OCCASION

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

DISCLAIMER

FAIR USE POLICY

CONTACT

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

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

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

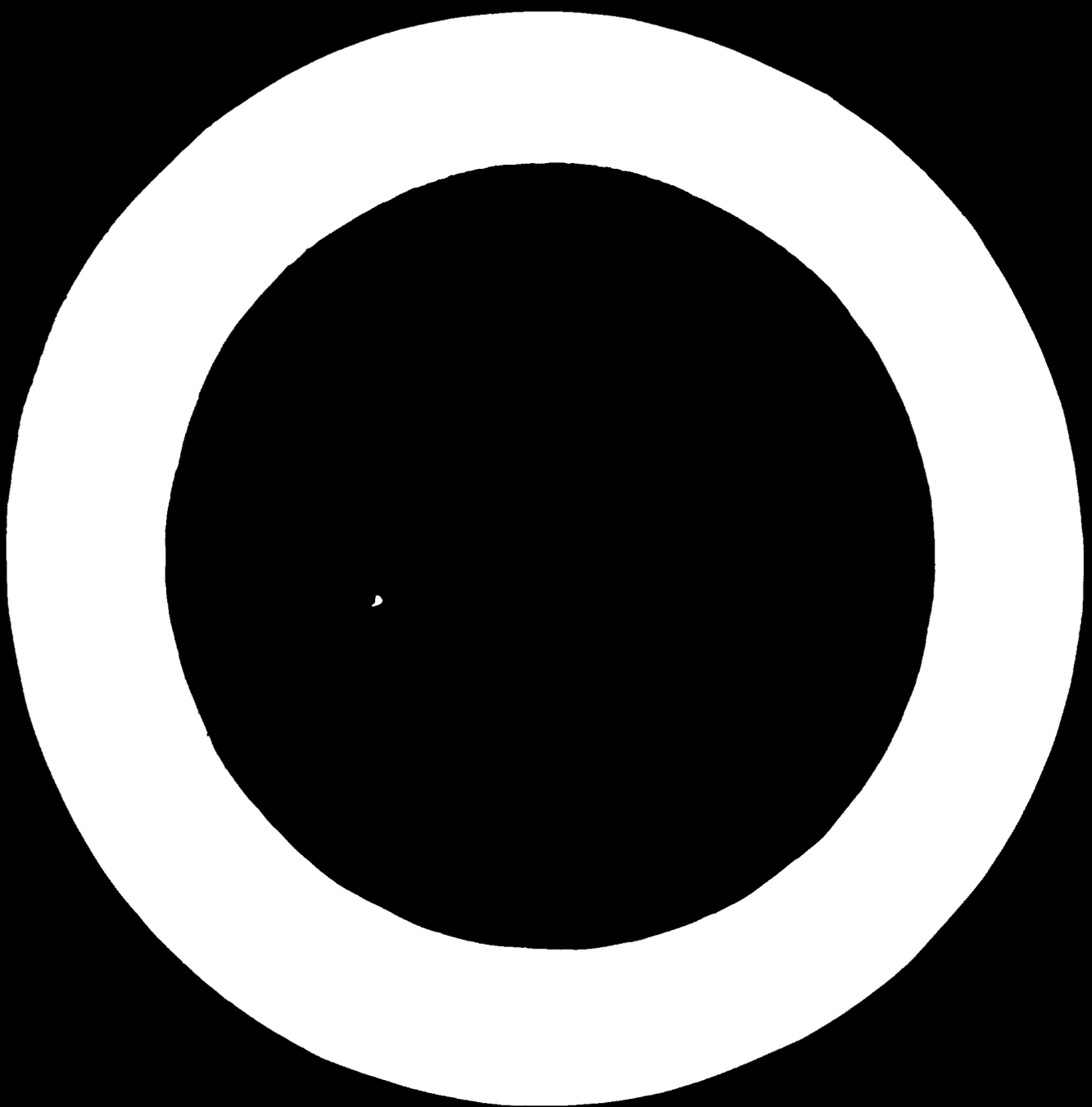
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
VIENNA

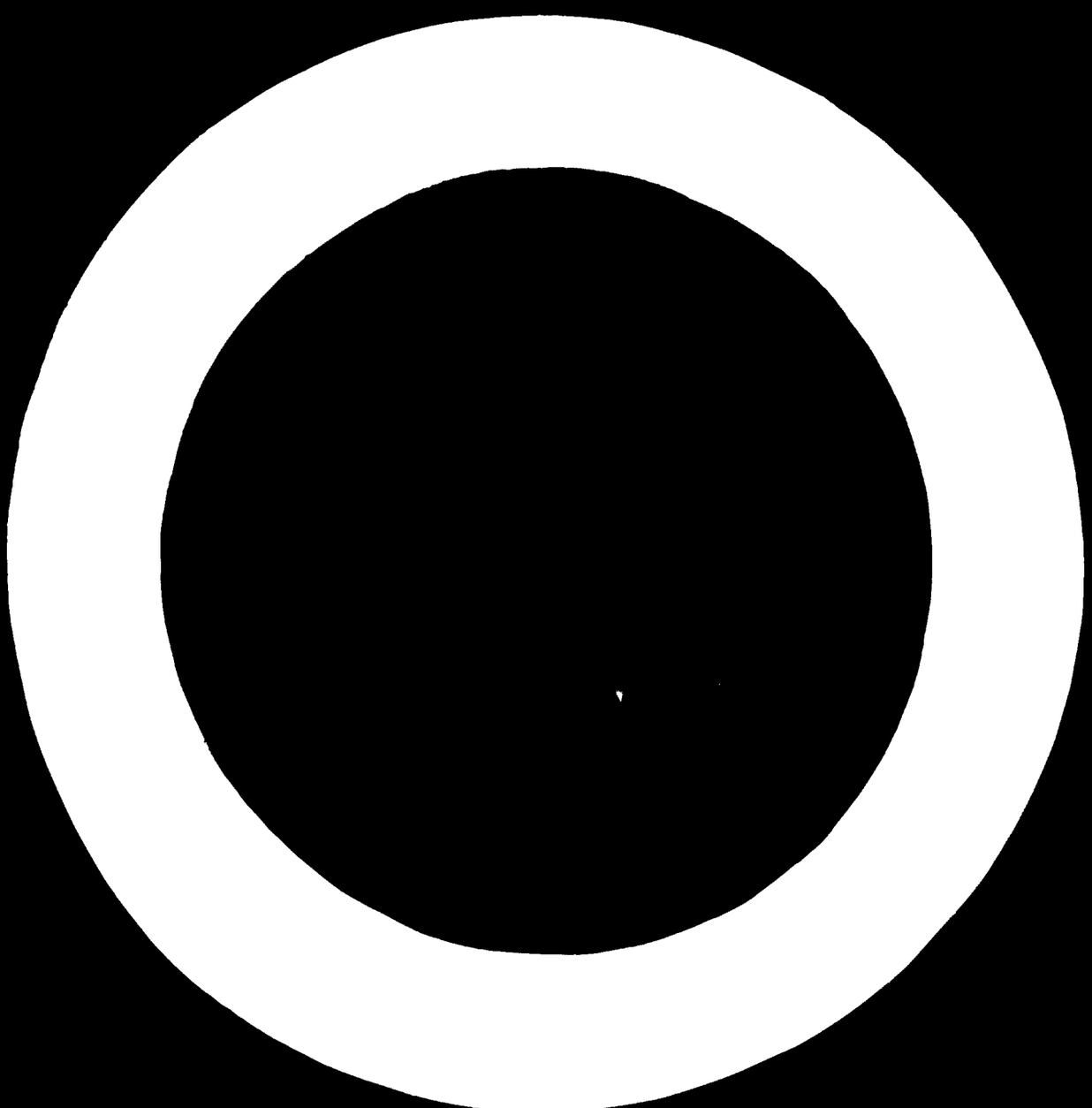
Development of Metalworking Industries in Developing Countries

Reports presented at the United Nations Interregional Symposium, Moscow 7 September—6 October 1966

Sales No.: E.69.II.B.2
ID/6

UNITED NATIONS
New York, 1969





D01184

WORLD MACHINE-TOOL PRODUCTION WITH SPECIAL REFERENCE TO DEVELOPING COUNTRIES

Secretariat of the United Nations Centre for Industrial Development

INTRODUCTION

Within the metalworking industry, the machine-tool industry plays a key role in the expansion of world industrial production since every branch of manufacture, whether durable consumer goods or machinery and equipment, is dependent on metalworking machinery.

This report presents a preliminary study of the current position of the industry in its global context and in the context of the developing countries.

Three conclusions emerge: world production has risen rapidly since the Second World War; production is carried out largely in small to medium establishments; and, production is concentrated in the industrial countries.

The developing countries, if China (mainland) is excluded, contributed less than 2 per cent of the total production in 1962. Even this was accounted for by only a few countries.

Such a concentration leads to a high volume of international trade and the total dependence of a large number of developing countries on imports of machine tools for industrial production. World exports of machine tools have been rising rapidly; between 1955 and 1962, they increased threefold in value.

