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THE MACHINE-TOOLS INDUSTRY IN BRAZIL: BACKGROUND MATERIAL FOR THE PROGRAMMING OF ITS DEVELOPMENT

Study prepared in co-operation with the Grupo Executivo da Indústria Mecânica Pesada (GEIMAPE), Sindicato da Indústria de Máquinas do Estado de São Paulo (SIMESP) and Associação Brasileira para o Desenvolvimento da Indústria de Base (ABDIB)

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/PRELIMINARY NOTE

PRELIMINARY NOTE

The importance of expanding production of capital goods at the present stage of Latin America's economic development, when the capacity to import is severely limited and a high rate of investment must be maintained, is generally recognized. The machine-tools industry has a key role to play in this expansion, since there is no branch of manufacture either of machinery and equipment or of durable consumer goods in which a high proportion of machines for metal working is not used. Thus, the contribution to the economic development of Brazil made by the industry discussed in this report is of more vital significance than could be deduced from the number of enterprises or the labour employed in the sector.

There is a close connexion between a country's degree of industrial development and the technical and economic structure of the machine-tools industry. In this respect, Brazil is at a transitional stage. The structure of the Brazilian machine-tools industry today is consonant with the country's requirements up to the present time, predominant among which have been machinery and equipment for maintenance purposes and lines of manufacture which do not call for great precision or long production series. But as a result of Brazil's recent industrial development, there are signs of increasing demand for the more complex and heavier machinery used in more highly specialized branches of manufacture. To meet such requirements, the machine-tools industry will be obliged to supply the market with quite different products and in order to manufacture these it will have to introduce radical changes both in its technical and economic structure and in its methods of work. It would therefore seem that the industry has reached a decisive phase in its evolution, and needs overhauling and bringing up to date so that it can continue to expand in the forthcoming decade.

However, in view of operating conditions in the industry, it is unlikely that these changes will come about of their own accord, simply in response to the stimulus of market demand. The small and medium-scale entrepreneurs of whom the industry is chiefly composed have not sufficient knowledge of the market as a whole, nor - more important still - can they foresee the direction in which this market will develop and the new types and models

/of machinery

of machinery that will be required by the metal transforming industry during the next few years. To present a qualitative and quantitative appraisal of the market up to 1971 - that is, to define the framework into which the Brazilian machine-tools industry will have to fit during the next stage of its development - is the primary purpose of the present study.

Detailed knowledge of the probable future market is an essential prerequisite, but not the only prerequisite for the introduction of structural changes in the machine-tools industry. The latter's possibilities of spontaneous development are restricted by the small size of the establishments concerned, the technical inadequacy of almost all of them, and the difficulties which an incipient industry is likely to encounter in absorbing the know-how available in the corresponding industry in the more advanced countries.

Clearly, then, deliberate steps must be taken to create institutional conditions which will bring about the necessary transition towards a more balanced industrial structure and greater technical efficiency. These conditions should be conducive, in the first place, to the development of new industrial undertakings in the sector and the consolidation of those already in existence, through agreements on royalties in respect of technical assistance and the manufacture of new models. Secondly, they should be such as to encourage the creation - possibly through a specialized institution - of national technical assistance facilities, chiefly designed to help small and medium-scale establishments in their efforts to modernize, expand and technically improve their plant and manufacturing activities.

The second purpose of this study is to indicate current conditions in the industry and the direction in which changes should take place, as well as to suggest basic lines of approach to the establishment of a national institution to provide technical assistance for the machine-tools industry.

Thus, the study covers two aspects of the background material on which development programming for the Brazilian machine-tools industry must be based: a quantitative and qualitative evaluation of the market in the next decade, and an analysis of operational conditions in the industry as it exists in Brazil, with an indication of the changes required.

/Chapter I

Chapter I

INTRODUCTION, OUTLINE OF METHOD OF RESEARCH AND SUMMARY OF MAIN CONCLUSIONS

1. Introduction

The term machine-tools, in its widest sense, is applied to a group of machines used for cutting, forming, grinding and polishing metals, wood and other materials, and usually classified in two major categories: chip-producing (lathes, milling-machines, drills, boring-machines, etc.) and non-chip-producing (presses, forge hammers, bending, cutting and forming machines, etc.). Those in the second category are also frequently referred to by the general name of forming machines. The definition of machine-tools, however, varies from one country to another, so that in practice there is no standard interpretation of the term indicating which machines it should be taken to cover.[1/] For the purposes of the present study, machines used for metal working, whether in cutting or forming operations, are regarded as machine-tools.

Given the objectives and scope of the study, intensive field work was required in order to collect the basic data needed for knowledge and analysis of the existing situation, in respect of both demand for machine-tools and domestic production. The study was prepared in close contact with the Executive Board of the Heavy Metal Transforming Industry (GEIMAPE), the Machine Industry Syndicate of the State of São Paulo (SIMESP) and the Brazilian Association for the Development of Basic Industries (ABDIB), which provided the necessary facilities, as well as the collaboration of two engineers from GEIMAPE and SIMESP.

The present study constitutes the first attempt of its kind in Brazil in the field of machine-tools - a sector in which there are many complex problems to consider. It must therefore be regarded as provisional in some respects and subject to reservation. Certain situations, such as those relating to future demand for machine-tools or to the average weight of the

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1/ In the United States, for example, the term "machine-tools" relates only to metal cutting machines, while in France both cutting and forming machines, for working both metal and wood, are comprised under the head of "machine-outil".

