. The share of the State in over-all production is:

	Percentage
Metal products	62
Non-electrical machinery	77
Electrical machinery	92
Transport equipment	87

The automotive industry has the highest percentage within metalworking, with 100 per cent, and the shipbuilding industry the lowest, with 3.3 per cent.

The machine tool industry

Originally, the Brazilian machine tool industry was established in the immediate vicinity of the metalworking and mechanical engineering industries, which are heavily concentrated in the State of São Paulo. However, the rapid development of this area, the consequent increase in the cost of land, and the need to expand existing plants has made it preferable to set up new enterprises in more remote areas.

The distribution of machine tool manufacturing enterprises in 1969 is shown below.

	Number of enterprises	*Percentage*
City of São Paulo	43	51.8
Outskirts of São Paulo	13	15.7
State of São Paulo	17	20.5
State of Santa Catarina	1	1.2
State of Rio Grande do Sul	5	6.0
State of Guanabara	4	4.8
Total	83	100.0

Source: "The machine tool industry in Brazil", 1970, IPEA.

Thirteen of these enterprises, large, well equipped, financially sound, with modern production facilities, account for 90 per cent of Brazil's machine tool exports.

The others, medium to small manufacturers, supply the local market with less sophisticated machinery that is not competitive on the world market.

One enterprise employs more than 500 workers, 12 enterprises employ between 100 and 500, and 12 more employ between 50 and 100. The majority (65 per cent) of the manufacturers produce metal-cutting machine tools such as lathes, milling, drilling, sawing, surface grinding, tool and cutter grinding machines. The remaining enterprises manufacture metal-forming tools such as presses, shears and bending machines.

Table 20 gives the production figures, divided into metal-cutting and metal-forming machine tools, for the years 1966 to 1970.

TABLE 20. MACHINE TOOL PRODUCTION AND TRADE IN BRAZIL, 1966 TO 1970

	1966	*1967*	*1968*	*1969*	*1970*
	Million dollars				
Production	32.0	47.5	28.3	21.6	22.4
Metal-cutting	...	...	...	12.7	13.2
Metal-forming	...	...	...	8.9	9.2
Exports	2.5	2.4	2.3	2.5	3.0
Imports	20.7	23.8	50.0	46.8	48.0
Proportion of consumption covered by:	*Percentage*				
Production	59	66	34	29	29
Imports	41	34	66	71	71

The machine tool consumption, from 1963 to 1968, broken down by type and units, is shown in table 21.

TABLE 21. MACHINE TOOL CONSUMPTION IN BRAZIL, 1963 TO 1968

(Units)

	1963	*1964*	*1965*	*1966*	*1967*	*1968*
Lathes						
Production	5,156	4,579	4,672	5,693	4,992	5,250
Imports	422	255	250	205	257	254
Consumption	5,578	4,834	4,922	5,898	5,249	5,504
Milling machines						
Production	322	369	177	255	215	263
Imports	351	235	183	251	329	578
Consumption	673	604	360	506	544	841
Drilling machines						
Production	3,569	3,818	2,699	3,224	3,154	4,454
Imports	269	157	154	213	216	435
Consumption	3,838	3,975	2,853	3,437	3,370	4,889
Grinding machines						
Production	86	101	100	159	124	167
Imports	480	287	248	301	392	548
Consumption	566	388	348	460	516	715
Other machines						
Production	4,169	5,005	4,003	4,358	3,622	5,033
Imports	1,051	365	459	710	820	1,333
Consumption	5,220	5,370	4,462	5,068	4,442	6,366
Total production	*13,302*	*13,872*	*11,651*	*13,689*	*12,107*	*15,167*
Total imports	*2,573*	*1,299*	*1,294*	*1,680*	*2,014*	*3,148*
Total consumption	*15,875*	*15,171*	*12,945*	*15,369*	*14,121*	*18,315*

Source: IPEA studies.

A comparison of unit and value figures (tables 20 and 21) shows that:

(a) Local industry still concentrates on the production of low-cost, low-technology products, which can fulfil the basic requirements of small-scale industry;

(b) Imported machinery, meeting more sophisticated industrial requirements, accounted in 1968 for 66 per cent of the value, but only 17 per cent of the number of units;

(c) For some machines, such as lathes and drilling machines, local production has reached an optimum stage and imports are restricted to cases where local manufacture is not economically viable and/or the required know-how is not available;

(d) For other machines, such as milling and grinding machines, though the local requirement of units is much lower, there is room for considerable improvement in local manufacture.

Projected demand for machine tools. Based on projections made for the metalworking industry and the distribution by types of machine for 1980, the machine tool park will develop as follows:

Thousands of units

	1971	*1975*	*1980*
Metal-cutting machine tools	236.1	302.4	390.2
Metal-forming machine tools	70.1	92.2	123.2
	306.2	394.6	513.4
Repairs (10 per cent allowance)	30.6	39.5	51.3
Total	336.8	434.1	564.7

The figures given below show the anticipated annual demand for the period 1969–1980. The figures are based on the increase of the machine tool park, plus a ten per cent replacement rate per annum. An average lifetime of 10 years is assumed.

Thousands of units

	1969–1971	*1972–1975*	*1976–1980*
Metal-cutting machine tools	23.5	24.2	24.5
Metal-forming machine tools	6.2	8.0	8.6
Total	29.7	32.2	33.1

The over-all demand for machine tools increases year by year, but the demand for some technologies drops, while that for others increases. For example, there is an increasing demand for sophisticated machines designed for advanced technology. These include: milling, boring, thread-milling, gear-cutting, and grinding machines. It should be noted that the estimated consumption is for the home market only.

Meeting local demand. The objective of Brazilian industry is to continue the technological development of its machine tool sector to the point where imports of machine tools can be restricted to those for which local manufacture is not economically viable. Before this point can be reached, however, two steps have to be taken. They are:

(a) The restructuring of the machine tool industry. This entails the enlargement of individual enterprises; improvement in the quality of the products and of the raw materials; and an increase in productivity per head and per machine installed capacity;

(b) Entering into the field of advanced technologies. This can be accomplished by a progression through the stages of hand-operated conventional machines, semi-automatic machines, conventional fully automatic machines and transfer-lines, machining centres and NC.

Government actions designed to expand the machine tool industry. The Government promotes all measures designed to ensure a supply of machine tools of the latest design to meet the increasing requirements of industry.

The Research Institute of Technology of the University of São Paulo was established for the following purposes:

(a) To co-ordinate a survey of the technical performance and standards of imported machine tools;

(b) To make recommendations to industry on methods of solving manufacturing problems, and to advise on the machine tools required for specific purposes;

(c) To design and construct machine tool prototypes, either at the request of local manufacturers or on its own initiative, and to offer the results to industry;

(d) To develop standards for the manufacture and testing of machine tools with regard to the design and disposition of the operating elements, in co-operation with international standardization agencies.

The Government has also introduced an incentive programme for the expansion of the industry. This programme is set up in such a way that only economically sound and technically feasible projects can benefit from it, thus encouraging the establishment of machine tool operations which conform to the technological requirements of the metalworking industry. Similar incentive programmes are planned to encourage exports of machine tools.

Chile

The metalworking industry

In 1970, the share of the Chilean metalworking industry in total industrial production was 22 per cent. Metalworking is the fastest growing industry in the country, with a growth rate more than two times greater than that of the rest of industry. While the growth in metal products and electrical machinery sectors maintains a steady pace, however, the mechanical machinery sector is lagging far behind. Most of the growth is concentrated in the automotive sector.

Table 22 shows the development of the metalworking industry from 1965 to 1970.

TABLE 22. DEVELOPMENT OF THE CHILEAN METALWORKING INDUSTRY, 1965 TO 1970

	1965	*1968*	*1970*	*Percentage increase 1965–1970*
	(million dollars)			
Metal products	69	90	91	32
Mechanical machinery	39	44	43	10
Electrical machinery	54	76	77	39
Transport equipment	80	110	128	60
Total metalworking	242	320	339	40
Total industry	1,264	1,441	1,500	19

Source: ECLA studies.

The structure of the industry, in terms of enterprises and manpower, in 1970, is shown below.

	Number of enterprises	*Number of employees*
Metal products	366	15,500
Mechanical machinery	186	6,100
Electrical machinery	48	9,900
Transport equipment	207	14,400
Total	807	45,900

The machine tool industry

The Chilean machine tool industry came into being shortly after the Second World War when, as a result of difficulty encountered in importing machine tools, many small firms began to manufacture a limited range of them. In the course of the years, competition forced some of these firms either to cease production or to merge with other plants. There are now twelve main manufacturers of machine tools in Chile and a large new enterprise is planned. This plant will have a manufacturing programme of, initially, about 200 lathes per annum for local consumption, a number of better-quality lathes for export and about 100 milling machines (universal production types) for local consumption.

Table 23 shows the consumption and local production of machine tools in 1960, 1970 and projected demand and production for 1980, by type of product. It will be seen from this table that the demand for machine tools cannot be met by local production.

TABLE 23. MACHINE TOOL CONSUMPTION AND PRODUCTION IN CHILE, 1960, 1970 AND ESTIMATES FOR 1980

(Units)

	1960		*1970*		*1980*	
	Consumption	*Production*	*Consumption*	*Production*	*Consumption*	*Production*
Milling machines	788	33	1,692	40	3,193	600
Drilling machines	2,859	520	5,711	940	10,111	1,800
Lathes	2,779	950	3,350	500	5,905	5,000
Grinding machines	1,001	-	1,994	-	3,512	50
Presses	3,684	430	7,433	790	13,304	3,150
Miscellaneous	2,532	446	6,376	850	13,517	4,000
Total	13,643	2,379	26,556	3,120	49,542	14,600

Source: "Report on the machine tool industry in Chile" (ID/WG.113/21).

Table 24 shows the number of machine tools imported in 1960 and 1970 and the import estimates for 1980, by type of product.

TABLE 24. MACHINE TOOL IMPORTS IN CHILE, 1960, 1970 AND ESTIMATES FOR 1980

(Units)

	1960	*1970*	*1980*
Milling machines	755	1,652	2,593
Drilling machines	2,339	4,771	8,311
Lathes	1,829	2,850	905
Grinding machines	1,001	1,994	3,462
Presses	3,254	6,643	10,154
Miscellaneous	2,086	5,526	9,517
Total	11,264	23,436	34,942

Source: "Report on the machine tool industry in Chile" (ID/WG.113/21).

The stock of machine tools. Table 25 shows the result of a census of machine tools carried out in Chile in 1965.

TABLE 25. THE MACHINE TOOL PARK IN CHILE, 1965

Type	*Age group*			*Total*
	Under 10 years	*10 to 20 years*	*Over 20 years*	
Milling machines	234	146	289	669
Drilling machines	1,436	890	669	2,995
Lathes	1,569	1,270	1,240	4,079
Grinding machines	366	116	124	606
Presses	971	688	680	2,339
Planing	247	238	358	843
Thread milling	141	126	121	388
Sawing	499	302	169	970
Cutting, bending	924	597	598	2,119
Miscellaneous	3,831	1,397	640	5,868
Total	10,218	5,770	4,888	20,876

Source: "National inventory of machine tools", 1965.