Consumption of machine tools in the developing countries, although increasing, is still below 10 per cent of the world total. Several observations are made in the study of the problems of meeting the increasing requirements of the developing countries. First, foreign exchange difficulties make it necessary that some portion of the national requirements of the developing countries is met by establishing domestic production, perhaps of simpler tools at the beginning. On the other hand, the variety of machine tools needed is so great that reliance will have to be placed on imports to supply a substantial proportion of the requirements. In either circumstance, it is imperative that adequate facilities for the repair and maintenance of machine tools be established by the developing countries as a matter of urgency. Other matters to be considered are the establishment of centralized metalworking units (shops or plants), specialization and large-scale production of more universal tools (such as bolts, nuts, screws and other fasteners) to economize on producing equipment, and the possibilities of importing second-hand machine tools.

THE ROLE OF THE MACHINE-TOOL INDUSTRY IN INDUSTRIALIZATION

The machine-tool industry is unique in that it produces machines which form the basis for the production of all modern machinery, devices and tools for industry, transport and agriculture. The industrial development of a country is dependent, to a considerable extent, on the number of machine tools it possesses, their age, quality and technical state.

It is recognized that one method of indicating the level of industrial development of a country is by the output of machinery and other equipment as a percentage of total output of the country. This can be seen from a comparison of the output of machinery and equipment as a percentage of total industrial output in highly developed industrial countries such as Czechoslovakia, 34 per cent; Eastern Germany, 33 per cent; France, 38 per cent; Germany (Federal Republic), 39 per cent; Soviet Union, 22 per cent; United Kingdom, 40 per cent, and the United States, 34 per cent, with countries at a lower level of industrial development, such as Burma, 2 per cent; Chile, 5 per cent; Pakistan, 3 per cent; Peru, 1 per cent; Philippines, 4 per cent, and Rhodesia and Nyasaland, 2 per cent.[1]

The machine-tool industry has a key role to play in the expansion of the production of capital goods at any stage of industrialization. It may be particularly important in developing countries whose capacity to import is limited. During the process of industrialization, developing countries often suffer a shortage of foreign exchange at the same time as they desire to increase their rate of investment. Currently, there is no single branch of the manufacturing industry in which a high proportion of metalworking machinery is not used. There is a close connexion between a country's level of industrial development and the technical and economic structure of its machine-tool industry.

A developed machine-tool industry is a relative latecomer to a developing country since it depends on the demand of a developed domestic metal-transforming (engineering) industry, or the development of an export market for its output. The production of other than the simplest machine tools, moreover, requires the existence of a highly skilled labour force. Consequently, machine-tool industries existed until recently only in the highly industrialized countries, and these remain the suppliers of machine tools to the developing world.

It will be shown, however, that the industrial countries

[1] *Production and Export of Mechanical and Electrical Engineering Goods*, United Nations, Geneva (1963), p. 3 (figures are for 1960, except Chile, 1957; Philippines, 1956; Pakistan, 1953; Burma, 1953; Rhodesia and Nyasaland, 1953; Peru, 1954); and *World Economic Survey, 1961*, United Nations, N.Y. pp. 28–29.

are also the largest importers of machine tools and that the development of a national machine-tool industry does not necessarily lead to a decline in imports of these tools.

In developing any sector of the national economy, continuous technical progress and the rise of labour productivity are accelerated by advanced machinery and techniques. The rate of industrialization and technical progress in the highly industrialized countries are partly dependent on the progress of their machine-tool industry which could be considered as the heart of the machine-building industry. Indeed, the cost of metalworking machine tools, foundry and woodworking machinery and equipment constitutes approximately a half of the total expenditure for equipment, or about 20-25 per cent of all capital expenditure involved in the building of a mechanical or machinery manufacturing plant in industrial countries.[2] This alone indicates the role of the machine-tool industry in an industrial economy and in the machinery production industry in particular. It is important, therefore, to make an early analysis of the possibilities which exist for the establishment of a machine-tool industry in developing countries, to determine the appropriate scale of production, and what types of machine tools it would be best to produce.

Although the establishment of a machine-tool industry presupposes the existence of metal producing and engineering industries, it is important that the possibilities for the establishment of a machine-tool industry should be examined by developing countries, along with other plans for industrialization.

Definition of the machine-tool industry and classification of machine tools

The term "machine tools" is widely used to describe a group of machines which are used in the metalworking industry to convert the raw material of the metal-producing industry or other products into different machine parts of various shapes and dimensions.

The term can include different categories of machinery depending on the country, language or even the subject under discussion. It has a number of different interpretations even in English, excluding such a broad definition as "tool worked by machinery, not by hand"[3] or a more precise definition such as "power driven machine designed for shaping solid work by tooling either by removing material (as in a lathe or milling machine) or by subjecting to deformation as in a punch press".[4]

In practice, there is no standard rule indicating which machines are included in the category of machine tools. In one country, the category includes only metalworking machine tools, in another, woodworking machines and stoneworking machines are also included. In a third country, metal-cutting machine tools and woodworking machine tools are included in the category "machine tools", but metal-forming machine tools form another group of machines.

In two well-known classifications, the Brussels Nomenclature for the classification of goods in customs tariffs (1955 and 1964) and the United Nations Standard International Trade Classification (SITC), the term "machine tools" is used in its widest sense and applies to metal cutting, metalworking and woodworking, as well as to machines for working stone, ceramics, concrete, and some other mineral materials and cold glass. In specialized technical and economic literature, however, as in the present study, the term "machine tools" is used in its narrowest sense in which only metalworking machine tools are included.

Metalworking machine tools include a large variety of types which differ in size, means of control, purpose for which they were designed and scale of production. There are more than thirty different classes of metalworking machine tools built in more than 1,500 sizes and types to meet different needs.

According to the shaping method used, metalworking machine tools are divided into two major groups, one of which is metal-cutting machine tools and the other metal-forming machine tools.

The former includes lathes, drilling, boring, grinding and polishing, milling, broaching, gear cutting and grinding, planing, sawing, shaping, slatting and several others; the latter includes bending, forging, presses, shearing, sheet and plate-working machines, thread-rolling machines and several others.

This division is determined by the kind of metalworking process. Almost every kind of machine tool mentioned above can be further divided according to the design fixtures and the surfaces to be machined, such as vertical, horizontal, radial, floor or table type, internal, surface, single- or multi-spindle, single- or multi-heads, capstan, centre, bench or pedestal, single or double column, single or double action, friction or hydraulic action, etc.

Metal-cutting machine tools are divided by the degree of accuracy of their performanee: normal accuracy, precision, etc. Machine tools can be either general all-purpose machine tools or specialized for a particular product or particular type of production. In this respect machine tools can be automatie, semi-automatie, combined into automatic transfer machine lines and/or with numerical control.

Classification of machine tools by size and weight is also important. The weight of an ordinary machine tool does not exceed 10 metric tons. The weight of heavy machine tools is between 10 and 100 metric tons. Machine tools which exceed 100 tons should be considered as particularly heavy or unique.

Grinding and gear-cutting machine tools are exceptions. In this case, heavy machine tools weigh from 10 to 60 tons and particularly heavy machines weigh more than 60 tons.

It is possible that any particular machine part could be produeed by a large range of machine tools, but only a few of these could produce it efficiently and only one would be the best choice for the particular job. That is why it is important to have a scientifically constructed standard international classification to facilitate international trade and customs requirements and the selection of the correct machine tool for a particular purpose.

[2] *Economic Gazette*, No. 32 (105), 10 August 1963, USSR.
[3] *Concise Oxford Dictionary*, 1960.
[4] *Webster's Third New International Dictionary*, 1964.

For convenience, a classification usually uses some form of code, which gives a number to class, group or subgroup of machine tools. As a first step, a national classification is essential, but the creation of an internationally accepted standard classification of machine tools would be of considerable benefit to all nations. This could be discussed at forthcoming international seminars or symposia on the problems of engineering industries.

World production of machine tools

As a preliminary step in the study of this industry, this survey is to review the world pattern of production and trade in machine tools and relate the development of the industry to the level of industrialization. "Within the machine-building industry (however), machine tools are perhaps the most difficult to study. The great variety of types and models produced, the possibilities of interchanging them in carrying out a given job, the constant technical improvements which are being introduced and the varying levels of automation that can be obtained all combine to introduce great analytical complexities"[5] in the examination of this industry. The findings, therefore, must be considered provisional, as there is a great scarcity of relevant statistical material, and much that is available is of dubious accuracy.[6] It is possible, however, to present a reasonably accurate picture of the world industry and to highlight some of the considerations in an attempt to promote its expansion in developing countries.

Before the Second World War, the production of machine tools was largely in the hands of the United States, a few European countries and Japan. Destruction in the war left the United States as the major producer, but recovery in the other producing countries has been rapid indeed. The value of world production increased by 76 per cent between 1955 and 1962, which was greater than the increase in either the value of total world manufacturing (ISIC 2–3) or in metal products (ISIC 35–38) during the same period.[7] The largest country increases have been in Germany (Federal Republic), 142 per cent; Soviet Union, 136 per cent; Japan, 1,900 per cent; Italy, 325 per cent; mainland China, 276 per cent, and India, Argentina and Brazil with 1,200 per cent, 280 per cent and 527 per cent respectively.[8]

In 1962, the value of world production of machine tools reached $4,300 million. The United States produced 19.6 per cent of the world's machine tools; Germany (Federal Republic), 19 per cent; the Soviet Union, 16.4 per cent; the United Kingdom, 8.7 per cent; Japan, 6.4 per cent; France, 5.4 per cent; Italy, 4.3 per cent; Eastern Germany, 3.7 per cent; Czechoslovakia, 3.2 per cent, and Switzerland, 2.9 per cent.