/domestically-produced

domestically-produced or imported machines which will form the country's inventory in the future -, to mention only one or two -, can be evaluated only on the basis of assumptions which, while established on logical grounds and supported by the experience of other countries, do not warrant the assumption that they will be strictly fulfilled; in this connexion, the field of machine-tools is particularly complex, and does not seem to be governed by laws or criteria that can be universally applied or extended from one area to another without the intervention of widely varying factors difficult to assess in quantitative terms.

The primary concern of the present paper is the study of the machine-tools industry with respect to the actual construction of the machines; complementary industries, such as the manufacture of accessories and spare parts for the machines in question, have not been taken into account. Similarly, owing to lack of time and resources for research, no attempt has been made to deal with the production of the corresponding tools. These aspects of the question are closely linked to the machine-tools sector, and should undoubtedly be tackled in any future studies that may be carried out in this connexion.

2. Summary of research method and main conclusions

(a) Machine-tool requirements

In order to establish machine-tool requirements for the next ten years, consideration was given on the one hand to the needs deriving from the country's own industrial development, and on the other to machines for replacement purposes. The basis adopted for estimating the former was Brazil's total stock of machine-tools in 1960, which had to be determined by means of a survey. The inventory was taken in the metal transforming industries[2/] - the leading consumers of the machines in question - in the State of São Paulo, where almost 70 per cent of these industries, total labour force is employed. Subsequently, by extrapolation, this result

2/ Manufacture of metal products; machine industry, excluding the manufacture of electrical apparatus; manufacture of electrical and communications material; and transport material industry.

/was extended

was extended to the rest of the country, and the machine-tools used for maintenance work in other sectors (for example, the textile, food processing, chemicals and rubber industries) were added, for which purpose an estimate was prepared on the basis of the experience recorded in other countries. By these means it was determined that the national inventory of machine-tools in 1960 consisted of 205 654 units. This inventory displays two interesting characteristics. In the first place, the high proportion of simple universal machines would seem to indicate that it is typical of an industrial structure in which activities with low volumes of output predominate; in the second place, it is a fairly new collection of machines in which those under ten years old represent 55 per cent of the total, and only 24 per cent are over twenty years old.

From individual study of each of the various branches comprised by the metal transforming industries, an estimate of each one's machine-tool requirements up to 1971 was arrived at, on the basis both of growth trends in the past and of projects for developing new activities in the sector and demand prospects in respect of the final goods concerned. Thus, with the inclusion of an estimate of machines for maintenance, it was computed that by 1971 the country's inventory of machine-tools would total 369 146 units, i.e., it would exceed the 1960 figure by 80 per cent. This would imply an average annual growth rate of 5.5 per cent, which compares reasonably well with the growth prospects established for the gross domestic product (5.7 per cent per annum) and for the metal transforming industries (10.2 per cent).

In estimating the number of machines for replacement purposes,[3/] a conservative assumption was adopted, to the effect that one-third of the machines which were over twenty years old in 1960 - i.e., 8 per cent of the 1960 inventory - would be replaced by 1971.

3/ The term "replacement" in the present study relates to the final scrapping of a machine because it is no longer fit to perform any operation, so that the figures indicated represent net substitution requirements.

/By this

By this method demand for machine-tools from 1961 onwards was established at 179 947 units, and after substraction of the machines incorporated into the inventory in that year the conclusion was reached that requirements for 1962-71 would total 158 826 machine-tools.

(b) The existing machine-tools industry

Concurrently with the inventory of existing machines a survey of the domestic machine-tools industry was carried out. This activity, which was started in Brazil during the Second World War in response to the need to supply those internal requirements which were seriously affected by import difficulties, has made striking progress in the last twenty years, especially since 1956. At the present time it constitutes an industrial complex of 114 establishments, employing about 5 000 persons and producing an annual output that has risen above 13 000 tons.

Of these establishments, 88.8 per cent are situated in the State of São Paulo, which clearly indicates that this activity has been very closely linked to the expansion of the metal transforming industries.

Not all the enterprises are engaged exclusively in manufacturing machine-tools; it is common to find them undertaking other lines of metal transforming production. According to the survey, the proportion of the establishments which manufacture items other than machine-tools ranges from 46.5 to 100 per cent, according to the kind of machine in question. In terms of trade activity, the machine-tool industry's share in the annual invoicing of 62.5 per cent of the enterprises is not less than 75 per cent.

A point worth mentioning relates to the breakdown of this group of establishments by size. Three-fourths of the enterprises manufacturing machine-tools employ fewer than 50 persons, only 7.8 per cent employ between 100 and 500, and only one employs more than 1 000 persons. Such a structure is patently not the most appropriate for coping with larger manufacturing tonnages than those recorded at present and with the demands in respect of quality and range of types which the consumer industries will make in the course of the next few years. Consequently, the evolution of this structure towards a breakdown by size which is better adapted to future demand conditions will be one of the essential elements in the development of the industry if it is to secure a larger share in satisfying consumption in Brazil.

/The manufacturing

The manufacturing enterprises have an inventory of 2 527 machine-tools at their disposal. In this connexion, it is of interest to point out that the eight establishments which employ over 100 persons - 8.9 per cent of the total - own nearly 30 per cent of these machines. This group of enterprises possesses complete, efficient and up-to-date production equipment, and at the same time the technical knowledge required for the proper use of the machines; and its projects and manufacturing lines keep pace with domestic market requirements and with the constant technological advances in the sector. In marked contrast with the situation of this group is that of the small-scale enterprises whose manufacturing equipment is too light and too incomplete to be satisfactory, while at the same time indirect technical services are neglected.