Dividing these figures into industrial groups, the distribution is as follows, in percentages:

Industrial group	*Under 10 years*	*10 to 20 years*	*Over 20 years*
Basic metal	48.2	26.6	36.8
Metal products	47.8	32.0	20.2
Machinery	47.7	28.1	24.2
Electrical machinery	62.9	22.9	7.9
Transport equipment	48.2	23.1	28.7

The electrical industry is the newest and therefore the best equipped as far as the age of its machine tools is concerned, while the basic metal industry is the most conservative.

The estimated stock of machine tools in 1970 and projections for 1980 are shown below:

	1970	*1980*
Milling machines	2,573	5,766
Drilling machines	10,700	20,811
Lathes	7,795	13,700
Grinding machines	3,609	7,121
Presses	12,872	26,176
Miscellaneous, including machines for planing, thread milling, sawing, cutting and bending	10,928	24,445
Total	48,477	98,019

Source: "Report on the machine tool industry in Chile" (ID/WG.113/21).

Colombia

The metalworking industry

The share of the metalworking industry in the total industrial production of Colombia in 1968 was 10.9 per cent, representing a value of $123.6 million, as shown in table 26.

TABLE 26. SHARE OF THE METALWORKING INDUSTRY IN TOTAL MANUFACTURING INDUSTRY IN COLOMBIA, 1968

	Gross industrial output	*Value added*	*Share of value added (percentage)*
		(million dollars)	
Metal products	112.0	54.7	4.8
Machinery, excluding electrical	23.7	12.7	1.1
Electrical machinery	76.0	32.8	2.9
Transport equipment	62.5	23.4	2.1
Total metalworking	274.2	123.6	10.9
Total industry	2,860.0	1,030.0	100

Table 27 shows the total number of industrial enterprises, the number of enterprises engaged in metalworking and the distribution by size (number of employees) of the enterprises in 1970.

TABLE 27. DISTRIBUTION OF METALWORKING ENTERPRISES IN COLOMBIA, 1970

(Units)

	Employees						
	1–9	*10–24*	*25–49*	*50–100*	*101–200*	*Over 200*	*Total*
Metal products	315	217	95	86	24	15	752
Machinery, excluding electrical	113	84	20	11	5	6	239
Electrical machinery	104	62	38	25	10	10	249
Transport equipment	368	140	39	24	9	10	590
Total metalworking	900	503	192	146	48	41	1,830
Total industry	6,886	2,222	882	528	278	240	11,036

Source: Colombian industrial census, 1968.

As the steel production and foundry capacity of Colombia are underutilized, raw material for metalworking is comparatively highly priced. However, although the growth of the metalworking industry has been slow, a corps of well-qualified personnel has been developed, which makes an excellent basis for future growth.

The Colombian Metallurgical Federation (FEDEMETAL) is setting up a technological development centre to help stimulate the metalworking industries. UNIDO is assisting in the establishment of this centre, which will feature an industrial information unit, fed by internaticnal sources, and an industrial design unit. The centre will provide technical assistance in specialized fields.

The machine tool industry

There are few machine tool manufacturers in Colombia. Most of them concentrate on the production of basic machinery for general work. A few large factories producing finished products have fairly complete repair and maintenance workshops that use imported machine tools.

There are no Government incentives for manufacturers of machine tools. They are obliged to pay the same taxes, customs duties etc. on the raw materials and mechanical appliances they import as the importers of complete machine tools.

Accurate production figures are not available, but estimates for the production of machine tools for the five-year period 1966–1970 are:

	Units
Cutting machines	1,410
Forming machines	580
Total	1,990

This gives an average annual production of 400 units. Imports of machine tools during the period 1967–1969 amounted to:

	Units	*Value (million dollars)*
Cutting machines	3,292	7.2
Forming machines	671	3.1
Total	3,963	10.3

No census of machine tools has been made recently in the country, but the National Department of Planning is beginning a census in the Bogotá area and FEDEMETAL intends to survey the whole country.

An evaluation of the size of the machine tool park, based on the very slow growth of the user industries during the years 1967–1969, leads to the conclusion that all of the machine tools produced locally or imported during that period have been used as replacements. The estimated consumption for 1970 was:

	Imports	*Production*	*Consumption*
Cutting machines	1,100	300	1,400
Forming machines	220	120	340
Total	1,320	420	1,740

The existing machine tool park is estimated as:

	Units
Cutting machines	18,000
Forming machines	4,500
Total	22,500

Ecuador

The metalworking industry

Industrial production in Ecuador in 1969 was valued at $324 million, of which the metalworking industry accounted for $16.6 million, or 5.1 per cent.

Table 28 shows the position of the metalworking industry, classified by industrial branch, in relation to the total manufacturing industry in 1969:

TABLE 28. THE METALWORKING INDUSTRY IN ECUADOR, 1969

	Production (million dollars)	*Share of total manufacturing industry (percentage)*	*Share of metalworking industry (percentage)*
Total manufacturing industry	324.0	100.0	
Metalworking industry	16.6	5.1	100.0
Metal products	9.6		57.7
Machinery	0.065		0.4
Electrical machinery	5.3		31.7
Transport equipment	1.7		10.2

Source: Industrial surveys prepared by the Government's National Office for Planning (Industries section).

Table 29 shows the number of employees and manufacturers in the metalworking industry in 1969, in relation to total manufacturing industry, broken down by industrial group.

TABLE 30. MACHINE TOOL IMPORTS
T = tons; V = cif value,

	1960		*1961*		*1962*		*1963*	
	T	*V*	*T*	*V*	*T*	*V*	*T*	*V*
Grinding machines	2.6	6.1	2.0	4.9	1.4	4.3	1.4	2.1
Planing and shaping machines	0.9	1.9	0.8	1.5	0.5	1.3	0.6	1.3
Milling (copying) machines	2.7	12.8	2.1	10.4	1.5	9.2	4.5	8.6
Drilling and boring machines etc.	1.7	6.8	1.3	5.5	0.9	4.8	3.3	21.9
Lathes	14.4	41.2	11.1	33.4	8.0	29.4	24.1	66.2
Sawing machines	0.4	1.1	0.3	0.9	0.2	0.8	0.7	1.3
Other machine tools[a]	52.0	97.1	40.3	78.5	29.1	69.1	46.5	145.3
Subtotal	74.7	166.9	57.9	135.1	41.6	118.9	81.1	246.7
Presses and hammers	1.9	9.9	1.5	8.0	25.8	62.0	5.0	13.3
Total machine tools	76.6	176.8	59.4	143.1	67.4	180.9	86.1	260.0
Components and parts of machinery	26.1	48.5	20.2	39.3	14.5	34.6	23.3	72.7
Grand total	102.7	225.3	79.6	182.4	81.9	215.5	109.4	332.7
$V_W = \frac{\text{dollars}}{\text{kg}}$	2.19		2.29		2.63		3.03	

Source: Foreign trade yearbooks prepared by the National Office for Planning (Industries section).

[a] Including non-universal machine tools (used for a specific function, for example, in the transfer

TABLE 29. PERSONS EMPLOYED AND MANUFACTURING ESTABLISHMENTS IN THE METALWORKING INDUSTRY IN ECUADOR, 1969

	Number	*Share of manufacturing industry (percentage)*	*Share of total metalworking industry (percentage)*	*Number*	*Share of manufacturing industry (percentage)*	*Share of metalworking industry (percentage)*
Metal products	1,766		59.9	45		63.4
Machinery	97		3.3	2		2.8
Electrical machinery	733		24.8	16		22.5
Transport equipment	355		12.0	8		11.3
Total metalworking industry	2,951	6.6	100.0	71	8.4	100.0
Total manufacturing	44,821	100		864	100	

Source: Industrial statistics prepared by the Government's National Office for Planning (Industries section).

The machine tool industry

There is no large-scale production of machine tools in Ecuador. Some small industries produce light machine tools (shearing, sawing, drilling and punching machines) for their own use or as experimental lines. Sawing machines and small lathes are produced in technical training establishments (primarily by copying other models) for vocational training purposes. There is also a group of metalworking and mechanical engineering enterprises which rebuild and maintain machinery in general, including machine tools.

IN ECUADOR, 1960 TO 1969
thousands of dollars)

1964		*1965*		*1966*		*1967*		*1968*		*1969*	
T	*V*	*T*	*V*	*T*	*V*	*T*	*V*	*T*	*V*	*T*	*V*
13.6	26.2	2.0	9.2	2.4	4.8	0.5	1.8	0.4	3.2	3.3	5.8
4.8	7.7	1.9	3.0	6.9	10.4	11.2	18.6	18.2	25.2	7.1	10.1
11.6	52.5	4.5	7.8	24.9	40.3	4.6	16.1	12.8	20.7	13.5	29.3
6.4	10.3	12.1	27.0	7.4	25.9	9.0	17.2	28.6	90.0	6.5	19.0
60.1	128.5	61.4	113.9	31.2	43.6	60.1	123.4	74.0	102.6	96.4	186.8
1.5	3.7	2.0	3.9	2.1	3.7	2.1	5.6	3.1	10.0	2.4	3.1
136.1	289.8	116.5	239.5	143.7	414.1	142.7	442.1	139.7	391.5	115.7	379.6
234.1	518.7	200.4	404.3	218.6	542.8	230.2	624.8	276.8	643.2	244.9	633.7
6.2	33.4	35.5	56.6	85.4	104.7	50.6	85.9	27.2	45.4	24.0	60.1
240.3	552.1	235.9	460.9	304.0	647.5	280.8	710.7	304.0	688.6	268.9	693.8
71.5	162.0	89.6	188.4	75.2	225.8	74.3	241.2	91.0	279.0	60.7	230.9
311.8	714.1	325.5	649.3	379.2	873.3	355.1	951.9	395.0	967.6	329.6	924.7
2.29		1.99		1.96		2.68		2.45		2.81	

machine industry), and also shearing, bending, broaching, drilling, punching and other unspecified machines.

Ecuador imports 99 per cent of its machine tools. In the past decade, imports totalled some 2,470 tons (including parts and components) or $6 million. Table 30 shows the weight (in tons) and the value (in thousands of dollars, cif) of machine tools imported in the period 1960–1969, by type of machine.

Evaluation of the machine tool park. The estimated volume of the machine tool park in Ecuador in 1969 was 1,792 units. This was determined on the basis of the weight and value of imports for the period 1960–1969 (table 30) and the average weight and value by type of machine.

The following projections for future demands of machine tools are based on the current trend in machine tool imports and metalworking and mechanical engineering production.