These ten largest producers of machine tools together produced 89.6 per cent of the total value of world production of machine tools in 1962. There are at present about thirty countries which together produce 99 per cent of total world production of machine tools. Ten years ago this number was half of what it is today. With a few exceptions, all countries of Europe, including Spain and Portugal, and India, Argentina, Brazil and other countries of Asia, Africa and Latin America now have their own machine-tool industry.

In spite of the growth of the machine-tool industry in developing countries, their share in the value of world production of machine tools remains negligible: 3.6 per cent of the world production of which China produced 1.9 per cent, India and Argentina about 0.6 per cent each and Brazil a little more than 0.5 per cent.

The world production pattern as between industrial and developing countries has not changed. Three countries, the Federal Republic of Germany, the United States and the Soviet Union still produce more than half the value of the world's machine tools. In 1964, they produced 57 per cent, the ten largest producers 90 per cent, and all others only 10 per cent.

A comparison of the production of machine tools *per capita* gives another interesting picture. The production of machine tools *per capita* of twenty-one countries is given in table 1. The table shows this indicator for 1960 and 1962, and the change in absolute and *per capita* production during this period. All countries shown in the table, except China (mainland), increased their production of machine tools *per capita*.

The highest rate of increase occurred in Japan with 360 per cent; the next four are Brazil with 237 per cent; India, 228 per cent; Belgium, 177 per cent, and Italy, 168 per cent. The Federal Republic of Germany, the Soviet Union and the United States achieved 141 per cent, 115 per cent and 109 per cent respectively.

In 1962, Switzerland had the highest value of produc-

[5] United Nations, *Report of the United Nations Seminar on Industrial Programming, São Paulo, Brazil (4–15 March 1963)*, p. 23 (Sales No.: 64.II.B.8).

[6] The statistics available on the machine-tool industry present important shortcomings. Data on output are scanty. The lack of a standard international classification system and the great variety of machine tools available has made the presentation of consistent world figures difficult.

Unless otherwise indicated, the data on imports and exports of machine tools used here has been taken from the United States Department of Commerce, Business and Defense Services Administration, *World Trade in Machine Tools*, 1955-58 and 1959-60. Some countries have been precluded from the analysis because of insufficient data. The export and import data compiled by the Department has been "derived from the exports of countries making significant shipments of machine tools". Import data was derived from the export figures of the countries of origin to avoid the wide variations in the methods of reporting imports. Only data from the principal exporting countries was used, so that complete world coverage is not available. The Department of Commerce estimates that the resulting error is less than 5 per cent and is relatively constant. National currencies have been converted to United States dollars at the official exchange rate or, where necessary, the rate ruling in the world market.

The major source of production data was the *American Machinist*, 1964 Production Preview, Special Report No. 546 (20 January 1964). These figures must be considered as approximate only. Their source was a private report by the European Committee for Co-operation of the Machine Tool Industries.

Export data calculated from this published information on the percentage of national production exported does not agree with the United States Department of Commerce data on exports of machine tools.

[7] World, including USSR and Eastern Europe. Percentage increase 1955–1962, in value of total manufactures, 37 per cent; in metal products, 41 per cent. United Nations *Monthly Bulletin of Statistics*, August 1963: Special Table A; Index numbers of industrial production, excluding USSR and Eastern Europe.

[8] For production figures see Annex I at end of chapter.

tion of machine tools *per capita* with $22.40; the Federal Republic of Germany $15.20 and Czechoslovakia and Eastern Germany $10.40. At the same time, the value of India's production of machine tools was less than US 6 cents *per capita*, which is 0.003 per cent of that in Switzerland.

The concentration of production in the industrial countries has contributed to the establishment of a highly developed trade pattern, as most of the developing countries are dependent for their supply of machine tools on imports from the industrial producers. The development of the trade in machine tools has also been due to the structure of the industry, particularly in the United States and Western Europe.

The structure of the machine-tool industry in the main capitalistic countries has not changed markedly since then. It can be seen for the United Kingdom in table 3 in which the structure of the British machine-tool industry for 1935-1955 is given, and in table 4 where the structure of the United States machine-tool industry in 1958 is shown. Detailed industry data is unavailable since then, but it is known that in England in 1959 there were more than 300 firms consisting of 1,130 establishments in 340 of which ten or fewer persons were employed.[9] In the United States in 1963 there were 413 establishments with twenty or more employees and the total number of employees was 73,779.[10]

This type of industry structure in the United States and Western Europe has led to the growth of tightly knit national trade associations and a resistance to the implementation of a standard international system of classification.

Table 1

PRODUCTION OF MACHINE TOOLS *PER CAPITA* IN 1960 AND 1962

Country	Population in millions		Production of machine tools per capita (in US dollars)		Increase in production between 1962 and 1960 (1962 as a percentage of 1960)	
	1960	1962	1960	1962	Production	Production per capita
Switzerland	5.4	5.7	19.7	22.4	120	114
Germany (Federal Republic)	54.0	54.8	10.8	15.2	148	141
Czechoslovakia	13.7	13.9	9.8	10.3	108	102
Eastern Germany	17.2	17.1	8.3	9.7	112	117
United Kingdom	52.7	53.4	5.1	7.1	142	139
France	46.5	47.0	3.4	5.4	159	154
Sweden	7.5	7.6	4.3	5.3	125	126
United States	179.3	186.6	4.4	4.6	109	109
Italy	49.4	50.2	2.2	3.7	172	168
USSR	208.8	221.5	2.9	3.35	119	115
Belgium	9.2	9.2	1.9	3.3	170	177
Hungary	10.0	10.1	2.5	3.2	128	128
Japan	93.4	94.9	0.8	2.9	375	360
Austria	7.1	7.1	1.5	2.0	136	137
Poland	29.7	30.3	1.66	1.73	119	105
Netherlands	9.6	11.8	1.1	1.55	169	141
Argentina	20.0	21.4	1.16	1.2	109	107
Canada	18.2	18.6	0.77	0.81	109	105
Brazil	71.0	75.3	0.131	0.31	250	237
China (mainland)	582.6	700.0[a]	0.13	0.11	100	085
India	435.0	449.4	0.025	0.057	238	228

Sources: *World Trade in Machine Tools*, United States Department of Commerce, *Machine-Tool Survey*, McGraw-Hill, New York; *Statistical Yearbook, 1963*, United Nations, New York.
a Proximate.

STRUCTURE OF MACHINE-TOOL INDUSTRY IN INDUSTRIAL COUNTRIES

In the United States and Western Europe, the machine-tool industry was mainly founded by superior individual craftsmen who developed their product principally by personal ingenuity and established family operations. With the gradual modernization of the industry, and the proliferation of types and sizes and the increased complexity of machine tools, the average size of the firms increased. The industry, however, is still characterized by a relatively large number of small manufacturers compared with their customers in other engineering industries. Manufacturers specialize in a few or perhaps only one particular line, with some firms even specializing in particular sizes or qualities of their individual line. Table 2 shows the size of establishments in the United States, France and the United Kingdom at the end of the war.

WORLD TRADE IN MACHINE TOOLS[11]

Specialization is a marked feature of the machine-tool industry internationally. This means that a substantial volume of imports is normal even in those countries where the industry is most developed.

Following the Second World War, the United States was the major world supplier, but the recovery of trade in machine tools has been even more rapid than that of

[9] Surveys of British Industry, No. 6. *The Machine Tool Industry*, Far East Trade, Supplement (Nov. 1959).
[10] *A Guide to the McGraw-Hill Plant Census*, McGraw-Hill, New York (1963).
[11] See Annex II at end of chapter.

Table 2

STRUCTURE OF MACHINE-TOOL INDUSTRY IN FRANCE (1949), THE UNITED STATES (1947) AND THE UNITED KINGDOM (1947)

France			*United States*			*United Kingdom*		
Size of establishments (number of persons employed)	*No. of establishments*	*Percentage*	*Size of establishments (number of persons employed)*	*No. of establishments*	*Percentage*	*Size of establishments (number of persons employed)*	*No. of establishments*	*Percentage*
0–49	60	50.0	0–49	431	57.9	1–49	104	46.4
50–99	30	25.0	50–99	95	12.8	50–99	38	17.0
100–249	16	13.4	100–249	106	14.2	100–299	55	24.6
250–499	8	6.6	250–499	53	7.1	300–499	13	5.8
500–999	6	5.0	500–999	34	4.6	500–749	3	1.3
1,000–2,499	—	—	1,000–2,499	20	2.7	750 or more	11	4.9
2,500 or more	—	—	2,500 or more	5	0.7			
Total	120	100.0		744	100.0		224	100.0

Source: ECLA, *The Machine Tools Industry in Brazil: Background Material for the Programming of its Development* (1962), E/CN.12/633, p. 69.