Market requirements, however, differ sharply in respect of quality, types and prices according to whether the machines are for use in the technically more advanced industries or in the small and medium-scale establishments whose level of technological development is lower and whose capital resources are very limited. As the national inventory of machine-tools grows, and with it the demands made in respect of quality, variety and at the same time low costs, production technology will be forced to develop, and some of the small and medium-scale manufacturers will also have to take part in this process.

In relation to volumes of manufacturing output, the data and information collected afford clear evidence of the colossal effort made by the manufacturers of machine-tools since 1956. In fact, in only six years the number of tons produced annually increased by 260 per cent, reaching in the course of that period cumulative figures exceeding 60 000 tons, the equivalent of over 62 000 machines. In 1961 the industry managed to produce 15 517 units, with a weight of 13 250 tons. This substantial increase in domestic production finds its justification in the powerful upswing of demand registered between 1956 and 1961 as a result of the establishment of the motor vehicle industry and the expansion of the various branches of the metal transforming sector.

/Today the

Today the industry offers the market fifty-two types of machine-tools in about 150 leading models, which represents a fairly satisfactory situation. Nevertheless, its production is not altogether commensurate with the numerical size of the national inventory and its range of types and models; and some machines are deficient in quality. This is another aspect of its development to which the sector will have to devote attention - the task of improving the quality of the machines currently produced and gradually increasing the number of models and types manufactured in order to maintain some degree of balance between the evolution of the inventory and domestic supplies of basic types.

From 1955 onwards, a gradual decrease in the average weight of the machines manufactured (from 1 136 to 854 kg) is observable in this sector, chiefly owing to reductions in the metal-cutting machines, which during this period dropped from 960 to 650 kg. Forming machines stood at an average of 1 800 kg. It must be stressed, however, that this decline in unit weight does not mean that the weight of the traditionally heavier types of machines has been reduced, but is attributable to the fact that in the last few years new models have been put out in smaller sizes, while at the same time construction of light machines has been intensified with the object of meeting the demand deriving from the manufacture of various light articles, as well as from the emergence of small-scale establishments. The perfecting of these machines and the incorporation of new types which are missing from the existing line of manufacture will be bound to entail a rise in the average weight of domestic products. In this connexion, it is interesting to point out that those machines which show development in respect of models and an increase in weight have secured a larger percentage share in the supply of the market, especially as regards lathes, saws, milling machines and presses.

Price levels, broadly speaking, may be said to fluctuate around an average of 2 dollars per kilogramme, which may be considered satisfactory. Furthermore, since the export of certain types of lathes and presses has been taking place for several years now and interest in purchasing Brazilian machine-tools exists in some of the Latin American countries, it would seem that their prices are acceptable.

/(c) Prospects for

(c) Prospects for the domestic industry in 1962-71

The interval between 1955 and 1961 was characterized by an exceptional increase in domestic consumption - attributable to the causes indicated above - which was reflected in the installation in Brazil of 158 719 tons of machine-tools, equivalent to some 101 700 units, the Brazilian inventory being almost doubled during that period. The domestic industry was not dissociated from this trend, and developed during the years in question, at a cumulative annual rate of about 14.7 per cent (in terms of weight), expanding from 5 085.6 tons in 1955 to 13 249.9 tons in 1961. This meant that on an average approximately 40 per cent of consumption in the period referred to was satisfied by means of domestically-produced machines, the proportion varying between a maximum of 54 per cent and a minimum of 25 per cent in consequence of marked changes in imports.

However, as already pointed out, this industry's contribution to the inventory consisted of simple, lightweight machines, and both in its structure and in its technical potential it displayed certain deficiencies which assume decided importance in relation to the analysis of its future possibilities. If no attention were paid to these technical shortcomings, which must necessarily be remedied if the industry is to develop, a mere study of its evolution in the light of statistical data would be entirely divorced from reality.

On the assumption that the machine-tools industry (a) will develop structurally in such a way that by the end of the period under study from 15 to 20 per cent of its establishments will be employing between 100 and 500 persons; (b) will increase and supplement its existing stock of machines; (c) will improve upon some of the machines currently manufactured; (d) will start production of forty-one new models of machines for chip-producing operations; and (e) will raise the unit weight by about 300 kg in relation to 1961, the conclusion may be reached that in 1966-71 it will be able to supply on an average 65 per cent of the domestic market, in terms of weight, and will be in a position to export a substantial proportion of its output. In such circumstances, a volume of production amounting to about 20 000 tons, i.e., 50 per cent more than in 1961, might be expected in 1971; this would cover approximately 70 per cent of consumption, leaving an exportable surplus of about 10 per cent.

/To attain

To attain these targets, both as regards the increase in the volume of production and with respect to improved quality and the incorporation of new machine types, machinery that can meet the technical demands involved will have to be available. Success will therefore also depend in part upon the incentives and facilities with which government agencies are able to provide this sector. A rough estimate of the investment which such a programme would entail, solely in relation to the machines that would have to be imported, gives a figure close to 6 million dollars, which might be subject to modification according to the quality of the machine-tools that it was proposed to construct.

To enable the industry to solve the financial problems which the foregoing programme implies, the following would have to be available:

(i) Long-term financing for the purchase of heavy machines, all of which would be imported;

(ii) Medium and short-term financing for the purchase of lighter machines, most of which would also be of foreign origin;

(iii) Financing for studies and construction of prototypes of new machine-tools.