	Imported	*Manufactured locally*	*Exported*	*Total*
1970–1974	1,410	110		1,520
1975–1980	4,310	1,000	110	5,200

Thus, the average annual consumption of machine tools in the period 1970–1974 will be 304, and in the following six-year period, 866. According to the National Office for Planning the number of machine tools in Ecuador should be: 1,792 for 1969, 3,312 for 1974 and 8,512 for 1980.

Mexico

Industrial development

The average annual economic growth rate in Mexico in the past decade was 7 per cent; that of the manufacturing sector was 8.6 per cent. Mechanical engineering showed the greatest advance, with 16 per cent a year during the period, as opposed to 8.9 per cent during the preceding decade. The transport equipment basically automotive industry (annual growth rate, 14 per cent), the chemical products industry and the basic metal industries followed. Traditional industries, such as textiles, clothing and footwear, showed slower growth rates (5–6 per cent).

Thus, since 1960 Mexico has achieved accelerated production of capital goods. Whereas in 1960, 70 per cent of these goods were imported, the figure now stands at 59 per cent.

The metalworking industry

Table 31 shows the size and development of selected metalworking industries, the number of plants and employees, and the production volume, in 1966 and 1968.

TABLE 31. THE METALWORKING INDUSTRY IN MEXICO, 1966 AND 1968

	Number of plants		*Labour (thousands)*		*Production volume (million dollars)*	
	1966	*1968*	*1966*	*1968*	*1966*	*1968*
Automotive	15	16	16.6	20.8	386	485
Foundry	23	28	9.4	12.7	270	305
Lamination	40	41	23.1	21.2	400	457
Aluminium	9	9	2.7	2.7	42	45

The industrial output of selected products in 1964 and 1969 and the percentage increase were:

	1964	*1969*	*Percentage increase*
	(thousand tons)		
Steel ingots	2,320	3,425	48
	(thousand units)		
Trucks	36	49	36
Tractors	--	5.8	--
Cars	61	114	86
Radio sets	956	1,150	20
Television sets	209	413	100

The machine tool industry

The manufacture of machine tools in Mexico began in 1959 in a stamping press factory. Today there are 17 enterprises engaged in the production of metalworking and woodworking machine tools. Soon, a new plant will start the production of engine lathes and milling machines of different specifications. At a later stage other lines of machine tools (turret and automatic lathes, surface and cylindrical grinders, boring machines and special-purpose machines) will be added.

The machine tool industry benefits from the tax allowances specified in a law on "New and Necessary Industries". Plants, when they begin activities, are allowed to import machinery, equipment and raw materials free of tax. Prior permission is required, however, to import machines that are already produced in Mexico, except in the case of LAFTA countries.

The major types of machine tools produced in Mexico, divided into three categories, are:

Metal-cutting	*Metal-forming*	*Woodworking*
Engine lathes	Presses	Planers
Automatic lathes	Drop forges	Saws
Drilling machines	Shearing machines or guillotines	Edgers
Grinders	Bending and rolling machines	Lathes
Saws		Shapers
		Tenoners
		Drilling machines

Machine tool production, imports and local consumption, from 1967 to 1970, were:

	1967	*1968*	*1969*	*1970*
		(million dollars)		
Production	4.2	4.5	5.0	5.0
Imports	35.3	54.0	55.0	56.0
Consumption	39.5	58.5	60.0	61.0

Source: American Machinist, 1968 – 1971.

Of the total production, by value, metalworking machine tools accounted for 86.9 per cent and woodworking for 13.1 per cent. Within the metalworking category, metal-cutting tools made up 62.2 per cent and metal-forming tools 37.8 per cent. Lathes and presses constituted the most important items.

By type of machine tools, the relationship between domestic manufacture and total consumption in 1969 was as follows:

	Percentage
Lathes	15.6
Drilling machines	12.5
Grinders	7.9
Presses and cutting machines	19.4
Drop forges	5.2
Woodworking machines	17.5

Table 32 shows the estimates of machine tools imported from 1967 to 1970 and the estimates for 1975 and 1980, by type of product.

TABLE 32. MACHINE TOOL IMPORTS IN MEXICO, 1967 TO 1970, WITH PROJECTIONS TO 1980

(Units)[a]

	1967	*1968*	*1969*	*1970*	*1975*	*1980*
Lathes	1,362	1,685	1,903	1,500	2,028	3,051
Milling machines	390	400	526	365	500	734
Drilling machines	929	957	835	993	2,020	3,070
Grinding machines	643	819	872	954	945	1,450
Presses	540	601	790	543	1,105	1,555
Other metalworking machines	1,873	2,282	2,242	2,406	3,040	3,840
Woodworking machines	1,560	1,195	1,586	2,127	1,770	2,260

Source: Foreign Trade Statistical Yearbooks, General Office of Statistics.

[a]The number of units was established on the basis of the following average weights (in tons) for the different types of machines: lathes 2.5; milling machines 1.5; grinding machines 2.0; presses 5.0; woodworking machines 1.0; others 2.0.

Stock of machine tools. The composition of the machine tool park by type of product and by age group, for 1960, 1970 and the estimates for 1980, compiled on the basis of annual imports is shown in table 33 (in units).

TABLE 33. THE MACHINE TOOL PARK IN MEXICO, 1960, 1970 AND ESTIMATES FOR 1980

	1960		1970		1980	
	Less than 5 years old (units)	*Share (percentage)*	*Less than 15 years old (units)*	*Share (percentage)*	*Less than 25 years old (units)*	*Share (percentage)*
Metalworking	13,677	87.3	73,148	84.7	174,283	84.7
Lathes	2,820	18.0	17,011	19.7	38,711	18.8
Milling machines	531	3.4	4,066	4.7	9,384	4.6
Drilling machines	980	6.3	9,000	10.4	30,246	14.7
Grinding machines	830	5.3	7,317	8.5	17,485	8.5
Presses	1,206	7.7	7,106	8.2	18,606	9.0
Other	7,310	46.6	28,648	33.2	59,851	29.1
Woodworking	2,000	12.7	13,062	15.3	31,390	15.3
Total	15,677	100.0	86,210	100.0	205,673	100.0

Sources: Foreign Trade Statistical Yearbooks, General Office of Statistics.

Paraguay

The metalworking industry

Paraguay has recently begun to develop its metalworking industry. In 1970, the industry's share of the GNP was 1.3 per cent, while its share in industry as a whole, including food processing, woodworking, chemical and leather processing, was 16 per cent.

The Government of Paraguay has established priorities for the development of two general categories of industry: "necessary" industries, which exploit or develop the raw materials of the country, thereby increasing export potential; and "desirable" industries, which help reduce imports, absorb local labour and allow a better utilization of the country's resources.

Neither the metalworking nor the machine tool industries are mentioned in these categories. Nevertheless, as shown in table 34, economic projections for the years 1970 to 1975 forecast considerable growth for the metalworking industry.

TABLE 34. ECONOMIC PROJECTIONS FOR THE METALWORKING INDUSTRY IN PARAGUAY, 1970 TO 1975

	1970 (thousand dollars)	1975 (thousand dollars)	Percentage increase
Metal products	890	1,350	66
Machinery, non-electrical	1,560	2,410	65
Electrical machinery	1,260	2,030	60
Transport equipment	3,460	5,880	59
Total metalworking	7,170	11,670	61

The Centro de Industriales Metalúrgicos has 47 member firms (11 foundry and ancillary units; 18 forges; 2 metal furniture and parts manufacturers; 16 general mechanical and electrical workshops) with a combined labour force of about 2,000.

The machine tool industry

At the moment, Paraguay is in the initial phase of industrial expansion. Demand for machine tools, so far, has been limited and has been covered mostly by imports.

Although a few metalworking plants have produced such equipment as small lathes, band saws, presses, fly presses, woodworking machines and machines for grinding sugar cane, no constant production line has been followed. In general, work has been done to order. Costs are high, owing to the almost complete dependence on imported raw materials. This makes it difficult to maintain production at a level that will allow the industry to compete with industries in neighbouring countries and still less with those in the traditional machine tool manufacturing countries.

Another factor that hampers the development of the machine tool industry is a shortage of the skilled manpower that is necessary to maintain efficiency.

The following is a rough estimate of the extent of the machine tool park in Paraguay:

Industry	*Units*
Metal products	100 150
Machinery, non-electrical	150 200
Electrical machinery	100 150
Transport equipment	200 250

Most of this equipment is obsolete and poorly maintained.

Auxiliary industries

Foundries. At present, 11 foundries and ancillary units are engaged in metal casting. Grates for boilers, coulters for ploughs, castings for various automotive vehicles, castings for industrial engines, manhole and drain covers, pipe fittings, cases for meters, and a wide range of other articles are being mass-produced to meet domestic needs. The Directorate for Shipping and Shipyard Equipment recently constructed a 5-ton ingot casting furnace for the manufacture of iron rods for construction and rolled products.

The consumption of metal in the foundry industry, which uses various kinds of scrap, can be summed up by the following approximate values, in tons per month: iron, 65; bronze, 5; aluminium, 3.

Forging. Forging supplements the other related metalworking activities. Production is limited to the manufacture of artistic railings, doors, and various types of "antique" wall lamps and chandeliers for interior decoration.

Forging activity is supplemented by the repair and maintenance of industrial equipment.

Peru

The machine tool industry

Development of the machine tool industry in Peru up to 1971 was slow, due to the small domestic demand for machine tools, the lack of technological know-how, and a lack of Government incentive and promotion schemes. Most of the machine

tools used by local industry were imported. The figures for the years 1967 to 1969 indicate the extent and value of these imports:

	Machine tools imported, 1967–1969	
	Units	*Million dollars*
Metal-cutting machine tools	1,961	5.6
Metal-forming machine tools	905	3.9
Total	2,866	9.5

Now, however, the Government is aware of the importance of machine tools for the development of the metalworking industry, and has placed the machine tool industry among those to be given first priority for development.

There are four machine tool manufacturers currently producing presses, drilling, sawing and bending machines, and the Ministry of Industry has been instructed to undertake feasibility studies for the establishment of an additional machine tool factory. International tenders have been invited for the installation and commissioning of this factory.

A state-sponsored corporation for industrial development has been made responsible for the co-ordination of projects for the manufacture of cutting, forming and woodworking machine tools. The objective is to supply the local market and the other countries of the Andean Group.

Machine tools assigned to Peru by the Group, under the terms of the Cartagena Agreement, include cutting and drilling machines (bench and column type), forming machines and mechanical presses.

The foundry industry, which will have to meet the requirements of the machine tool manufacturers, is relatively new. Plans have been formulated to improve quality in the existing three plants, and a new plant, with a capacity of 15,000 tons per annum, is under construction and will start operations in 1973.

In the field of electrical motors, it is estimated that the present capacity is sufficient to supply the requirements of the new machine tool manufacturing industry. However, facilities for heat treatment will have to be developed, as at present only small workpieces can be dealt with.

The following table shows the projected yearly machine tool consumption in Peru during the period 1975–1981.