Table 3

STRUCTURE OF THE MACHINE-TOOL INDUSTRY IN THE UNITED KINGDOM IN 1935, 1947 AND 1955

Size of establishments (no. of employees)	*1935*				*1947*				*1955*			
	Establishments		*Employees*		*Establishments*		*Employees*		*Establishments*		*Employees*	
	No.	*Percentage*	*Total*	*Percentage*	*No.*	*Percentage*	*Total*	*Percentage*	*No.*	*Percentage*	*Total*	*Percentage*
11–24	17	13.8	304	1.4	49	22.0	1,050	2.3	55	20.0	986	2.2
25–49	31	24.7	1,118	5.3	55	24.6	2,570	5.6	70	25.4	2,520	5.6
50–99	28	22.9	2,124	10.0	38	17.0	3,610	7.9	56	20.4	3,852	8.7
100–199	23	18.8	3,065	14.6	42	18.7	7,380	16.3	38	13.8	5,092	11.4
200–299	11	9.0	2,713	12.9	13	5.7	4,100	9.1	20	7.3	4,838	10.8
300–499	3	2.5	1,221	5.8	13	5.7	6,430	14.2	20	7.3	7,472	16.7
500–749	3	2.5	1,846	8.7	3	1.4	2,240	4.9	4	1.4	2,347	5.2
750 or more	7	5.8	8,691	41.3	11	4.9	18,050	39.7	12	1.4	17,645	39.4
Total	123	100.0	21,082	100.0	224	100.0	45,430	100.0	275	100.0	44,752	100.0

Source: *The British Machine Tool Industry*, Machine Tool Trades Association, London (1958).

Table 4

STRUCTURE OF THE MACHINE-TOOL INDUSTRY IN THE UNITED STATES OF AMERICA IN 1958

Size of establishments (no. of employees)	*No. of establishments*				*Average employment per establishment*	*Value of shipments*	
	Metal-cutting machine tools	*Metal-forming machine tools*	*Total*	*Percentage*		*Thousands of US dollars*	*Percentage*
1–4	213	60	273	29.8	2	9,093	9.0
5–9	99	41	140	15.3	7	13,326	1.4
10–19	84	43	127	13.9	14	24,063	2.4
20–49	88	65	153	16.7	32	65,881	6.6
50–99	47	30	77	8.4	70	78,489	7.9
100–249	48	31	79	8.6	160	179,484	18.0
250–499	21	10	31	3.2	351	161,453	16.2
500–999	17	9	26	2,8	757	263,626	26.4
1,000 or more	10	2	12	1.3	1,275[a]	202,088	20.2
Total	627	291	918	100.0	80	997,503	100.0

Source: United States Department of Commerce, Bureau of the Census, *1958 Census of Manufactures.*
[a] Estimated. For metal-cutting alone, 1,739.

production. Between 1955 and 1960, the percentage increase in the value of world exports of machine tools was 71.6 per cent, compared with an increase of 35.1 per cent in the value of production. This increase in trade has also far outstripped the rate of growth of the value of total world exports.

Table 5

TRENDS IN WORLD EXPORTS 1955–1960 (INCLUDING EASTERN EUROPE AND THE USSR)

(millions of US dollars, f.o.b.)

Year	*All commodities*[a]	*Machine tools*[b]
1955	93,700	439
1957	111,800	641
1960	127,700	753

[a] *United Nations Yearbook of International Trade Statistics* (1962), table A.
[b] United States Department of Commerce, Business and Defense Services Administration, *World Trade in Machine Tools* (1955-58, 1958-60), Washington, D.C.

By 1955, the United States had fallen to second place, behind the Federal Republic of Germany, as a world exporter; it has remained there since. These two countries exported 28 per cent and 30 per cent, respectively, of total machine tools in 1960, with the United Kingdom the third largest exporter with 10 per cent. Switzerland exported 9 per cent of the world total; Czechoslovakia, 5.8 per cent; Italy, 4.8 per cent, and France, 4.5 per cent.

All other exporters contributed less than 8 per cent of the total, but included in these are a number of smaller countries which exported more than 50 per cent of their production. (For example, Austria, Belgium, Netherlands and Sweden.) In some countries, domestic demand fostered the development of special skills and know-how, and the product pattern of exports reflects the product pattern of production.

In others, however, export demand has resulted in the specialization in the production of certain types of machine tools which are less related to the pattern of domestic demand. Further analysis of this question would require data on the proportion of output exported for different kinds of machine tools.

The degree of international specialization is indicated by the value of imports as a percentage of exports of the major exporting countries (see table 6). Between 1955–60 only six countries, the Federal Republic of Germany, the United States, Czechoslovakia, Switzerland, the Soviet Union and the United Kingdom imported less than they exported. Imports of all other countries were larger than exports. This is particularly true of Japan whose average annual imports were ten times its exports between 1955 and 1960 and, in 1958 alone, fourteen times exports.

Belgium, the Netherlands and Switzerland exported nearly three-quarters of their annual production during the period of 1955-1962. Czechoslovakia, Austria and Sweden exported about two-thirds of their production during the same period. The Federal Republic of Germany and Hungary exported about half.

World exports of machine tools in 1960 were directed in more than sixty countries but approximately 50 per cent of total world exports have been taken by the major exporting industrial countries themselves.

The world's largest exporters of machine tools are also among the leading importers. In 1962, for example, the Federal Republic of Germany was the largest exporter and the second largest importer.

Table 6

IMPORTS AS A PERCENTAGE OF EXPORTS OF MACHINE TOOLS

(in United States dollar value)

Country	*Percentages*					
	1955	*1956*	*1957*	*1958*	*1959*	*1960*
Germany (Federal Republic)	18.2	16.4	13.7	13.6	19.2	25.4
United States	11.8	15.1	16.5	14.2	20.3	13.5
United Kingdom	85.5	111.4	71.9	63.9	60.1	77.7
Switzerland	27.3	38.2	37.9	33.2	27.8	26.4
Czechoslovakia	5.4	10.6	18.4	24.9	14.2	1.9
Italy	182.3	154.9	145.2	97.0	73.3	113.9
France	256.6	300.9	368.5	421.0	216.7	158.0
USSR	40.3	38.8	79.7	33.8	109.4	261.0
Sweden	150.0	100.1	87.1	84.3	124.9	146.7
Belgium-Luxembourg	119.2	105.5	102.1	89.5	85.9	105.9
Netherlands	360.4	329.6	349.8	250.3	260.6	304.6
Japan	362.8	391.0	970.6	1,452.6	1,074.2	991.9
Denmark	100.2	99.8	98.0	125.4	239.5	191.1

Source: U.S. Department of Commerce, Business and Defense Services Administration, *World Trade in Machine Tools* (1955–1958; 1959–1960).

Table 7

VALUE OF TOTAL IMPORTS AS A PERCENTAGE OF TOTAL EXPORTS OF THE MAJOR MACHINE-TOOL EXPORTING COUNTRIES

1955	*1956*	*1957*	*1958*	*1959*	*1960*
52	55	55	48	50	58

Table 8

MACHINE-TOOL EXPORTS FROM EUROPEAN COMMITTEE NATIONS AND THE UNITED STATES

(in percentages)

Destination	Eur. Com. nations			United States		
	1960	1961	1962	1960	1961	1962
European Committee nations[a]	45.5	51.5	56.3	44.1	44.2	41.0
Other European nations	6.5	6.2	4.6	0.9	1.8	1.2
Eastern Europe	7.5	6.7	6.2	0.1	0.4	0.1
Africa	3.5	2.9	2.9	0.9	0.9	0.8
North America[b]	7.0	4.5	4.5	12.5	6.7	9.7
Latin America	9.5	8.6	7.3	17.3	15.8	15.6
Asia	16.0	16.2	15.0	21.5	27.7	26.6
Oceania	5.0	3.2	2.3	2.7	2.5	5.0

Source: American Machinist (9 December 1963).
[a] European Committee nations' exports to other European Committee nations.
[b] United States exports to Canada.

The main direction of the flow of machine-tool exports can be seen in table 8 for the two groups of larger exporters, the twelve nations of the European Committee[12] and the United States in 1960–62.

If the imports taken by the smaller industrial European countries of Austria, Spain, Finland, Poland, Yugoslavia, Hungary and Eastern Germany, and the semi-industrial countries of Canada and Australia are added to those of the major machine-tool exporting countries (see table 9), only about 30 per cent of world trade in machine tools is with the developing countries.

Table 9

MACHINE TOOLS: VALUE OF IMPORTS OF DEVELOPING COUNTRIES AS A PERCENTAGE OF THE VALUE OF TOTAL WORLD EXPORTS

1955	1956	1957	1958	1959	1960
28	27	28	36	32	27

Table 10

AVERAGE YEARLY MACHINE-TOOL CONSUMPTION OF SELECTED COUNTRIES DURING 1957–59

(in US dollars)

Country	Million dollars	Percentage of world consumption	Country	Million dollars	Percentage of world consumption
United States	685.7	24.20	China (mainland)	59.5	2.10
Soviet Union	482.6	17.00	Brazil	46.0	1.65
Germany (Fed. Rep.)	274 5	9.75	India	34.2	1.20
United Kingdom	224.9	8.00	Argentina	30.3	1.10
France	198.9	8.10	Mexico	8.7	0.30
Eastern Germany	92.7	3.30	Venezuela	5.2	0.10
Japan	88.3	3.10	Turkey	3.1	0.10
Czechoslovakia	87.1	3.05	Colombia	1.54	0.055
Switzerland	59.5	2.10	Iran	1.36	0.050
Italy	58.7	2.05	Philippines	0.99	0.035
Canada	50.9	1.85	Peru	0.93	0.030
Poland	37.4	1.35	Indonesia	0.79	0.025
Sweden	29.8	1.05	Iraq	0.39	0.015
Australia	26.4	0.95	Ethiopia	0.11	0.005
Netherlands	18.9	0.65	Ghana	0.04	0.002
Hungary	17.1	0.60			
Austria	14.8	0.55	Developing countries Total	193.15	6.8
Belgium	13.8	0.50	Total, included countries	2,532.25	94.1
Finland	3.9	0.15	Other countries[a]	165.0	5.9
Industrialized countries Total	2,465.9	87.3	World total	2,824.05	100.0

[a] Other industrialized countries for which similar data was not available included Denmark, Spain, Yugoslavia, Norway, Portugal and Romania, total consumption of which is not likely to exceed $1 million a year.