Lastly, given the many complex problems involved in the future development of this industry, structurally and technically - problems whose solution will have to be sought by programmed and co-ordinated effort -, it is of fundamental importance that there should be an agency in Brazil which would guide and direct the development of the industry, at the same time rendering the necessary technical assistance, so as to channel it properly into suitable lines of manufacture and enable it to play its role in Brazil's industrialization process as efficiently as possible.

/Chapter II

Chapter II

INVENTORY OF MACHINE-TOOLS IN 1960

It was considered useful to explore two avenues at one and the same time in order to determine the size of the machine-tools market in the next few years; one line of approach was to study the future requirements of each of the machine-tools consumer sectors, and the other was to follow up the trends of apparent consumption.

The first of these procedures called not only for a detailed knowledge of the existing stock of machines in the various industrial sectors (which in practice implied making an inventory of machine-tools in each of the consumer groups), but also for a careful study of the possible growth of these sectors during the next ten years; whereas the second entailed ascertaining the evolution of imports and of domestic production, i.e., of apparent consumption, in past years, and projecting that trend up to 1971. This latter method seemed to be the more direct and to offer quicker results in relation to the time and resources available. But in putting it into practice serious difficulties were encountered which proved insurmountable and subsequently made the rejection of this alternative inevitable. The chief obstacle was the impossibility of obtaining an import series detailed enough for the analysis to be carried out by types of machines and over a reasonable period of years that would permit the determination of consumption trends. Even if an over-all approach were adopted and the machines were considered in the aggregate, without differentiation of any sort, no representative curve of apparent consumption could be established, because of the marked fluctuations in imports, especially during the last six years, deriving from the establishment of the motor vehicle industry. As will be seen in chapter IV, in which an analysis of imports is presented, purchases abroad, which mounted to a peak in 1959, do not yet seem to have regained a normal level, or, in other words, the cycle is so far not sufficiently complete for the distorting effect on imports produced by Brazil's new motor vehicle industry to be observed in its entirety.

/Thus, the

Thus, the process of evaluating the future machine-tools market was confined to the first of the proposed alternatives, that is, to the determination of the number of machines currently in use in the principal consumer sectors and the appraisal of requirements during the next ten years in the light of the expansion which each of these sectors may reasonably be expected to achieve.

Although this procedure made heavier demands in respect of time and effort, owing to the intensive field work entailed in collecting the relevant data, as well as to the complexities inherent in such a study, it enabled estimates to be prepared at the level of the consumer sectors themselves. It was thus possible to attain a higher degree of accuracy, and - perhaps more important still - to ascertain the size and composition of the inventory of machine-tools installed in Brazil, which is a valuable statistical asset for the measurement of its industrial potential, and, in particular, its specific possibilities in relation to the manufacture of durable and capital goods.

1. Inventory of machine-tools existing in Brazil in 1960

In order to determine the number of machine-tools existing in Brazil within the relatively short space of time available for the purpose, the work had to be carried out in various stages and on the basis of a series of hypotheses which allowed maximum utilization of the information and resources to hand. This meant sacrificing the accuracy of the inventory to an extent estimated at about 10 to 15 per cent at least, since in general the line of approach and the hypotheses adopted are conducive to under-estimation of the stock of machines.

The survey carried out was concentrated entirely on machine-tools for metal working used as production media in the metal transforming industries, and excluded machines used for maintenance and repairs in other sectors (for example, textiles, rubber, glass, chemicals, etc.). The inventory was thus confined to four groups of industries using the machines in question primarily in productive operations: those manufacturing metal products; the machine industry, excluding manufacture of electrical apparatus; those

/manufacturing electrical

manufacturing electrical and communications material; and the transport materials industry. A detailed list of the activities covered by these four groups is presented in annex I.[1/]

As can be seen in table 1, in 1958 these four groups comprised 4 362 establishments in the whole of Brazil, and employed 273 587 persons in all, 59 per cent of the establishments and 69 per cent of the personnel being concentrated in the State of São Paulo. Similarly, within each individual group the proportion of the employed manpower accounted for by this state was high, exceeding 70 per cent in the last three groups and amounting to 58 per cent in the case of the manufacture of metal products.

This circumstance, in combination with the fact that detailed statistics for all four groups were available in the State of São Paulo, as well as a complete register of the industries established, prompted the decision to take a sample survey of machine-tools in that state and afterwards, by extrapolation, to arrive at an estimate of the situation in the country as a whole.

Thanks to the register of industrial production kept by the Department of Statistics of the State of São Paulo, it was possible to break down these four groups into sixty-six subdivisions at the level of the fourth digit of the decimal classification, which meant not only that the sample of industries to be covered by the survey was likely to be as homogeneous as possible, but also that the enterprises could be more accurately classified and the activities under study subsequently regrouped in larger aggregates for the purposes of publication of the findings. Similarly, knowledge of the evolution undergone by these subdivisions from 1955 onwards was of great assistance in estimating the growth trends of each major group for the period 1961-71 with which the present study deals. Unfortunately, at the time of writing, the industrial statistics available in Brazil stop short at 1958, so that the data to hand had to be extrapolated up to 1960, the year for which enterprises were requested to report on the machines in operation. Again, the statistics available, even when detailed in respect

1/ With the inclusion in this case of the machine-tools used by industries in the four groups for tool-making, maintenance and repairs.