Machine	*Units*
Lathes	887
Milling	225
Drilling	600
Planing and shaping	211
Surface grinding	123
Tool and cutter grinding	53
Saws	249
Others	34
Total	2,382

Uruguay

The metalworking industry

In 1967, the share of the metalworking industry in the industrial output of Uruguay was only 4.3 per cent. It is expected that by 1974 it will have increased to 16.7 per cent. The main reason why the metalworking industry has developed so slowly is that there are no iron ore deposits in the country. This basic raw material has to be imported.

The Government has given first priority to the development of industries based on the processing of local raw materials. For this processing, a limited amount of metalworking is required, but it consists mainly of servicing and repair.

The metalworking industry in Uruguay is basically one of small to medium-sized enterprises producing small series for local requirements. Table 35 shows the distribution of these enterprises, by number of employees, in 1968.

TABLE 35. DISTRIBUTION OF METALWORKING ENTERPRISES IN URUGUAY, 1968

(Units)

Sector of metalworking industry	*Number of employees*					
	1–9	*10–19*	*20–49*	*50–99*	*100+*	*Total*
Metal products	10	41	38	12	10	111
Machinery, non-electrical	16	13	14	6	-	49
Electrical machinery	6	21	15	10	7	59
Transport equipment	19	52	36	12	10	129

Source: 1968 census of industry.

Small, efficient shops with a comparatively high labour content and a low degree of automation supply the constantly changing local demand. Larger shops, in the automotive industry, make piece parts for export to neighbouring countries. They receive in exchange basic vehicle parts. Truck parts, with the exception of chassis (including traction), which are imported, are manufactured and assembled locally.

The machine tool industry

Manufacturers in Uruguay produce simple machine tools, such as common lathes, presses and shears. One small shop is still producing mechanical presses.

In some cases, metalworking enterprises make their own simple tools, copying designs of older machine tools and adapting them to specific requirements.

Since national production is limited, most of the machine tools used in Uruguayan industry are imported.

The value of machine tools imported from 1960 to 1971 was:

	Million dollars		*Million dollars*
1960	0.25	1966	0.30
1961	1.00	1967	0.43
1962	1.60	1968	0.15
1963	0.80	1969	0.43
1964	0.50	1970	0.80
1965	0.67	1971	0.75

The machine tool park. With the exception of the tools produced by a few large companies that have been established recently with foreign capital and/or know-how, the machine tool park in Uruguay is highly diversified regarding age, origin and degree of maintenance. An unusual feature of the metalworking industry is that most of the shops are over-equipped with machine tools; but many of them are obsolete. This is the result of the strong protective measures behind which the local metalworking industry began its development.

The machine tool park is currently estimated at:

	Units
Metal industry products, including machinery	3,000–3,500
Electrical machinery and equipment	1,300–1,500
Transport equipment	1,000–1,200

Venezuela

The metalworking industry

The metalworking industry, which accounted for only 9 per cent of Venezuelan industry in 1960, had increased its share to 13.9 per cent by 1969.

The following table shows the percentage growth rates for over-all industry, the metalworking industry, and the various components of the metalworking industry, from 1960 to 1969:

	Percentage		
	1960–1965	*1965–1969*	*1960–1969*
Over-all industry	10.0	6.5	8.4
Metalworking	16.1	11.1	13.8
Metal products	12.2	11.5	11.9
Machinery, non-electrical	20.1	15.0	17.8
Electrical machinery	12.2	9.3	10.9
Automotive equipment	20.5	11.1	16.2

Source: ECLA studies.

In the period 1965–1969 there was a noticeable decline in the growth rate of industry as a whole and in every sector of the metalworking industry. The metal products sector showed the smallest decline while automotive equipment showed the greatest. The highest average growth rate was in the machinery sector.

With regard to the metal products sector, it is expected that the manufacture of laminations will start by 1974, but basic piece parts, such as ball bearings, will still have to be imported. Construction material and coupling elements and fittings for the petrochemical industry are the main items in this sector.

With respect to the machinery sector, agricultural machinery (with the exception of tractors) is manufactured for local consumption; tools and simple machines are also produced, mainly for the mining and petrochemical industries; and a diesel motor plant is at the planning stage.

The main items manufactured in the electrical sector are batteries, dry cells, distribution and connexion elements, cables and wires. The country does not yet produce electric motors or telephones.

In the automotive sector, local manufacture and assembly has reached 40 per cent of the weight of the finished product (motors and transmission gear excepted). The volume of production-assembly of motor vehicles is about 80,000 units per annum, distributed among 14 plants.

In 1970, some 48,500 persons were employed in the metalworking sector.

The machine tool industry

There are no enterprises engaged in the manufacture of machine tools for commercial purposes in Venezuela. However, some units that manufacture non-electrical machinery occasionally produce special machine tools for their own needs.

The main reasons why local manufacture of machine tools has not been established are the following:

(a) Machine tools may be imported practically duty-free. Customers can choose from an international variety obtainable at the lowest world market prices. Therefore, a limited range of locally produced machines would have little attraction;

(b) The investment needed to set up a machine tool industry would be heavy, and Venezuelan industrialists prefer to invest in more traditional industries;

(c) High wages in Venezuela make the manufacture of labour-intensive products for a limited market scarcely worth while;

(d) A feasibility study recently carried out on the establishment of a machine tool industry in Venezuela yielded negative results.

Machine tool imports in recent years were valued as follows:[2]

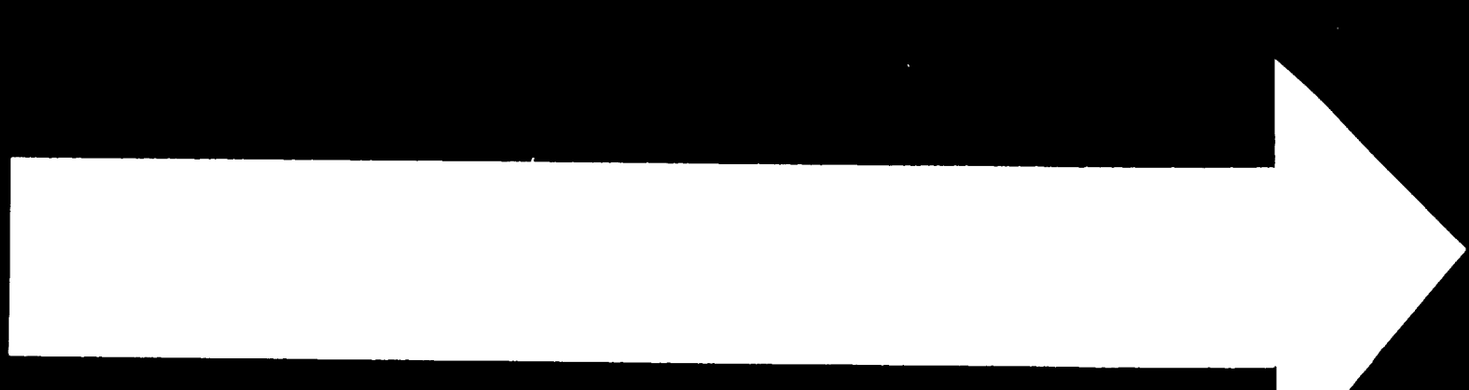
	Millions of dollars f.o.b.
1965	7.7
1966	7.6
1968	6.0
1969	5.8

The machine tools most widely used in Venezuelan industry are: lathes; drills; surface grinding presses; guillotines; saws; and machines for planing, shaping, shearing, folding, boring, slotting, threading, wire-drawing and profiling. Equipment for soldering, oxyacetylene cutting, and zinc, nickel and chrome plating is also used a good deal.

Stock of machine tools. As there are no restrictions on the importation of machine tools into Venezuela, and as import licences are not required, there is a lack of official statistics and direct information from dealers and manufacturers in this field. This makes it rather difficult to estimate existing stocks. On the basis of personnel employed in the metalworking industry, however, it has been reckoned that the stock of machine tools in 1968 amounted to 22,000 units.[3]

[2] "Some considerations on the development of machine tools in Latin America", ECLA 1972 (ID/WG.113/38).

[3] Ibid.



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Annex

LIST OF PAPERS PREPARED FOR THE SEMINAR[a]

ID/WG.113/1	Preliminary information sheet
ID/WG.113/2	N/C machine tools – keeping pace *Charles J. Sanderson*
ID/WG.113/3 and Add.1	Guiding policies and plans for the development of machine tools *P. Stöckmann*
ID/WG.113/4	The machine tool industry in Venezuela *José M. Pons*
ID/WG.113/5/ Rev.1 and Add.1	Aide-mémoire
ID/WG.113/6	Report on machine tools in Uruguay *G. A. Panizza*
ID/WG.113/7	Proposal for the establishment of a jig, fixture, die and mould training centre *Secretariat of UNIDO*
ID/WG.113/8	Proposal for the establishment of an NC machine tool demonstration centre *Secretariat of UNIDO*
ID/WG.113/9	Report on the machine tool industry in Colombia *Roberto Leal*
ID/WG.113/10	Report on the situation of the machine tool industry in Brazil *Antonio Carlos da Silva Henriques*
ID/WG.113/11	Production and pre-requisites for production of machine tools in Latin America *Ralph Gabriel*
ID/WG.113/12	After-sale service *R. Le Brusque*
ID/WG.113/13 and Corr.1 and 2	Machine tools in the countries of Latin America *Secretariat of UNIDO*
ID/WG.113/14	Report on the situation in the machine tool industry in Ecuador *H. N. Huilcarema*
ID/WG.113/15	Investment and co-operation with foreign partners *K. B. Grautoff*

[a] A limited number of copies are available from UNIDO upon request.