In recent years over half of this remainder has been taken by the more industrialized of the developing countries: Brazil, Argentina, India, mainland China and Mexico. (In 1960: 4.3 per cent; 3.9 per cent; 2.3 per cent; and 1.5 per cent, respectively.)

It is clear that the production and trade of machine tools is confined very largely to industrialized or industri-

[12] The European Committee for Co-operation of Machine Tool Industries. Members: Austria, Belgium, Denmark, Federal Republic of Germany, France, Italy, Netherlands, Portugal, Spain, Sweden, Switzerland and United Kingdom.

alizing countries and that the production and even use of machine tools, except for simple repairs and maintenance, presupposes a certain level of economic development and industrialization.

World machine-tool consumption

The value of machine-tool consumption is another important indicator of the level of industrial development and the rate of a country's industrialization. In table 10, the average annual consumption of selected countries between 1957-59 is given. This period was chosen because the data was available only for those years. The ten major consumers are also the ten main producers of machine tools. Their total annual consumption was approximately 80 per cent of world annual consumption between 1957-59. The thirty-four countries which are shown in the table consumed approximately 94 per cent of the remaining consumption.

America and Asia. Consumption in Africa is negligible. Consumption in the highly industrialized countries of Europe during the five years presented in table 11 is approximately sixteen times larger than that in Asia during the same period.

The relationship between the production and consumption of machine tools and the level of industrialization

Countries can be divided into two broad groups. The first group includes those countries whose machine-tool industries are developed to the point where their exports make a significant contribution to world trade in this commodity (over $US 5 million) or comprise over 30 per cent of their production. Included in this group are the United States, Europe and the USSR. Japan is a borderline case but has been included here because of the size of its domestic industry. The second group includes

Table 11

Annual *per capita* machine-tool consumption

(in US dollars)

World region or countries	*1958*	*1959*	*1960*	*1961*	*1962*
12 countries of European Committee for Co-operation of Machine Tool Industries	3.57	3.57	4.47	5.77	5.84
USSR and countries of Eastern Europe	2.36	2.46	2.87	3.20	3.27
United States and Canada	2.74	2.86	3.24	2.80	3.06
Latin America	0.56	0.63	0.70	0.76	0.79
Other European countries	0.46	0.60	0.70	0.88	0.72
Asia	0.18	0.18	0.23	0.37	0.42
World average	0.90	0.90	1.14	1.32	1.42

Source: European Committee for Co-operation of Machine Tool Industries.

African countries consume the least machine tools. Consumption in Ghana, with a population which could be compared with such European countries as Sweden, Czechoslovakia and Austria, for example, is negligible compared with these countries. The value of machine-tool consumption *per capita* also gives some idea of the industrial level of a country or group of countries. Average annual consumption *per capita* between 1958 and 1962 was $US 4.64 in the twelve countries belonging to the European Committee for Co-operation of Machine Tool Industries.[13] It was $US 2.96 in North America, $US 2.83 in Eastern Europe, $US 0.68 in Latin America, $US 0.27 in Asia and about $US 0.1 in Africa. The world average annual consumption *per capita* was approximately $US 1.1 during 1958-1962. Table 11 gives the annual *per capita* machine-tool consumption for several groups of countries.

As can be seen from table 11, annual *per capita* machine-tool consumption in the highly industrialized countries of Europe and the United States is very high compared with that of the developing countries of Latin

all other countries, the distinguishing feature of which is their lack of machine-tool exports.

Countries in the second group can be further divided into three subgroups. Subgroup I includes semi-industrialized countries such as Canada and Australia which have a developing machine-tool industry, but still depend largely on machine-tool imports, and the value of whose machine-tool exports are less than $5 million (actually less than $1 million). These countries have a developed engineering industry with more than a million persons engaged in manufacturing, and virtually all their steel consumption is provided by the domestic industry. *Per capita* figures for gross domestic product and value added in manufacturing are as high as the industrial countries, indicating a high level of economic development and welfare.

Subgroup II includes the industrializing countries of India, Brazil and Argentina. The machine-tool industries in these countries have the same characteristics as those in subgroup I. The industrial sector, however, is not as developed in subgroup II as in I, the total value added in metal products being less than 50 per cent of that in subgroup I. These countries, particularly Argentina, are also more dependent on steel imports to meet consumption

[13] Austria, Belgium, Denmark, Federal Republic of Germany, France, Italy, Netherlands, Portugal, Spain, Sweden, Switzerland and United Kingdom.

requirements. The main difference between subgroups I and II, however, is in their levels of general economic development as measured by *per capita* GDP and *per capita* value added in manufacturing.

Subgroup III is clearly distinguished from the previous subgroups. The machine-tool industry is negligible or non-existent, consumption requirements being met from imports. The engineering industry is similarly undeveloped, and there are less than 400,000 engaged in total manufacturing. These countries are also characterized by low levels of living as measured by the general economic indicators of *per capita* GDP and value added in manufacturing.

It is clear from this classification that the machine-tool industry is a late-comer in the process of industrialization and the scope for the expansion of the industry in developing countries is very great. In both the semi-industrialized countries of subgroup I, and the more highly developed of the developing countries in subgroup II, the consumption of machine tools is still primarily met from imports. Consumption, except of simple tools for repairs and maintenance, is dependent on a developed engineering industry as exists only in the few more industrialized of the developing countries such as India and Brazil. It is also clear that the existence of a machine-tool industry is not correlated with general economic development as measured by *per capita* gross domestic product, but rather with the absolute size of the industrial sector.

The process of development of the machine-tool industry has in the past involved the gradual substitution of domestic production for imports, beginning with the least complex types of tools. If the experience of the industrialized countries is repeated in the developing areas, however, the absolute value of machine-tool imports will not necessarily decline. As a country's production increases, so will the value of its exports as it tends to specialize in the production of certain types of tools, at the same time maintaining its imports of other specialized tools. It can be expected that the increased development of the machine-tool industry will increase the volume of world trade in this field.

Conclusions

Developing countries' share in world machine-tool production

During the past decade, Europe and the United States continued to consolidate their position as the world's leading machine-tools producing areas. In 1964, the total value of machine-tool production was estimated at $4,700 million, an increase of 6 per cent over the 1963 total of $4,400 million and almost double that of 1955. As in previous years, three countries accounted for over 50 per cent of world machine-tool production in 1964: United States (25 per cent), USSR (17 per cent) and Federal Republic of Germany (15 per cent). The share of all the developing countries in world machine-tool production remains only about 8 per cent and the share of individual developing countries is still very small (for example: India 0.8 per cent, Brazil 0.67 per cent). In contrast with the relative stability of other countries, Japan's production has grown rapidly from 0.55 per cent of world production in 1955 to 6.5 per cent in 1961. During this period, Japan moved from fourteenth to the fifth largest machine-tool producer.

Share of developing countries in the world trade of machine tools

Only imports of machine tools into developing countries can be discussed, as their exports are negligible (less than 0.03 per cent of the total world exports). Their share of world imports is also comparatively small. Table 12 shows the distribution of world imports of machine tools from the main exporting countries (United States and Europe), the exports of which represented 85 88 per cent of total world export between 1955 and 1962.

The industrial regions include practically all countries of Europe, North America, Japan and Oceania. Japan is excluded from Asia, so the figures for Africa, Latin America and Asia include only developing countries. It can be seen that the industrialized countries absorbed between four-fifths and three-quarters of world exports during this period. Even though the average annual rate of increase of imports by the Latin American and Asian countries was higher than that of the industrialized countries during this period (Asia, 19 per cent, Latin America, 16 per cent, industrialized area, 15 per cent), the share of world imports did not increase perceptively.

In 1962, the share of world imports of machine tools reached 9.5 per cent in Latin America and 6.4 per cent in Asia. The average annual increase of machine-tool imports into Africa was only 8 per cent over the period but its share of the total world machine-tool imports was only 2.4 per cent in 1962. Annual machine-tool imports into developing countries was not stable during this period, and the accumulation of imported machine tools in the developing countries was a fraction of the accumulation in industrial countries (in Latin America, a seventh less, in Asia, a ninth and in Africa, a twenty-seventh.[14]

Developing countries' share in the world consumption of machine tools

The low rate of production and import of machine tools into developing countries has produced a low level of consumption of machine tools as compared with that in developed countries. This gap widened during the past five years since world machine-tool production increased at an average rate of 12 per cent *per annum* while the developing countries reduced their imports, which form the main share of their consumption, and even decreased their production in some years.

Imports into Asia and Latin America were lower during 1960–64 than during the 1955 59 period. The average annual increase of imports into Latin America was only 3 per cent during 1960–1962 compared with 26 per cent during 1955–1959. For Asia, these figures were

[14] See table 12, total for 8 years.