/Table 1

Table 1

BRAZIL: NUMBER OF ESTABLISHMENTS, PERSONNEL EMPLOYED AND VALUE OF PRODUCTION IN THE FOUR MAJOR GROUPS COVERED BY THE INVENTORY, 1958 a/

(Value of production in millions of cruzeiros)

Major group	Total for Brazil	State of São Paulo	Percentage relationship Sao Paulo/ Brazil
I. Manufacture of metal products, excluding transport machinery and equipment			
Number of establishments	2 060	1 010	49 b/
Number of persons employed c/	94 830	55 003	58 b/
Value of production	41 670	26 668	64 b/
II. Manufacture of machinery, excluding electrical machinery			
Number of establishments	1 026	701	68
Number of persons employed c/	51 389	40 285	78
Value of production	17 576.9	15 598	89
III. Manufacture of electrical machinery, apparatus, accessories and other appliances			
Number of establishments	467	369	79
Number of persons employed c/	53 038	40 581	76
Value of production	31 162.6	26 255.3	84
IV. Manufacture of transport material			
Number of establishments	809	490	61
Number of persons employed c/	74 330	53 098	71
Value of production	46 850.3	35 682.7	76
Total for the four major groups			
Number of establishments	4 362	2 570	59
Number of persons employed c/	273 587	188 967	69
Value of production	137 259.8	104 204	76

Source: National Statistical Council (Brazilian Institute of Statistics and Economics IBGE), Statistical Department of the State of São Paulo.

a/ Establishments employing more than 5 persons.

b/ Estimate based on the 1950 Industrial Census.

c/ Including employees and operatives.

/of industrial

of industrial activities, are not sufficient for the preparation of a mathematical sample.[2] Consequently, it was decided to embark upon systematic sampling of enterprises in each group, taking 100 per cent of the establishments in groups of up to 5, and of those in the bigger groups about 20 per cent, i.e., 1 in 5. By this method a sample was established which comprised 732 establishments out of a total of 3 260, or 22.5 per cent.

The survey was actually carried out by sending the selected enterprises specially prepared questionnaires asking for certain general data (installed capacity and consumption of power; number of persons employed; average number of hours worked per month; value of annual sales; and the principal and secondary activities of the establishment measured in terms of percentages of sales), and information on the number of machine-tools in use in relation to forty-four types of machines. As a large proportion of the machine-tools had been brought into the country during the preceding ten years, the problem of the age of the existing machines was not taken into account on this occasion, although it will have to be considered in any similar studies that may be undertaken in the future. In addition to the information thus gathered, use was made of data collected in a survey carried out in 1960 by SIMESP, which facilitated the task in hand and enabled high coverage to be secured in the machinery manufacturing sector.

For the purposes of presentation of the findings obtained, the sixty-six subdivisions were reclassified in four major aggregates, broken down into twenty groups corresponding to the third digit of the decimal classification, as described in annex I.

Table 2 shows the findings of the survey, which, as mentioned above, covered 22.5 per cent of the existing establishments,[3] and, on an average 66.8 per cent of the personnel employed, the proportion ranging from a minimum of 40.6 per cent to a maximum of 100 per cent, according to the group

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2/ On the basis of the declarations of individual enterprises, it would have been possible to obtain a stratified grouping of establishments for each of the sixty-six subdivisions, but this would have involved exceptionally heavy work for which neither time nor resources sufficied.

3/ Employing 5 or more persons.

/Table 2

Table 2

BRAZIL: GENERAL DATA OBTAINED THROUGH THE SURVEY CARRIED OUT IN THE STATE OF SAO PAULO

Group	Total 1960 a/			1960 survey		
	Number of establishments	Number of persons employed	Sales turnover (millions of cruzeiros)	Number of establishments	Number of persons employed	Number of employed as a percentage of total
I. Manufacture of metal products	1 113	59 000	48 270	173	29 098	49.3
1. Rolling, wire drawing and manufacture of metal appliances		20 381	22 426	38	8 338	40.9
2. Stamping and manufacture of containers		9 102	7 833	21	3 695	40.6
3. Light metal work and boiler work		20 006	11 997	49	11 570	57.8
4. Cutlery, manufacture of arms, hand tools and hardware		6 139	3 134	15	3 449	56.2
5. Manufacture of miscellaneous metal appliances		3 372	2 880	50	2 046	60.7
II. Manufacture of machinery, excluding electrical machinery	899	51 237	33 117	313	40 779	79.6
1. Manufacture of non-electrical motors		1 993	1 450	10	1 415	71.0
2. Machinery, apparatus and equipment for hydraulic, thermal and ventilation plant		4 404	3 107	35	3 254	73.9
3. Machine-tools and general industrial equipment		15 300	8 995	148	11 417	74.6
4. Machinery and equipment for agriculture and rural industries		7 159	5 309	41	5 028	72.7
5. Miscellaneous machinery, apparatus and equipment		22 381	14 256	79	19 665	87.9
III. Manufacture of electrical and communications machinery, apparatus and appliances	425	46 711	55 373	80	26 830	57.4
1. Machinery, apparatus and appliances for the production, accumulation, transmission and transformation of electric power b/		20 875	22 490	40	13 138	63.2
2. Electrical apparatus and appliances		14 731	18 168	21	7 590	51.5
3. Communications material		11 105	14 715	19	6 042	54.4
IV. Manufacture of transport material	823	93 226	121 466	166	70 516	75.6
1. Shipbuilding and dockyard repairs		140	49	-	-	
2. Railway equipment		3 900	2 622	3	3 240	83.1
3. Motor vehicles		32 576	81 423	10	32 576	100.0
4. Spare parts for motor vehicles c/		48 000	30 684	136	28 527	59.4
5. Trailers and coachwork		3 845	3 212	9	2 689	69.9
6. Bicycles and motor-cycles		4 100	3 089	6	3 212	78.3
7. Animal traction vehicles		665	387	2	272	40.9
Grand total	3 260	250 174	258 226	732	167 223	66.8

a/ Estimated on the basis of expansion between 1955 and 1958, according to statistical data supplied by the Statistical Department of the State of Sao Paulo.

b/ Including electrical components for motor-vehicles.

c/ Excluding electrical, rubber or glass parts.