ID/WG.113/16	Provisional agenda and programme of work
ID/WG.113/17	Machine tool rebuilding *J. W. McKinlay*
ID/WG.113/18/Rev.1	List of participants
ID/WG.113/19	Small-scale machine tool production *L. Faria*
ID/WG.113/20	Report on the situation in the machine tool industry in Peru *Jorge W. Delucchi*
ID/WG.113/21	Report on the machine tool industry in Chile *E. M. Miralles*
ID/WG.113/22	Report on the situation in the machine tool industry in Bolivia *Gastón A. Soliz*
ID/WG.113/23	The situation of the machine tool industry in Paraguay *Victor M. González*
ID/WG.113/24 and Corr.1	Survey on machine tool characteristics and production in Argentina 1962 - 1972 *INTI*
ID/WG.113/25	Problems arising because of the introduction of numerically controlled machine tools in industry *R. Chioccarelli*
ID/WG.113/26	Report on the status and prospects of the machine tool industry in the Argentine Republic *Luis Ramos Vértiz*
ID/WG.113/27	The importance of metalworking industry and machine tools in the development of a country *A. Cannetta*
ID/WG.113/28/Rev.1	List of documents
ID/WG.113/29	The maintenance and repair of machine tools *Luis Ramos Vértiz*
ID/WG.113/30	Industrial promotion and the capital goods sector *Carlos Pozzo*
ID/WG.113/31	Situation of the machine tool industry in Mexico *R. M. Guzmán*
ID/WG.113/32	Marketing - capital goods *N. T. Heaton*
ID/WG.113/33	Methodology for the drawing up of a programme for the development of the metal-transforming industries *Roberto Kubes Weingart*
ID/WG.113/34	Development of special machine tools in Argentina *presented by Berardi Argentina S.A.*
ID/WG.113/35	The machine tool pneumatic and hydraulic components industry in Argentina *Israel Mahler*

ID/WG.113/36 Evolution and development of machine-tool manufacture for metal-forming operations in Argentina
José R. Rossi and Samuel Kait

ID/WG.113/37 Situation of the machine tool industry and market in Mexico
R. G. Martínez

ID/WG.113/38 Some considerations on the development of machine tools in Latin America
presented by the secretariat of ECLA

ID/WG.113/39 Some aspects of machine tool industry in developing countries and quality of its products
A. N. Avdoulov

ID/WG.113/40 Problems of adopting numerically controlled machine tools in enterprises
Italo Aquiles Pettiti

ID/WG.113/41 Study on the San Francisco Industrial Park
presented by the San Francisco Industrial Park

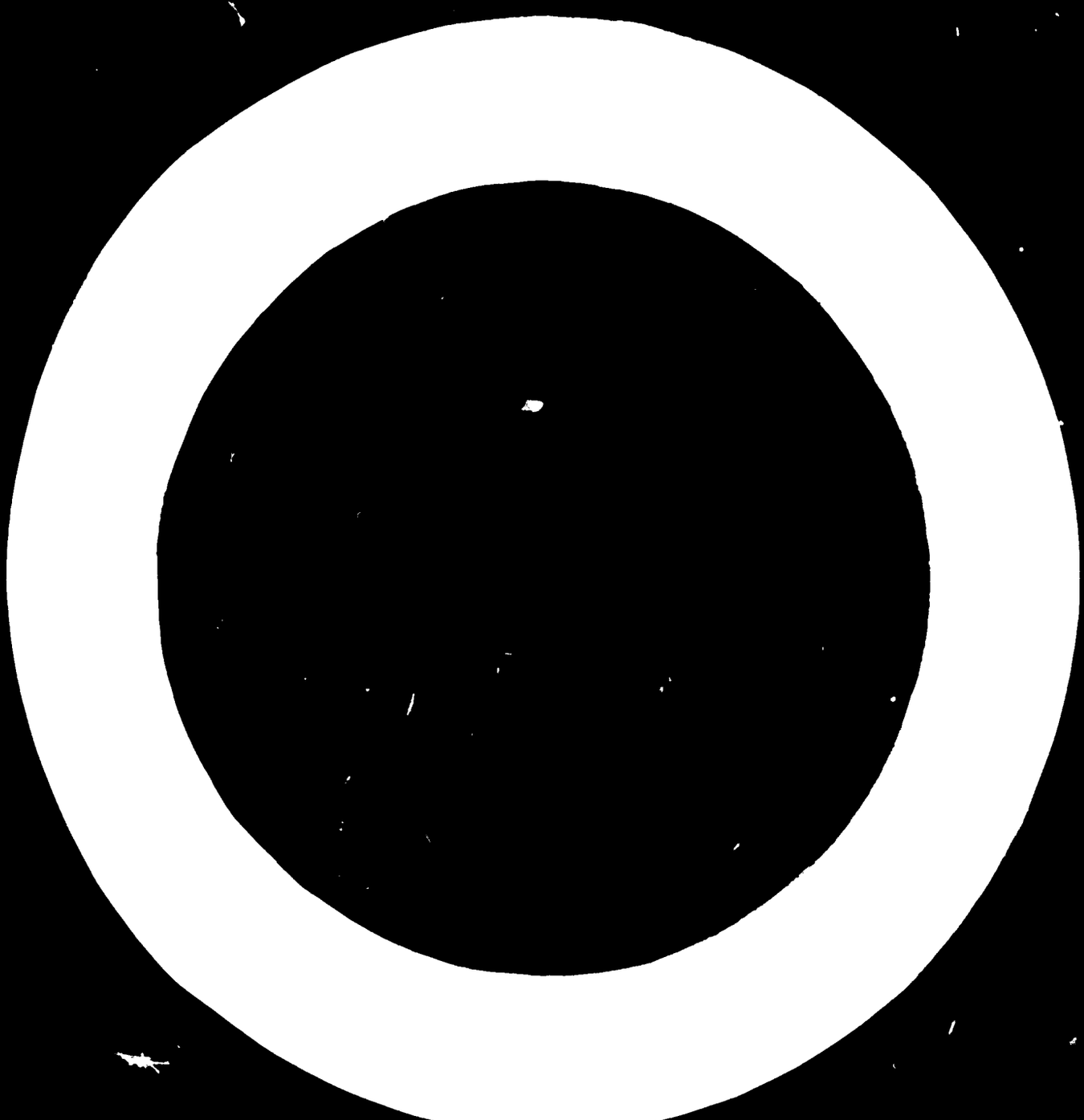
ID/WG.113/42 The role of machining centres in the manufacture of special machines
presented by Berardi Argentina S.A.

ID/WG.113/43 National policy with regard to machine tools
presented by the Development Department, Secretariat of Planning and Government Promotion, Argentina

ID/WG.113/44 Some comments on decision No. 57 of the Cartagena Agreement
Carlos Martín-Alcalá, UNIDO Consultant

Part two

Machine tool technology



I. CLASSIFICATION, SELECTION, UTILIZATION, MAINTENANCE AND REPAIR OF MACHINE TOOLS

Classification

Machine tools may be divided into two basic groups: metal-cutting and metal-forming. Metal-cutting machine tools are used for the following operations: turning, drilling, milling, tapping and threading, broaching, planing, shaping, slotting, cutting off and sawing, grinding, honing and lapping, polishing and buffing. Metal-forming machine tools are used for bending and forming, pressing, punching and shearing, forging, and riveting.

Numerically controlled (NC) machines are classified according to their type of control, which may range from simple point-to-point to full contouring control. A recent development of NC has been the establishment of machining centres in which a number of machining operations previously undertaken on separate machines are combined on one NC machine with a controlled sequence of operations and automatic tool changing.

Selection

The diversity of types and performance characteristics of machine tools might present difficulties to developing countries in selecting those most suitable for their requirements. However, most machine tools manufactured to perform a specific task are broadly similar in design, which makes comparison easier.

Metal-cutting machine tools vary according to:

(a) Type of cutting insert (drills, cutters, grinding and polishing wheels);

(b) Function (turning, milling, drilling, gear-tooth cutting, grinding or polishing);

(c) Grade of surface finish required (rough to polished);

(d) Workpiece dimensions (from bench-type machines to those capable of machining parts 10 or more metres across and weighing hundreds of tons);

(e) Degree of accuracy required (from rough to precision work);

(f) Range of work (general-purpose or specialized);

(g) Number of tools used simultaneously (single or multiple-spindle, multiple-carriage, multiple-tool machines);

(h) Number of parts machined simultaneously (single or multiple position machines);

(i) Degree of mechanization and automation (serviced by an operator or fully automatic);

(j) Design features (vertical, horizontal, drum, open side, duplex, pendulum, and unit).

General-purpose machine tools are usually used in jobbing work, small-scale and batch production. They are comparatively cheap and have a wide range of speeds and feeds, but only highly skilled workers can exploit their capacities to the full. The operator must be able, without the aid of fixtures, to mount, align and fix the parts to be machined, set up the cutting tools, perform certain operations manually and take all necessary measurements. The volume and quality of output depend largely on the operator's skill.

Centre lathes, knee-type milling machines, shapers, vertical drilling and conventional cylindrical grinding machines are examples of general-purpose machine tools.

Although specialized machine tools are designed for machining certain types of work-pieces, they can usually accommodate many different sizes. They allow quick and precise mounting of work-pieces and simultaneous machining by several cutting tools. They give a high rate of output but are economical only when used for medium or large batches.

A machine tool of the correct size can be chosen on the basis of the following dimensional criteria:

Machine tool	*Dimensional criteria*
Turning and engine lathes	Swing over the lathe bed: distance between centres
Vertical and radial drilling machines	Maximum drilling diameter for medium-carbon steel; size of table
Horizontal boring machines	Boring spindle diameter; size of table
Cylindrical grinding machines	Maximum diameter and length of work-piece machined
Internal grinders	Maximum diameter of hole ground
Surface grinders	Rectangular table width and length or rotary table diameter
Gear-hobbing, gear-shaping, gear-shaving, gear-grinding, and gear-tooth chamfering machines	Maximum diameter and tooth module of work-piece
Knee-type horizontal and vertical milling machines, copying milling machines	Width and length of table working surface; maximum distance between spindle and table
Single- and double-column planers	Maximum work-piece width, height and table stroke
Shaping machines, slotting machines	Maximum ram stroke and shaping width
Thread-cutting machines	Size range of threads to be cut

The types and sizes of machine tools in a manufacturer's range usually follow an arithemetical or geometrical progression with regard to the main technical parameters. A closely spaced progression is used for the common types and sizes of machine tools in order to provide a machine that will meet the exact requirements of individual users.

When new machine tools are being selected, consideration should be given to the existing stock of machines to make sure that the new additions complement them. This is comparatively easy in a small plant, but as the size of operation increases it becomes progressively more difficult. At the national level it is impossible unless adequate statistical records are maintained. To be useful, these records should show the numbers of machines, not only in broad categories, but within closely defined limits; the age and condition of the machines should also be indicated.

The machine tool should be selected with a full knowledge of the various methods of manufacturing the particular component needed. The choice of an unsuitable machine may result in inefficiency for many years as, whatever machine is selected, it will be in service for a long period. The cheapest machine may prove to be a poor investment as breakdowns may occur more frequently as a result of overloading.

Utilization

The industrial development of a country depends largely on the number, age, quality and type of machine tools it possesses. The way in which these tools are used, however, is also very important. Some countries have a sufficient number of tools but are not utilizing them properly and are, therefore, making unnecessary expenditures for buying and servicing them.

The effective utilization of machine tools is a very important factor in increasing productivity. In considering this factor, the industries of a country should answer the following questions:

(a) Is the machine tool suitable for the job in question? What are the alternatives for its use?

(b) Is the machine working at optimum capacity? What is the utilization (in percentage of the total machine time available) and how can it be improved?

(c) Is it better to have special-purpose or general-purpose machine tools? (The latter are adaptable to a wider variety of jobs, but have lower capacity.)

(d) Should machines take over manual tasks? If so, which tasks?

The production control and planning departments are vital to the effective utilization of machines. However, it may be much more difficult for these departments to function effectively in a developing country than in an industrialized country, since procurement of raw material is often difficult, especially in the case of alloy steels. There may also be delays in obtaining the required jigs and fixtures and cutting tools. Replaceable (throw-away) carbide tips, for example, appear to be used much less frequently in countries that are only beginning their industrialization than in those where industrialization is more advanced.