Table 12

SHARE OF WORLD MACHINE-TOOL IMPORTS FROM THE UNITED STATES AND THE MEMBER COUNTRIES OF THE EUROPEAN COMMITTEE OF MACHINE-TOOL INDUSTRIES, OF THE INDUSTRIALIZED AND DEVELOPING COUNTRIES IN 1955–1962

(in millions of Swiss francs)

	Imports of				
	Industrialized countries (Europe, North America, Japan and Australia)	*Africa*	*Latin America*	*Asia (Japan excluded)*	*Totals*
1955					
Value	1,524	66	180	105	1,881
Percentage	81.0	3.5	9.5	5.6	100.0
1956					
Value	1,812	75	184	168	2,243
Percentage	81.0	3.2	8.2	7.5	100.0
1957					
Value	2,182	94	234	255	2,767
Percentage	79.0	3.4	8.5	9.1	100.0
1958					
Value	1,981	89	366	281	2,721
Percentage	72.0	3.3	13.5	10.3	100.0
1959					
Value	1,943	81	424	255	2,705
Percentage	72.0	3.0	15.7	9.4	100.0
1960					
Value	2,465	85	375	337	3,265
Percentage	75.0	2.6	11.5	10.3	100.0
1961					
Value	3,313	101	406	352	4,222
Percentage	78.0	2.4	9.7	8.0	100.0
1962					
Value	3,946	115	462	310	4,865
Percentage	82.0	2.4	9.5	6.4	100.0
Total for eight years:					
Value	19,170	706	2,631	2,063	24,669
Percentage	77.5	2.7	10.7	8.4	100.0
Average annual percentage increase	15.0	8.0	16.0	19.0	15.0

[a] The simple addition of the columns may not give the amount appearing under the heading "Totals" because of rounding.

Table 13

THE RATIO OF CONSECUTIVE YEARLY VALUES OF CONSUMPTION, PRODUCTION AND IMPORTS OF MACHINE TOOLS, DEVELOPING COUNTRIES AND WORLD TOTAL DURING 1955–1964

The ratio of consecutive yearly values of:	*1956/1955*	*1957/1956*	*1958/1957*	*1959/1958*	*1960/1959*	*1961/1960*	*1962/1961*	*1963/1962*	*1964/1963*
Production of machine tools by:									
Brazil	1.13	1.12	1.11	1.13	1.60	1.99	1.25	1.34	1.00
India	1.19	2.21	1.21	1.18	1.78	1.94	1.25	1.15	1.25
China (mainland)	1.11	1.10	2.02	1.44	1.05	1.00	1.00	—	—
Argentina	1.84	1.66	1.08	1.06	1.00	1.14	0.96	—	—
Developing countries	1.32	1.52	1.35	1.20	1.36	1.74	1.11	1.12	1.06
World production	1.25	1.04	0.85	1.06	1.29	1.16	1.12	1.06	1.06
Import of developing countries of:									
Africa	1.14	1.25	0.95	0.91	1.05	1.19	1.14	—	—
Latin America	1.04	1.27	1.56	1.16	0.88	1.08	1.13	—	—
Asia (Japan excluded)	1.60	1.53	1.10	0.91	1.32	1.04	0.88	—	—
All developing countries	1.26	1.35	1.20	0.99	1.08	1.10	1.05	—	—
World import	1.19	1.23	0.98	0.99	1.21	1.29	1.16	—	—

8 per cent and 28 per cent, respectively, and for Africa, 13 per cent and 6 per cent. Africa has shown a relative increase but its share of the total imports of machine tools into developing countries is only about 12 per cent. Table 13 gives the percentage yearly increase of production and imports of the world and the developing countries.

Machine-tool requirements in developing countries

The process of industrialization cannot be accelerated without an increase in the stock of efficient machine tools at the disposal of developing countries. Table 14 gives an indication of the number of machine tools at the disposal of selected countries. The determination of the quantity of machine tools that would be required by a developing country during a given period is a very complicated problem which involves the analysis of the whole programme of industrialization of the particular country. Regardless of the procedure and method used, it is clear that a census of the metalworking industry and an inventory of the machine tools available in the country should be undertaken. The findings would provide valuable information which could help to determine the machine-tool requirements of the country.

Table 14

MACHINE-TOOL INVENTORIES AND NUMBER OF PERSONS EMPLOYED IN THE METAL-TRANSFORMING INDUSTRIES IN SELECTED COUNTRIES

Country	*Number of machines*	*Number of persons employed (thousands)*	*Number of persons per machine*
United States of America	2,200,000	4,616	2.1
Soviet Union	2,350,000	4,539	1.9
United Kingdom	1,100,000	3,049	2.8
Federal Republic of Germany	1,300,000	2,419	1.9
France	500,000	1,078	2.2
Italy	363,000	595	1.6
Japan	750,000	1,350	1.8
Brazil	152,000	353	2.3
Chile	12,000	44	3.6

A study of the consumption of the quantity and types of various machine tools used in the different manufacturing industries of developed and developing countries should also be undertaken. This could provide a prototype for a rough estimate of the requirements of machine tools in planning industrial development. On the basis of such surveys, some specific models for determining the quantity and types of machine tools required for the manufacture of particular products could be prepared for the use of the developing countries in the programming of their development.

Obtaining machine tools during the process of industrialization

The importation of machine tools and the establishment and development of a machine-tool industry require the expenditure of foreign exchange. Attention should be paid to a consideration of both the importation and production of machine tools, but a number of other measures can also be taken which could help to meet the increasing demand for machine tools during the early stages of industrialization.

The first is the establishment of adequate facilities for the repair and maintenance of machine tools throughout the country. The useful life of machine tools can be quite long, as the experience of the developed countries shows (see table 15). The longer their life the greater the possible accumulation of machine tools at the disposal of developing countries.

Second, the establishment of centralized metalworking shops (or plants) which could be equipped with such machines as tool-room machines, gearworking machine tools, jig-boring machines and others, to do jobs for smaller metalworking firms which could not afford to operate such specialized machine tools. Such co-operation would permit a reduction in the number of expensive machine tools and more efficient use.

Table 15

USEFUL LIFE OF MACHINE TOOLS IN DIFFERENT TYPES OF PRODUCTION

Group	*Type or scale of production*	*Product manufactures*	*Average useful life of machine tools*
I	Mass	Passenger cars, refrigerators, radio and television sets, etc.	8 years
II	Large batch	Vehicles, transport equipment, machine tools, industrial equipment of different plants, etc.	20-22 years
III	Small batch	Maintenance, repair	24-28 years
IV	Job	One or several items produced at a time; small-scale industry	to 40 years

Third, developing countries should promote specialization in the metalworking industry from its beginning. State or privately owned specialized plants for the production of bolts, nuts, screws and other fasteners, as well as for small tools, forgings, castings and pressing and other products may be established. Such plants could use mass and large batch production equipment and by this means reduce the quantity of machine tools required in the country if the same tools were produced by a number of small factories.

Fourth, the importation of second-hand machine tools should also be considered if a market for such machine tools exists in the developed countries.

The establishment of the machine-tool industry

Some developing countries, such as Argentina, Brazil, China, India and the United Arab Republic have already established their own machine-tool industry. A study of their experiences should be undertaken and made available. This would be an important contribution. Countries which plan to establish a machine-tool industry must take account of the linkage with other industries. The existence of a number of well-developed industries is a pre-

requisite for the establishment of a machine-tool industry.

Initially, a developing country may contain machine-tool repair shops and plants, woodworking machine-tool plants and other existing mechanical works. Centralized repair shops or plants, initially established for the purpose of serving the metalworking industry, could later be developed into producing machine tools. This would encourage the accumulation of the necessary experience and skills. Another problem in developing countries is the training of designers who could develop their own machine tools. It would probably be necessary initially to purchase licences for the production of foreign machine tools. Invitations could be extended to foreign machine-tool firms to assist the developing countries in the establishment of machine-tool industries.