/of industries

of industries concerned. Lists of the machine-tools pertinent to the survey for each aggregate and the corresponding groups are presented in tables 3, 4, 5 and 6, from which it can be seen that the machines inventoried amounted to a total of 40 508 units - 32 140 for chip-producing operations and 8 368 for forming operations, i.e., 79.3 and 20.7 per cent of the total, respectively.

As regards estimating the State of São Paulo's total stock of machine-tools on the basis of the sample taken, a few prior considerations must be noted with respect to what this sample really represents, in order to establish the best method of extending it to the universe. For this purpose, recourse was had to the relationship between the number of machines per 100 persons employed and the size of the establishment, also measured in terms of the personnel employed. This coefficient varies widely according to the size of the establishment, decreasing considerably as the number of persons employed increases, because a higher proportion of the increase relates to indirect personnel - in other words, small establishments have a much bigger proportion of direct labour (operatives in charge of machines) than those operating on a larger scale, and, consequently, more machines per person employed. In figure I, which was constructed on the basis of the findings of the survey, it can be seen that the ratios in question roughly follow a hyperbolic curve which registers the sharpest fluctuations within the size range corresponding to establishments employing up to 500-600 persons.[4/]

A study of the findings of the survey shows the average size of the establishments that replied to the questionnaire to be in the neighbourhood of 228 persons,[5/] with an average of 24.2 machines per 100 persons employed.

4/ The graph is presented solely for the purpose of indicating in broad outline the influence of size of establishment on the number-of-machines/personnel-employed ratio, and no attempt is made to draw any conclusive deduction from it, since such fluctuations can also be observed although in a lesser degree, between two establishments of equal size, owing to differences in manufacturing procedures, kinds of products made, working methods, organization of functions, etc. This is also apparent in the graph from the scattering of the points in relation to the representative trend curve plotted.

5/ While the sample comprised large and small establishments, a higher proportion of the replies received came from the former group.

/Table 3

Table 3

BRAZIL: MACHINE-TOOLS COVERED BY THE SURVEY CARRIED OUT IN THE STATE OF SAO PAULO, 1960

I. Manufacture of metal products

Type of machine	1	2	3	4	5	Total for group I
A. Chip-producing machines						
Lathes	739	153	717	138	51	1 798
Bench lathes	62	21	37	16	5	141
Engine lathes	185	84	287	83	39	678
Copying lathes	9	-	2	-	-	11
Frontal or plateau lathes	10	-	8	-	1	19
Vertical lathes	-	-	3	-	1	4
Turret and semi-automatic lathes	184	40	278	20	4	526
Automatic lathes	242	5	64	3	1	314
Others	48	3	38	16	-	105
Milling machines	71	26	132	56	17	302
Universal	48	14	67	25	12	166
Vertical	7	3	22	5	2	39
Others	16	9	43	26	3	97
Drilling machines	268	114	705	143	39	1 269
Bench drills	125	63	383	102	10	683
Pedestal drills	124	47	288	35	29	523
Radial	12	4	28	6	-	50
Multi-spindle	7	-	6	-	-	13
Boring machines	15	-	24	1	-	40
Vertical	2	-	-	1	-	3
Horizontal	13	-	24	-	-	37
Jig boring machines	-	-	-	-	-	-
Shapers and planers	93	49	155	62	18	377
Shapers	72	45	130	59	9	315
Table planers	15	4	19	3	8	49
Others	6	-	6	-	1	13
Threading machines	215	17	35	1	4	272
Broaching machines	2	-	18	1	1	22
Special gear-cutting machines	-	-	3	1	-	4
Metal-cutting machines	125	34	148	40	17	364
Reciprocating saws	65	17	69	21	10	182
Band saws	29	12	41	12	3	97
Circular saws	31	5	38	7	4	85
Grinding machines	74	52	50	18	25	219
Plain	17	29	20	8	11	85
Universal cylindrical	20	14	8	7	4	53
Centreless	20	-	-	1	2	23
Others	17	9	22	2	8	58
Tool-grinding machines	71	6	32	10	14	133
Universal	50	3	26	10	14	103
Special	21	3	6	-	-	30
Total	1 673	451	2 019	471	186	4 800
B. Machines for forming operations						
Presses	426	419	638	246	26	1 755
Hydraulic	19	7	177	12	6	221
Eccentric	220	371	377	178	16	1 162
Friction	91	9	54	47	3	204
Upsetters	53	-	3	5	1	62
Others	43	32	27	4	-	106
Forging machines	21	1	13	11	1	47
Drop hammers	13	1	4	9	1	28
Pneumatic hammers	8	-	9	2	-	19
Machines for sheet	122	71	178	25	15	411
Shears	41	48	72	13	4	178
Press brakes	12	7	49	3	5	76
Bending rolls	22	6	39	3	2	72
Others	47	10	18	6	4	85
Total	569	491	829	282	42	2 213
Grand total	2 242	942	2 848	753	228	7 013

1. Rolling, wire drawing and manufacture of metal appliances.
2. Stamping and manufacture of containers.
3. Light metal work and boiler work.
4. Cutlery, manufacture of small arms, hand tools and hardware.
5. Manufacture of miscellaneous metal appliances.