Detailed machining instructions should be prepared by the planning department for every part that is to be manufactured. These instructions should include the cutting speeds and feed rates for each part of the operation; too low a rate will prolong the operation unnecessarily, whereas too high a rate will result in poor surface finish and premature tool failure.

Full utilization of the machines will not be achieved unless there is also an effective organization for routine servicing and maintenance.

In addition to these easily eliminated causes of under-utilization, there are three others which are not so easy to deal with:

(a) Too many companies producing the same type of product (because demand was over-estimated);

(b) Reduction in demand due to a changing pattern of trade;

(c) Lack of managerial competence.

Before a remedy can be found, a detailed study of the problem must be made so that the causes can be isolated and understood. A detailed market research study might show that a different product would fully utilize the expertise and resources of the plant, or, additional markets might be found. A company may also find it necessary to ask the government for protection against lower-priced imports or for tax concessions. Since the operation of these plants creates employment, a government has a direct interest in ensuring that they shall be viable.

The effective utilization of machine tools should be the primary concern of management. Every aspect of the operation must be kept under scrutiny to prevent unnecessary loss of output due to machine breakdown, labour shortage, reduced sales volume or weakness in the production control system. Management should also consider whether capacity can be increased by subcontracting to other companies rather than by installing additional facilities that may not be fully utilized. On the other hand, if surplus capacity exists, it may pay to seek subcontract work to make full use of the plant.

Another important cause of underutilization that is very often found in developing countries is both economic and institutional in nature: low capital costs compared to labour costs. The low capital costs result from tax and tariff exemptions, too liberal investment credits, tied extemal credits etc. Over-all labour costs, on the other hand, are much higher than they seem at first sight, due to lack of skill, labour regulations etc. The problem is further compounded by the fact that inflation tends to stimulate over-investment in capital goods.

Operators required for machine tools

Machines, however well selected and installed, are of little value unless skilled operators are available to run them. There should be enough operators to work double shifts if the full potential of the machines is to be utilized.

Operators should be able to understand complicated blueprints, if modern systems of dimensional and quality control, with tolerances expressed in fractions of millimetres, are to be employed. They must also know how to make any immediate adjustment for a deviation from the required tolerances in the operation of their machines. Properly trained operators will get the best from their machines.

Adaptations

The effectiveness of many machine tools can be greatly increased by adding such accessories as power-operated chucks, hydraulic copiers, pneumatic vices and other air-operated attachments, pre-set tooling, and in-process gauges (on grinding machines). The list could be greatly extended to include all the complicated attachments that convert a turret lathe, for example, into a fully automatic sequence-controlled machine.

The effectiveness of the basic machine itself may be improved by increasing the feeds and speeds. This may be done by changing the main-drive pulley ratio or increasing the size of the drive motor. When the feed rate is not related to main-spindle rotation, it may be desirable to make additional adjustments to the feed system itself.

Alterations to the machine should be made only after a careful review of its characteristics and all of the factors affecting its operation.

Numerical control (NC)

Machine tools fall into three general categories:

(a) Conventional machine tools for the production of units;

(b) Machine tools equipped with numerical control (NC) for the production of small and medium-sized runs;

(c) Fully automatic machines for mass production.

Each case for the introduction of NC has to be evaluated individually, In some instances, for example, if the programming capabilities on the shop floor are superior to the skill of the operators, prototypes of the most complicated design can be better manufactured on an NC machine than on conventional machine tools.

The main saving of NC lies in the waiting time of the machine; here great economies can be achieved. Other advantages are:

(a) Direct labour: NC reduces the number of machine tools required for a given operation and can be applied by operators with a correspondingly lower level of skill;

(b) Set-up costs: by performing more than one operation simultaneously, the set-up time is reduced;

(c) Tooling costs: the need for jigs and fixtures is reduced and, with it, their manufacture and storage costs.

Numerically controlled machine tools can cover certain technological gaps in the manufacturing of capital goods and machinery in developing countries as they replace a type of personnel that is very scarce in these countries, e.g. universal machine operators, and die and tool makers. NC calls for the use of more readily available personnel, such as programmers and technicians.

Introducing NC in developing countries

The introduction and utilization of NC does not depend on the state of the economy of a country, or on its degree of industrialization, but simply on the

economics of the production process under consideration. After it has been introduced, a number of tasks remain to be performed by both manufacturer and user.

The manufacturer is responsible for his sales force, which should have a clear understanding of the economics of the use of the machine, in order to determine how best it can benefit the manufacturing process of the customer.

Training facilities should be available for the customer so that his operators and programming staff can learn to use the equipment properly. Sometimes a programming course is necessary. Servicing facilities, much more sophisticated than those for conventional machine tools, with full electronic capabilities, should be available.

It is convenient sometimes to put a programming office at the disposal of the customer to help him to draw up the first programme. This office might later be used as a consulting unit.

The user, for his part, should re-train his operators in the realization that often the handling of an NC machine does not require the high skills necessary for handling conventional machine tools. Alternative employment will have to be found for many of the old labour force.

He should set up a programming unit. This may consist of a single person, but one highly qualified and trained.

The user should be aware of the economic aspects of replacing a machine tool, e.g. before renewal is strictly necessary.

These matters have to be considered well in advance, so that proper use can be made of this advanced technology.

The manufacture of NC machine tools in developing countries

In principle, NC machine tools are derived from conventional machine tools, simply by adding electronic controls fed by a punched or magnetic tape, which controls the movements of the machine. This was, in fact, the starting point of NC machine tools.

The main steps taken in this development were, basically:

(a) The development of drive motors and propulsion motors for the feed movements, which start and stop at predetermined moments and with high acceleration or deceleration;

(b) The technique of the step-motors for machine tools;

(c) The incorporation of sophisticated electronics into shops, which till then had only handled mechanical engineering;

(d) The development of programming skills, namely the translation of a drawing into the computer language of punched or magnetic tape;

(e) The automation of the tool changing mechanisms, once the automation of feed and drive had been achieved.

The manufacture of NC machine tools in a developing country, however, is a completely different matter. The decision whether or not to start manufacturing is not so much a matter of technique as of economics. In the case of advanced

techniques it is important to be able to rely on a local market of sufficient size. The whole operation must be economically viable and it should not be necessary to consider exporting a considerable share of the production, or even the necessity of exporting, in order to survive.

Maintenance and repair

The purpose of maintenance is to increase the lifetime of machines and to prevent breakdowns. The greater the degree of mechanization of an enterprise, the greater the need for precise schedules for lubrication, performance checks and parts replacement.

Preventive maintenance

The responsibility for lubrication should be assigned to maintenance personnel and not left in the hands of the machine operator. In the case of a large enterprise, maintenance teams should be organized.

An effective lubrication plan would include:

(a) A schedule specifying the lubrication needed daily, together with a system for checking that it has been carried out;

(b) A chart for each machine showing its lubrication points, the amount and type of lubricant to be applied to each point and the frequency of application;

(c) A list of recommended lubricants and a system for keeping them in stock;

(d) A system of standardized lubricating, e.g. different lubricants for oil and grease, colour-coded according to viscosity;

(e) Facilities for storing and dispensing lubricants;

(f) Specialized equipment for applying lubricants.

Performance checks

As a machine ages, the quality of the items made on it deteriorates. This process of wearing out has three stages:

(a) Initial run-in: the rate of wear depends on surface finish of the mating parts;

(b) Normal operation: a prolonged period in which little wear takes place;

(c) Deterioration: the rate of wear increases, the play between mating parts increases rapidly, further accelerating wear, and the noise level increases appreciably.

The operating time of the machine can be taken as a rough indication of the wear; but the actual load carried, that is, the electrical energy consumed, is a more reliable criterion and can be measured with a watt-hour meter connected in series with the machine.

Every machine tool should also be equipped with a time recorder, which makes it possible not only to schedule maintenance activities more precisely but also to study the law governing the wear of the machine as a function of operating time.

The following items should be checked regularly:

(a) Power input to the machine while it is running idle at various speeds;

(b) Mechanical efficiency curve;

(c) Abnormal noise or vibration;

(d) Machining accuracy;

(e) Loss of geometrical precision due to play in the spindle or guides.

These checks may disclose that a number of adjustments are required and that certain parts should be replaced in addition to those that are replaced regularly, such as drive belts, filters, clutches and electronic components. For effective preventive maintenance, spare parts must always be on hand for regular and emergency replacements. However, the stock of spares should be kept at the minimum level necessary, as stock represents a non-productive use of capital.

Repairs

Every machine tool will eventually require more extensive repairs than can be accomplished by routine maintenance. For such repairs it may be necessary to remove the machine to a special section of the plant where better facilities are available for the work. During the repair many parts that have not actually failed will be replaced in order to prolong the period of use of the machine before repairs are again required. Detailed records of the time and material used in these repairs should be kept for comparison with the records of similar machines and also for determining, after further service, whether the machine should be replaced or rebuilt.

Rebuilding

Rebuilding is not necessarily part of a manufacturer's work, but can be an independent operation aimed at rebuilding machine tools in general, regardless of brand or size.

Rebuilding can be broken down into a series of steps, allowing for adaptation according to the specific type of machine to be rebuilt.

In order to keep down-time of the machine as short as possible, the exact dates when the customer should send in his machine and when the work on it will be completed should be fixed.

The basic steps of rebuilding (which can cost as much as 50–60 per cent of the price of a new machine) are:

(a) Stripping. On arrival the machine is completely stripped and a report issued about the findings, analysing the needs for each part with respect to re-fitting, re-machining and re-fitting, or complete replacement;

(b) Processing of castings. All castings have to be stripped down to the bare metal, then washed, filled, and painted with primer;

(c) Scraping. The bedways either have to be re-planed and re-scraped, ground, or re-scraped. Rough scraping is done with a hand-operated mechanical scraping device, while final scraping is carried out with a standard hand scraper;

(d) Machining. The re-machining of parts takes place at the same time as new parts are being fitted ready for assembly;

(e) Electrical fitting. The standard procedure is to strip, clean, re-wire, re-varnish and re-assemble all electric motors and to procure a complete new set of electrical control equipment. The re-use of the electrical controls incorporated in the machine presents several difficulties, mainly the non-availability of spares for old machines and the time necessary for discovering the specific fault;

(f) Assembling and testing. In this step all units have been fitted ready for assembly, any new hydraulic power units are ready to be piped to the machine, and the re-wiring of the new control panel has been prepared so that final assembly can be carried out.

When these operations have been carried out, the machine is tested under normal working conditions, if possible in the presence of the customer's operators so that any faults or discrepancies can be rectified on the spot.

In deciding whether or not to rebuild a machine it is advisable to take into account its replacement cost. In general, the cost of rebuilding a heavy machine tool is 25–30 per cent that of the cost of a new machine, while for a medium-sized machine tool it is 50–60 per cent.