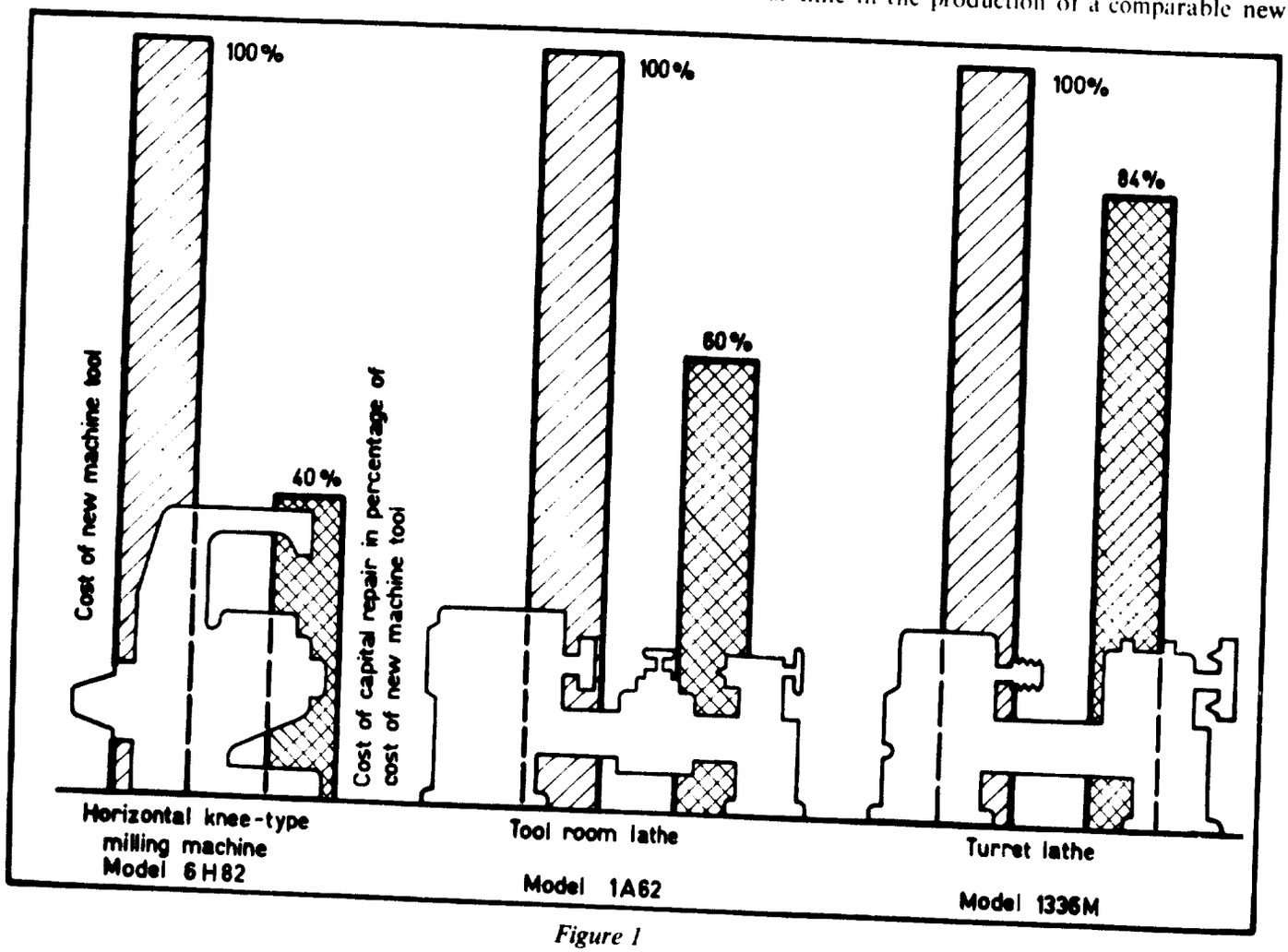


Figure 1

COMPARATIVE COST OF NEW MACHINES AND COST OF CAPITAL REPAIRS

Organization of maintenance and repair of machine tools

The provision of maintenance and repair services must be emphasized. The problem of the reliability of machine tools is of increasing importance in all countries because the development of modern machine tools is characterized by an increasing degree of automation, horsepower and speed. Imperfect organization and methods of machine-tool repair increase maintenance and repair costs which can often exceed the original cost of a machine tool (see figure 1).[15]

Research into developed countries' experiences in the field of the maintenance and repair of machine tools, carried out by the Experimental Scientific Research Institute for Machine Tools, Moscow (ENIMS) since 1959, shows that the organization of centralized repair shops and plants in a country has significant advantages over sending machine tools back to the manufacturer for repair. Research has shown that the labour time in specialized central repair plants is about 40 per cent of the labour time in the production of a comparable new machine. The production cost in the case of centralized repair in the USSR is 20–25 per cent less than that of existent practice.[16]

In developing countries where industry is centralized, it provides favourable conditions for the introduction of centralized repair plants. It would not only reduce costs but allow the use of more modern methods and require a smaller number of highly skilled personnel.

[15] *Reliability of Metalcutting Machine Tools* by Prof. A. S. Pronikov and Prof. A. M. Dalsky, Moscow Workers Publishing House (1965), p. 5.

[16] *Organization of Centralized Repair and Modernization of Machine Tools*, ENIMS (1961).

It may be suggested also that a special organization dealing with the problems of the machine-tool industry should be set up in developing countries. Depending on requirements of such an organization, it could be established as a special centre or as a department within the framework of a technological institute. Such an organization could consider the problems involved in the importation of machine tools, their design, preparation and the training of the necessary labour.

ANNEX I

PRODUCTION OF MACHINE TOOLS

(in millions of US dollars)

Country	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1962*	*1963*	*1964 (estimated[a])*
United States	984	1,293	1,189	628	650	788	792	857	920.0	1,160.0
Soviet Union	336	382	440	510	510	602	649	718	760.0	790.0
Germany (Federal Republic)	343	418	452	412	466	563	706	831	753.8	725.0
United Kingdom	211	236	278	238	229	267	336	379	319.7	340.0
Japan	13.9	23.2	39.4	57.9	61.4	125.3	232	278	292.6	304.6
France	127	130	159	174	134	160	188	234	224.0	220.0
Czechoslovakia	74	81	93	116	122	134	132	139	195.0	207.3
Eastern Germany	69.5	93	116	133	139	144	151	160	165.0	*b*
Italy	44	60	54	57.5	61	110	185	187	194.5	126.0
Switzerland	81	86	93	93	102	107	116	127	120.5	121.4
China (mainland)	20.9	23.2	25.5	52.1	75.3	79	79	79	*b*	*b*
Poland	28	39.4	36.4	39.4	40.5	45.2	47.5	53.8	*b*	*b*
Sweden	27.3	32	30.8	33.6	27.8	32.4	38.5	40.5	49.0	46.0
Hungary	18.5	18.5	20.9	22.0	24.3	25.5	29	32.4	30.0	*b*
India	1.6	1.9	4.2	5.1	6	10.7	20.4	26.0	30.0	37.8
Australia[c]	6.0	6.9	7.3	6.8	5.9	7.2	7.3	6.2	34.0	35.0
Brazil	3.7	4.2	4.6	5.1	5.8	9.3	18.5	23.2	31.0	31.0
Canada	11.6	12.5	13.2	11.6	13.9	13.9	13.9	15.1	23.0	25.5
Argentina	6.7	12.3	20.4	22	23.2	23.2	26.6	25.5	*b*	*b*
Belgium	12.3	15.1	15.3	14.8	13.7	17.6	23.9	30.1	25.3	24.1
Austria	5.1	6.5	7.2	6.3	7.4	10.2	11.4	14.1	13.1	14.0
Netherlands	7.0	8.1	7.6	7.9	7.9	10.4	14.8	18.3	11.1	11.6
Total	2,432.1	2,982.8	3,106.8	2,646.1	2,726.1	3,285.1	3,817.8	4,274.2	4,277.6[d]	4,282.7[e]

Sources: *American Machinist*, 1964 Production Review, p. 126. Except for: Germany (Federal Republic of) (1958), from *The Financial Times, Review of Industry*, London; Japan (1960), from US National Machine Tool Builders' Association, *Survey of Foreign Machine Tool Markets*, p. 106; and Australia, from Australian Industries' Development Association, *Director Reports*, No. 145 (August 1964).

[a] *American Machinist*, 1965 Outlook, p. 133.

[b] Figures are not available.

[c] Year ending 30 July.

[d] Total production without China (mainland), Poland, Argentina, but excluding Spain ($US 27.0 million); Romania ($US 39.0 million); Denmark ($US 9.6 million), Yugoslavia ($US 8.8 million) and Portugal ($US 1.8 million). World estimated production for 1963 was $US 4,400 million.

[e] Total production without Eastern Germany, China (mainland), Poland, Hungary, Argentina, but including Spain ($US 50.0 million); Denmark ($US 9.9 million); and Portugal ($US 3.5 million). World estimated production for 1964 was $US 4,700 million.