/Table 4

Table 4

BRAZIL: MACHINE-TOOLS COVERED BY THE SURVEY CARRIED OUT IN THE STATE OF SAO PAULO, 1960

II. Manufacture of machinery, excluding electrical machinery

Type of machine	1	2	3	4	5	Total for group I
A. Chip-producing machines						
Lathes	228	414	1 849	529	1 529	4 549
Bench lathes	7	25	91	18	186	327
Engine lathes	122	313	1 391	390	631	2 847
Copying lathes	9	2	20	9	24	64
Frontal or plateau lathes	3	5	28	10	7	53
Vertical lathes	5	2	13	17	47	84
Turret and semi-automatic lathes	43	40	230	66	311	690
Automatic lathes	19	-	37	8	244	308
Others	20	27	39	11	79	176
Milling machines	40	38	451	58	555	1 142
Universal	13	28	291	40	200	572
Vertical	9	7	81	5	61	163
Others	18	3	79	13	294	407
Drilling machines	93	216	918	304	1 092	2 623
Bench drills	14	47	240	110	381	792
Pedestal drills	37	150	552	162	541	1 442
Radial	37	16	117	28	56	254
Multi-spindle	5	3	9	4	114	135
Boring machines	17	11	94	4	44	170
Vertical	4	3	2	-	4	13
Horizontal	13	8	81	3	34	139
Jig boring machines	-	-	11	1	6	18
Shapers and planers	21	69	684	124	210	1 108
Shapers	17	51	427	77	162	734
Table planers	2	12	235	30	40	319
Others	2	6	22	17	8	55
Threading machines	5	6	30	32	117	190
Broaching machines	6	-	12	9	12	39
Special gear-cutting machines	5	2	73	6	42	128
Metal-cutting machines	24	68	305	109	213	719
Reciprocating saws	18	48	236	79	127	508
Band saws	4	15	51	24	61	155
Circular saws	2	5	18	6	25	56
Grinding machines	83	28	233	20	344	708
Plain	9	8	49	-	68	134
Universal cylindrical	15	14	114	11	164	318
Centreless	8	4	15	-	27	54
Others	51	2	55	9	85	202
Tool-grinding machines	25	10	138	16	149	338
Universal	12	9	88	8	90	207
Special	13	1	50	8	59	131
Total	547	862	4 787	1 211	4 307	11 714
B. Machines for forming operations						
Presses	30	70	165	106	478	849
Hydraulic	5	13	27	18	59	122
Eccentric	16	44	111	67	296	534
Friction	5	5	13	16	18	57
Upsetters	-	-	1	2	4	7
Others	4	8	13	3	101	129
Forging machines	2	1	18	15	6	42
Drop hammers	-	1	5	4	1	11
Pneumatic hammers	2	-	13	11	5	31
Machines for sheet	4	111	118	136	183	552
Shears	2	41	46	44	70	203
Press brakes	1	26	13	19	43	102
Bending rolls	-	36	38	36	40	150
Others	1	8	21	37	30	97
Total	36	182	301	257	667	1 443
Grand total	583	1 044	5 088	1 468	4 974	13 157

1. Manufacture of non-electrical motors.
2. Machinery, apparatus and equipment for hydraulic, thermal and ventilation plant.
3. Machine-tools and general industrial equipment.
4. Machinery and equipment for agriculture and rural industries.
5. Miscellaneous machinery, apparatus and equipment.

/Table 5

Table 5

BRAZIL: MACHINE-TOOLS COVERED BY THE SURVEY CARRIED OUT IN THE STATE OF SAO PAULO, 1960

III. Manufacture of electrical and communications machinery, apparatus and appliances

Type of machine	1	2	3	Total for group III
A. Chip-producing machines				
Lathes	701	400	131	1 232
Bench lathes	95	43	41	179
Engine lathes	297	118	36	451
Copying lathes	17	5	-	22
Frontal or plateau lathes	1	4	-	5
Vertical lathes	11	1	-	12
Turret and semi-automatic lathes	153	103	47	303
Automatic lathes	52	39	5	96
Others	75	87	2	164
Milling machines	116	79	13	208
Universal	66	55	6	127
Vertical	20	10	4	34
Others	30	14	3	47
Drilling machines	485	417	112	1 014
Bench drills	241	242	65	548
Pedestal drills	200	149	40	389
Radial	19	10	7	36
Multi-spindle	25	16	-	41
Boring machines	7	22	4	33
Vertical	4	1	3	8
Horizontal	3	16	1	20
Jig boring machines	-	5	-	5
Shapers and planers	135	72	32	239
Shapers	119	58	24	201
Table planers	9	8	6	23
Others	7	6	2	15
Threading machines	100	18	14	132
Broaching machines	2	11	-	13
Special gear-cutting machines	6	9	-	15
Metal-cutting machines	164	91	30	285
Reciprocating saws	39	36	10	85
Band saws	42	41	16	99
Circular saws	83	14	4	101
Grinding machines	85	61	20	166
Plain	28	23	9	60
Universal cylindrical	29	18	4	51
Centreless	5	7	-	12
Others	23	13	7	43
Tool-grinding machines	70	32	9	111
Universal	47	14	7	68
Special	23	18	2	43
Total	1 871	1 212	365	3 448
B. Machines for forming operations				
Presses	870	151	266	1 287
Hydraulic	213	30	47	290
Eccentric	501	44	178	723
Friction	19	6	8	33
Upsetters	7	1	3	11
Others	130	70	30	230
Forging machines	-	-	1	1
Drop hammers	-	-	-	-
Pneumatic hammers	-	-	1	1
Machines for sheet	123	144	50	317
Shears	58	73	28	159
Press brakes	24	35	17	76
Bending rolls	21	14	2	37
Others	20	22	3	45
Total	993	295	317	1 605
Grand total	2 864	1 507	682	6 053

1. Machinery, apparatus and appliances for the production, accumulation, transmission and transformation of electric power.
2. Electrical apparatus and appliances.
3. Communications material.