With proper maintenance, machine tools will give service for from 10 to 20 years. There is always the possibility, however, that the machine will become obsolete in that time. In the case of general-purpose machines, this is unlikely, since the design does not change frequently. Other machines, however, become obsolete as advances are made in manufacturing techniques. In this case rebuilding is uneconomic.

Labour accounts for most of the cost of rebuilding; the cost of materials is quite low. Rebuilding is therefore particularly advantageous for developing countries; they usually have an abundance of cheap labour that can be trained for the work and the purchase of material requires a negligible amount of foreign currency.

A machine rebuilt by an experienced shop should serve as well as a new one and should retain its alignments even better than a new machine because the main-frame castings have become fully aged.

II. MANUFACTURE OF MACHINE TOOLS

Machine tool development is influenced by the following factors:

(a) The requirements of the users and their ability to utilize modern machine tools;

(b) The technical, financial and personnel capability of the machine tool industry;

(c) The capacity of the industries supplying the machine tool industries, taking into account that the demand for machine tools is governed by the following factors: the targets of the national economy; the technological development of the country; and the local labour market.

Various types of machine tool parts are required for the expansion of a highly developed industry and for the equipping of a new one. However, international technological development proceeds fairly uniformly, even if its application varies widely in individual countries.

It is more important to use automated processes in countries where there is a shortage of labour than in those where the supply is sufficient. Nevertheless, in order to be able to manufacture in a competitive market, the most modern methods have to be employed, regardless of the current local situation. In preparation for meeting future demands, and in order to keep abreast of the latest technological developments and requirements, the machine tool manufacturer has to keep in close contact with the users of his machines and with research centres.

The main requirements for the future development of machine tools may be summarized as follows:

(a) Tools: high-speed tools require a high degree of automation as human reactions are too slow;

(b) Idle time: the higher the cost of the machine, the higher the cost of idle time. These costs might be reduced by changing over and resetting tools in two automatic operations;

(c) Work pieces: these become bigger and heavier on the one hand, and smaller, but in larger quantities, on the other. It is essential that they be handled automatically;

(d) New materials: harder and more wear-resistant materials require higher speeds for handling and new technologies in processing, as for example, spark erosion and elector chemical machining. In addition, the substitution of plastic for metal in many applications requires special consideration.

In order to meet these requirements, the following must be developed:

(a) Drives that will operate with high-speed quick-change transmissions or regulated DC motors;

(b) Bearings that will resist high speed and power;

(c) High speed tools, such as those tipped with carbide or ceramic;

(d) Simple electronic controls that can be adapted to the most sophisticated NC devices;

(e) Measurement systems, both for incorporation into the machine and for the inspection of the finished product;

(f) Production materials, the main components being cast iron and steel, for the machine itself. These must be of the best quality.

Design

The process of building a machine tool starts with its design (unless one has been made available through either national or international co-operation). The design stage is followed by the preparation of detailed drawings and schedules. Other basic steps include:

(a) The determination of the tool's technical application and comparative cost;

(b) A feasibility study to examine whether the model selected complies with the specification and falls within the budgeted price range;

(c) The manufacture and testing of a prototype, to ensure that performance meets specification and endurance capacities incorporated in the pre-production batch.

The technical characteristics of the machine to be built will be taken into consideration at the design stage. These include the following:

(a) Specifications determining the product to be machined and the degree of automation required;

(b) Pre-determination of the control of the machine in order to provide a relative speed between tool and workpiece. This is normally either a rotation of a lathe or a milling machine;

(c) A feed motion that will ensure the exit of material from the workpiece;

(d) The provision of an adequate power supply to operate the workpiece and tool at a regulated cutting speed;

(e) The incorporation of static resistance to counterbalance the deflection between tool and workpiece;

(f) Dynamic stiffness to avoid high amplitude vibration resulting from cutting force and speed;

(g) Heat generated by the machine during the cutting process or through loss in the kinematic train, which will cause expansion and change of shape;

(h) Minimization of wear of the slideways;

(i) Measuring devices to control the size of the workpiece. This work is normally carried out indirectly through the displacement of the slideways;

(j) The controls of the machine, mainly the control of displacement and the control of sequence; the degree of automation determines the amount of control needed. This can vary considerably, ranging from a simple contactor over sequence control circuitry, hydraulic means, compressed air, and "fluid logic" to numerical control for the more sophisticated types.

In addition to the technical aspects, the need to match the machine to the capacity of the operator has to be considered. The appearance of the machine, from the aesthetic point of view, is also important. Other factors to be considered are the machine's endurance characteristics; the means available for manufacturing it; and the conditions under which it will have to operate.

The design staff normally consists of:

(a) A product-oriented team that is able to develop, creatively, new ideas and concepts, with a leader who has extensive experience of the particular type of machine tool;

(b) A production engineer from the plant who is available for consultation on problems related to manufacturing costs;

(c) Technicians for the preparation of detailed drawings, schedules and other routine matters;

(d) A development engineer to carry out tests.

In addition to local sources, it is desirable to have access to external sources of scientific information, e.g. development centres.

Prerequisites of production

Machine tools must operate satisfactorily and be competitively priced. Their selection is, therefore, important. The main components of a machine tool may be classified as follows:

(a) Castings of high quality, which account for 5 to 6 per cent of the total weight of the machine;

(b) Steel forgings and alloy steels of different types;

(c) Highly sophisticated machine parts, such as anti-friction rollers and ball-bearings, sintered bronze bearings, oil seals, lubrication pumps, air and oil pumps and fittings, hydraulic and pneumatic valves, manual and power-operated chucks, tracer and other specialist attachments, electrical control equipment and cables, electric motors, electric cooling pumps, sheet metal guards, dowel pins and high-tensile bolts.

As quality is the main factor, it will be necessary to consider importing parts if local manufacturers are unable to conform to the quality standards set.

An adequate force of highly skilled machinists and fitters should be available. Training facilities, to provide additional skilled manpower, are necessary.

No machine tool manufacturing company can be self-sufficient in all processes. It has to rely on other industries for specialized services. The main functions of such industries are heat treating (in steel plating operations) and panel engraving.

At first, jigs, fixtures and other tools will probably be imported, but it may ultimately be desirable to include this item in the domestic manufacturing programme.

Machine tool manufacturers in Latin America usually require their managements to be closely associated with all aspects of production, for which experience in the manufacture of high-quality engineering products in small batches is necessary.

The manufacturing programme

Each manufacturing programme depends on a number of individual factors, but the following general observations are true for most.

(a) Planning is vital;

(b) It is impractical to start building the most sophisticated types of machine tools, or to begin with NC production;

(c) It is equally inadvisable to start by manufacturing the simplest type of machine tool, which is already available;

(d) A market study should be undertaken to determine if there is a demand for a more advanced machine type with an increasing potential.

Cost analyses

Development costs include the cost of the design, the cost of producing the new model, and the cost of marketing it. In industrialized countries a round figure of $250,000 can be taken as a guide-line for the cost of designing, developing and producing a prototype for a new machine. This represents between 5 and 30 per cent of the total production cost, the higher figure applying to small quantity production, the lower figure to a large quantity, such as 1,000 units per annum. The growing cost of development has led to licensing and other types of co-operation agreements designed to spread the costs over a greater number of unit sales. The manufacturing facilities available can be a limiting factor; the most advanced design may be unsuitable owing to limited manufacturing facilities or the non-availability of specialized components.

Cost analysis should be carefully investigated at each stage of the project. There are three principle variants to be considered that influence manufacturing costs, namely, price reduction for bulk buying; reduction in manufacturing hours, owing to familiarity with the product (or to the use of different manufacturing techniques in the case of larger-scale production); and, perhaps most important, the value of development cost, which must be written off against each machine.

Machine tool manufacturing is not as capital intensive as, for instance, steel making or the chemical industry, but it is more so than many consumer goods industries.

The capital equipment investment per employee varies between $1,250 for a small plant and $6,000 for a large plant provided with modern machinery.

A further investment in working capital, amounting to between $2,000 and $4,000 per employee or, alternatively, 50–75 per cent of the annual sales value, will be required. The working capital usually comprises materials in the raw and semi-finished condition and financial requirements for debtors and creditors.

In some developing countries the output per employee is as low as $2,000 per annum, but in these cases the investment has usually been very low. The manufacture of machine tools cannot be economically justified by a company in the region unless an output per employee of $5,000 per annum can be anticipated. In an industrialized country the expected annual output would be at least $10,000 per employee and a figure of this order should certainly be the aim of any company proposing to engage in the manufacture of machine tools.

Small-scale production

Production in small series, for example, 10 to 20 units, only requires facilities of simple design, as far as repeatability is concerned. On the other hand, small-series production calls for a high degree of craftsmanship in manufacturing, assembling and inspecting (which is often carried out by the worker himself). Moreover, nowadays copying machines, even NC machines, are capable of handling this type of production. Small or medium-sized companies have the following general characteristics:

(a) Staff of 100 or less and limited financial and production resources;

(b) One manager who controls technical, administrative and commercial aspects of production (usually an expert in only one function, to which he devotes most of his time, thereby neglecting the others);

(c) A stimulating environment, which encourages the personnel to develop their own ideas and initiative.

In principle, there is not necessarily a connexion between small companies and low profitability, but there is always an optimum size, which depends mainly on the manufacturing programme, the geographical location and the level of development of the country.

Problems of the smaller company

The main problems of the small to medium-sized company are similar to those of the bigger one, but there is a different emphasis on a number of factors, which include:

(a) Marketing strategies;

(b) Sales techniques and recruitment of a sales force;

(c) Technological capacity (assessed from research and development through testing);

(d) Manufacturing capacity (the available plant and machinery organization and labour).

The size of the market and its needs influence the operation. A small, not-too-demanding market will not stimulate the manufacturer. This can lead to stagnation, but a too-dynamic market may leave him behind.

In comparison with other industries, the machine tool industry is essentially a small business industry. The following table shows the average size of machine tool manufacturing companies in selected countries:

	Number of employees
United Kingdom	232
Federal Republic of Germany	200
Switzerland	132
Japan	71

Other difficulties faced by small and medium-sized companies in the machine tool industry are the following:

(a) The problem of self-financing for expansion, as the industry is capital intensive;

(b) The difficulty of attracting highly skilled personnel;

(c) The necessity of performing the same functions as a big company but without the resources of such companies. (These include market research; publicity; design and development; and basic research);

(d) The need to use labour, rather than machinery, in order to minimize capital expenditure;

(e) The cost of labour in relation to productivity in high-technology operations.

Co-operation

A possible solution to these problems lies in the use of one of the many facilities for co-operation that are available, e.g. technical centres for industrial co-operation and development. These centres can co-ordinate a number of functions and enable different industries, where there is no conflict of interest between them, to co-operate in the following:

Design, manufacture and testing of prototypes

Market research

Systematic quality control

Mergers and co-operation agreements

Technical and economic studies

Standardization studies

The centres could perform, impartially, more every-day tasks, e.g. purchasing material, and selecting and training personnel. There are many such institutions in Latin America; some are efficient and well equipped, but it has been found that industry is not making real use of their facilities. This may be due to the fact that their services are not well known, or because there is a reluctance on the part of the user to discuss the problems of his manufacturing unit with outsiders.