ANNEX II

WORLD EXPORTS OF MACHINE TOOLS, 1955-1962

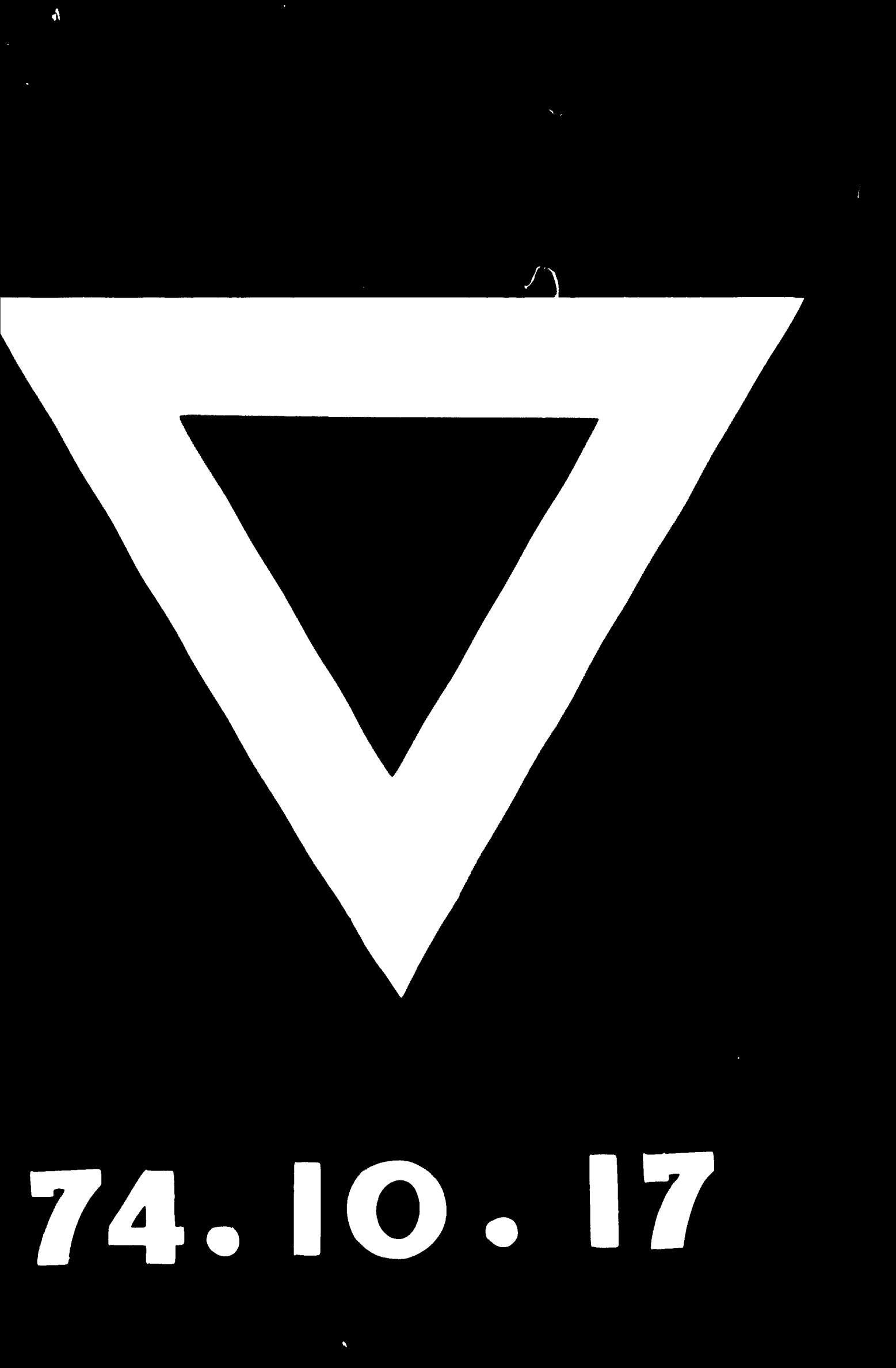
(thousands of US dollars)

Country	1955 Value	1955 Per-centage	1956 Value	1956 Per-centage	1957 Value	1957 Per-centage	1958 Value	1958 Per-centage	1959 Value	1959 Per-centage	1960 Value	1960 Per-centage	1961 Value	1961 Per-centage	1962 Value	1962 Per-centage
All machine tools																
Germany (Federal Republic)	128,222	29.2	158,675	30.9	199,853	31.2	199,018	32.4	200,838	32.6	224,517	29.8	360,000	31.0	391,000	29.30
United States	125,088	28.5	141,659	27.6	182,258	28.4	165,118	26.9	145,504	23.6	209,640	27.8	305,000	26.3	342,000	25.60
United Kingdom	52,601	12.0	58,741	11.5	76,485	11.9	65,332	10.6	63,241	10.3	78,922	10.5	94,200	8.1	117,000	8.80
Switzerland	45,017	10.3	48,573	9.5	58,299	9.1	52,016	8.5	59,216	9.6	69,018	9.2	88,300	7.6	97,800	7.40
Czechoslovakia	15,055	3.5	19,066	3.7	24,147	3.8	30,581	5.0	41,905	6.8	43,848	5.8	92,500	7.9	97,400	7.30
Italy	14,632	3.3	19,110	3.7	24,620	3.8	25,213	4.1	26,466	4.3	35,993	4.8	57,400	4.9	78,500	5.95
France	17,245	3.9	18,412	3.6	21,041	3.3	13,418	2.2	26,112	4.2	33,841	4.5	50,500	4.4	71,500	5.40
Soviet Union	8,892	2.0	9,892	1.9	9,582	1.5	18,090	2.9	20,200	3.2	13,796	1.8	45,400	3.9	57,400	4.30
Sweden	11,357	2.6	15,808	3.1	17,900	2.8	19,991	3.2	10,352	1.7	13,920	1.8	25,800	2.3	24,300	1.82
Belgium-Luxembourg	9,596	2.2	11,277	2.2	11,768	1.8	11,467	1.9	10,403	1.7	11,497	1.5	18,800	1.8	23,700	1.78
Netherlands	4,323	1.0	5,675	1.1	5,785	0.9	6,028	1.0	6,007	1.0	6,539	0.9	11,200	1.0	14,300	1.07
Japan	3,176	0.7	2,745	0.5	4,380	0.7	2,816	0.5	3,071	0.5	7,506	1.0	9,300	0.8	11,300	0.85
Denmark	3,667	0.8	3,654	0.7	4,996	0.8	4,785	0.8	3,374	0.5	4,164	0.6	*a*	*a*	5,700	0.43
Total, all countries	438,871	100.0	513,287	100.0	641,204	100.0	613,873	100.0	616,689	100.0	753,201	100.0	1,158,400	100.0	1,331,900	100.0

Country	1955 Value	1955 Percentage	1956 Value	1956 Percentage	1957 Value	1957 Percentage	1958 Value	1958 Percentage	1959 Value	1959 Percentage	1960 Value	1960 Percentage
Metal-cutting machine tools												
Germany (Federal Republic)	86,017	27.0	113,005	29.9	143,364	31.6	138,861	32.5	142,048	32.6	161,742	30.5
United States	87,006	27.3	99,009	26.2	118,766	26.2	100,464	23.5	81,738	18.8	127,774	24.1
United Kingdom	40,222	12.6	44,525	11.7	51,855	11.4	44,907	10.5	46,905	10.8	53,499	10.1
Switzerland	39,616	12.5	43,524	11.5	49,132	10.8	45,320	10.6	51,169	11.8	59,632	11.2
Czechoslovakia	11,807	3.7	14,953	4.0	18,938	4.2	24,968	5.8	33,524	7.7	35,078	6.6
Italy	11,634	3.7	15,885	4.2	20,169	4.5	20,008	4.7	20,803	4.8	27,251	5.1
France	12,963	4.1	13,868	3.7	14,599	3.2	10,032	2.8	19,637	4.5	26,668	5.0
Soviet Union	7,247	2.3	8,701	2.3	7,797	1.7	15,485	3.6	18,252	4.2	10,430	2.0
Sweden	7,505	2.4	9,166	2.4	11,066	2.4	9,972	2.3	7,175	1.6	9,768	1.8
Belgium-Luxembourg	5,601	1.8	7,238	1.9	7,858	1.7	7,913	1.9	6,990	1.6	7,195	1.4
Netherlands	2,936	0.9	3,437	0.9	3,673	0.8	3,757	0.9	3,543	0.8	4,661	0.9
Japan	1,987	0.6	1,502	0.4	2,014	0.4	1,331	0.3	1,380	0.3	4,511	0.8
Denmark	3,511	1.1	3,495	0.9	4,805	1.1	4,710	1.1	2,296	0.5	2,844	0.5
Total, all countries	318,053	100.0	378,308	100.0	454,036	100.0	427,728	100.0	435,460	100.0	531,053	100.0
Metal-forming machine tools												
Germany (Federal Republic)	42,205	34.9	45,670	33.8	56,489	30.2	60,157	32.3	58,790	32.4	62,775	28.3
United States	38,082	31.5	42,650	31.6	63,492	33.9	64,654	34.7	63,766	35.2	81,866	36.9
United Kingdom	12,379	10.3	14,216	10.5	24,630	13.2	20,425	11.0	16,336	9.0	25,423	11.4
Switzerland	5,403	4.5	5,049	3.8	9,167	4.9	6,696	3.6	8,047	4.4	9,386	4.2
Czechoslovakia	3,248	2.7	4,113	3.0	5,209	2.8	5,613	3.0	8,381	4.6	8,770	4.0
Italy	2,998	2.5	3,225	2.4	4,451	2.4	5,205	2.8	5,663	3.1	8,742	3.9
France	4,282	3.5	4,544	3.4	6,442	3.4	3,386	1.8	6,475	3.6	7,173	3.2
Soviet Union	1,645	1.3	1,191	0.9	1,785	0.9	2,605	1.4	1,948	1.1	3,366	1.5
Sweden	3,852	3.2	6,642	4.9	6,924	3.7	10,019	5.4	3,177	1.8	4,152	1.9
Belgium-Luxembourg	3,995	3.3	4,039	3.0	3,910	2.1	3,554	1.9	3,413	1.9	4,302	1.9
Netherlands	1,387	1.0	2,238	1.7	2,112	1.1	2,271	1.2	2,464	1.4	1,878	0.8
Japan	1,189	1.0	1,243	0.9	2,366	1.3	1,485	0.8	1,691	0.9	2,995	1.4
Denmark	156	0.1	159	0.1	191	0.1	750	0.1	1,078	0.6	1,320	0.6
Total, all countries	120,819	100.0	134,979	100.0	187,168	100.0	186,145	100.0	181,229	100.0	222,148	100.0

Source: United States Department of Commerce, Business and Defense Services Administration, *World Trade in Machine Tools*.

a Figures not available.


74.10.17