The marketing of machine tools

In order to operate as an economically viable entity, a machine tool manufacturing company must be active in the following fields: reasearch, development and design; manufacturing; and marketing.

However, there is no development simply for the sake of technical perfection; the life-cycle of products becomes shorter as industrialization advances. Moreover, the amount of production cannot be a matter of manufacturing convenience.

This means that the only products that can be sold are those that can be adapted to the customer's needs and that can be competitive. Marketing has two clearly distinct functions: *(a)* to define the product for a given market, in terms of technology, quantity, timing and price, and *(b)* to sell an end product that has been manufactured at the right time, in the right quantity and at the right cost.

Components of the marketing function

The components of a successful marketing policy include: market research; publicity; marketing planning; product quality; after-sales service; and co-operation with other companies and organizations in marketing the product.

Market research

This consists of: a survey of the use of the product at the customer's premises, including such factors as the way in which it is used and the purpose for which it is used; a survey of the customers themselves, their activities and future potential; a survey of the industrial groups that are capable of using the product, their size and number and how they are influenced by economic fluctuations; and a survey of the local and foreign competitors, their strengths and weaknesses.

Publicity

The purpose of publicity is to inform the prospective customer regarding the product and the company. The product may be publicized by the use of advertising, catalogues and descriptive literature, technical information (e.g. magazine articles), handbooks and pamphlets, fairs and exhibitions, and audio-visual presentations.

Marketing planning

Marketing planning includes the preparation of a design for a specific customer; the adaptation of current production to new requirements; and ideas for the manufacture of new products. Information required by the manufacturing department concerning the amount of production includes the appropriate time for marketing the product. In planning sales for long-, medium- and short-term activity, the following must be considered: quantity; markets, or customer groups; and particular form and tool required.

Product quality

It is necessary to convince the customer of the advantages of the offer made. He should be aware that not only the product, but a combination of product, manufacturer's reputation, salesmen's ability, price, conditions and service are being offered. All customers do not necessarily benefit to the same extent from the same purch Sales activity should result in a technically and commercially defined purcha order, regardless of the market (technical or geographical) or the industrial group that the customers belong to.

After-sales servicing

This comprises a wide variety of activities, some of which are carried out even before the sale takes place. They include:

(a) Training the customer's staff in the proper handling of the machine (sometimes undertaken prior to shipment);

(b) Informing the customer, in writing, about the importance of regular maintenance;

(c) Carrying out repairs at the customer's premises by, for example, sending repair teams equipped with spare parts;

(d) Organizing preventive maintenance services in the form of either a contract for servicing at regular intervals, or service vouchers that can be used when the customer deems it necessary to have the machine serviced;

(e) Making a supply of spare parts available to the customer. This requires a considerable stock of up to 100,000 items, with the related capital and a fast and simple order-processing operation. It should be the aim of any manufacturer of machine tools to fill spare parts orders *ex stock* on the day the order is received.

Co-operation in marketing

Co-operation with other companies and organizations in the marketing of machine tools is important in order to maintain good relationships between producers and industrial users and to keep marketing and sales costs within reasonable limits.

Investment and co-operation with foreign partners

The basic need of most developing countries is to find a short cut to industrialization, to avoid the difficult and time-consuming trial and error method used by the industrialized countries. The achievement of this goal would mean great savings in foreign capital, more work for the indigenous labour force and the possibility of earning foreign currency, through exports of the finished product.

The view previously held by the industrialized countries that co-operation meant giving away know-how lightly and destroying export markets has been widely replaced by the more forward-looking view that it is in their own interest to further the industrialization of developing countries, which represent their own customers and suppliers.

Such joint ventures allow the ever-increasing cost of development to be spread over larger markets, through world-wide manufacture. The role of the industrialized countries is becoming one of solving the more complicated technical problems and of helping developing countries to build products using existing know-how. The developing countries can refer to a central manufacturing unit for more complicated products and components. Thus, the integration of joint production sources into a world sales and service organization, with a continuous control over quality and servicing standards, is a possibility.

Thanks to the key role it plays in the industrialization process, the machine tool industry in the industrialized countries can assist its counterpart in the developing countries by providing know-how, by helping to set up local machine tool building industries, and by supplying equipment and technical information. This is best achieved by continuously modernizing existing manufacturing plants in order to maintain the end product at the latest technological standards and internationally competitive; by providing consultancy services and hardware for new industries, as the third partner to the supplier and receiver of know-how; by supplying plant and equipment in the form of complete industrial set-ups, such as centralized mould and die production units, or autonomous plant sections, such as a tool room; or by

providing training centres for metalworking, to help build up a corps of skilled personnel. Assistance in the following activities would be helpful:

(a) Defining the economics of the project;

(b) Carrying out studies on the industrial structure of markets, with special attention to future tendencies;

(c) Making recommendations concerning economic viability;

(d) Determining production programmes;

(e) Planning projects;

(f) Drawing up lists of suppliers and their prerequisites;

(g) The critical path of PERT[4] planning and time scale;

(h) Procurement and installation of tools;

(i) Personnel training;

(j) Putting projects into operation.

Methods of co-operation

Three possible methods of co-operation between an industrialized country and a developing one are discussed below.

The first and simplest method is through licensing. The licensor must be careful not to supply the licensee with licences for the manufacture of a machine of a higher standard than he can produce. The agreement should be based on a consideration of the licensor's most up-to-date developments and also on the fact that an older, well-proven product can often be more suitable than a new, untried one. This applies equally to the manufacturer and to the market. As licensing agreements usually entail legal considerations such as patent rights, and the ownership of know-how, it is sometimes necessary to draw up a controlling agreement. The fact that this might be needed illustrates the weakness of the licensing type of co-operation.

Developing countries, experienced in licensing, suggest that when this type of co-operation is envisaged, the following considerations be taken into account:

(a) Licensing is not a solution *per se* to the problem of the lack of the minimum mechanical and manufacturing know-how;

(b) Careful attention should be given to the payment regulations stipulated;

(c) The licensing agreement should include an effectively planned assistance programme comprising all aspects of design, training, manufacturing know-how, material specifications etc.

The second method of co-operation is a joint venture that overcomes the disadvantages of the licensing agreement by distributing responsibility, financing and benefits equally between both partners. Great importance is often attached to the percentage of ownership, a point which in a well-run operation quickly becomes academic. Success or failure lies mainly in the distribution of responsibilities and activities.

[4] Programme Evaluation and Review Technique.

The "senior" partner (the industrialized country) handles international sales, while the "junior" partner handles domestic sales for locally manufactured and imported products. Research and development should be accessible at an agreed price. An exchange of personnel should be arranged between the two parties, thus consolidating the partnership at all levels.

The third method of co-operation implies 100 per cent ownership by the supplier of the know-how, and requires an extensive knowledge on his part of the particular developing country. There is a tendency in developing countries towards economic nationalism and independence, and this is a fact that the industrialized countries have to accept and understand.

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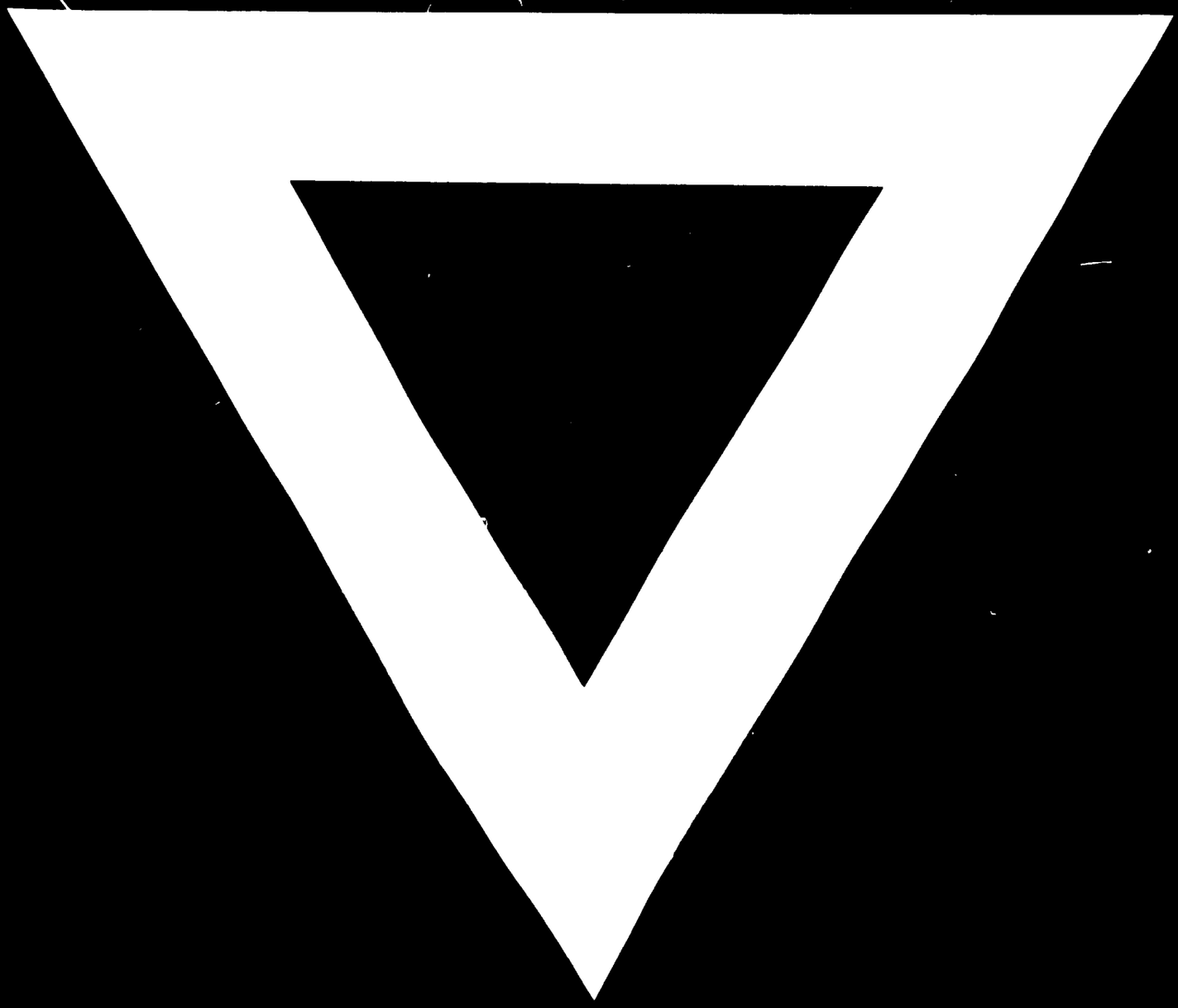

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