/Table 6

Table 6

BRAZIL: MACHINE-TOOLS COVERED BY THE SURVEY CARRIES OUT IN THE STATE OF SAO PAULO, 1960

IV. Manufacture of transport material

Type of machine	1	2	3	4	5	6	7	Total for group IV	Grand total for 4 major groups
A. Chip-producing machines									
Lathes	-	118	917	2 274	72	215	25	3 621	11 200
Bench lathes		10	40	267	12	13	1	343	990
Engine lathes		53	339	881	50	62	10	1 395	5 371
Copying lathes		5	66	93	1	8	2	175	272
Frontal or plateau lathes		-	32	21	1	-	-	54	131
Vertical lathes		10	20	27	-	2	1	60	160
Turret and semi-automatic lathes		32	204	578	8	82	7	911	2 430
Automatic lathes		1	157	281	-	41	-	480	1 198
Others		7	59	126	-	7	4	203	648
Milling machines	-	26	501	511	13	70	1	1 122	2 774
Universal		10	135	222	8	24	1	400	1 265
Vertical		5	105	67	2	1	-	180	416
Others		11	261	222	3	45	-	542	1 093
Drilling machines	-	56	1 317	1 482	75	198	17	3 145	8 051
Bench drills		14	189	551	24	114	6	898	2 921
Pedestal drills		24	658	712	28	71	10	1 503	3 857
Radial		16	121	84	20	2	-	243	583
Multi-spindle		2	349	135	3	11	1	501	690
Boring machines	-	4	151	114	1	4	-	274	517
Vertical		-	47	20	-	1	-	68	92
Horizontal		4	96	80	1	1	-	182	378
Jig boring machines		-	8	14	-	2	-	24	47
Shapers and planers	-	27	101	349	27	27	4	535	2 259
Shapers		18	74	290	22	24	3	431	1 681
Table planers		9	20	30	4	1	1	65	456
Others		-	7	29	1	2	-	39	122
Threading machines	-	4	101	139	1	26	2	273	867
Broaching machines	-	2	87	74	3	3	-	169	243
Special gear-cutting machines	-	-	179	224	-	7	-	410	557
Metal-cutting machines	-	29	162	446	57	30	6	730	2 098
Reciprocating saws		17	43	212	12	11	5	300	1 075
Band saws		9	81	138	35	11	-	274	625
Circular saws		3	38	96	10	8	1	156	398
Grinding machines	-	13	698	584	6	38	-	1 339	2 432
Plain		4	75	108	2	12	-	201	480
Universal cylindrical		6	205	144	2	5	-	362	784
Centreless		2	36	105	-	9	-	152	241
Others		1	382	227	2	12	-	624	927
Tool-grinding machines	-	15	218	290	15	22	-	560	1 142
Universal		8	114	162	15	12	-	311	689
Special		7	104	128	-	10	-	249	453
Total		294	4 492	6 487	270	640	55	12 178	32 140
B. Machines for forming operations									
Presses	-	42	559	1 641	43	235	23	2 543	6 434
Hydraulic		12	152	287	12	7	12	482	1 115
Eccentric		18	310	1 005	30	169	8	1 540	3 959
Friction		1	6	133	1	18	3	162	456
Upsetters		6	2	24	-	5	-	37	117
Others		5	89	192	-	36	-	322	787
Forging machines	-	16	4	67	3	9	1	100	190
Drop hammers		13	1	24	2	1	1	42	81
Pneumatic hammers		3	3	43	1	8	-	58	109
Machines for sheet	-	22	145	207	65	17	8	464	1 744
Shears		5	45	98	24	6	6	184	724
Press brakes		2	29	37	26	6	1	101	355
Bending rolls		4	6	23	10	-	1	44	303
Others		11	65	49	5	5	-	135	362
Total		80	708	1 915	111	261	32	3 107	8 366
Grand total		374	5 140	8 402	381	901	87	15 285	40 508

1. Shipbuilding and dockyard repairs.
2. Railway equipment.
3. Motor vehicles.
4. Spare parts for motor vehicles.
5. Trailers and coachwork.
6. Bicycles and motor cycles.
7. Animal traction vehicles.

/According to

According to figure I, on the other hand, the average size of the establishments composing the universe is 77 persons, with 35 to 40 machines per 100 persons, which suggests that the sample should be adjusted to allow for the small establishments that were not covered. To this end, a second sample, at the level of the size of establishment not covered by the survey, was taken in each of the four major aggregates, as shown in detail in table 7. Although a direct adjustment in accordance with the ratios deriving from figure I might have been acceptable as an approximation, this would have served merely to correct the total number of machines, not its composition by types, the only way of rectifying which was by means of the second survey. The results of this sample taken to adjust the ratio between the number of machines and the personnel employed were added to those of the survey previously carried out, and in this way a total of 94 706 units was arrived at for the State of São Paulo (for details see table 8). To determine the number of machine-tools installed in the whole of Brazil, use was simply made of the ratio between each of the four major aggregates and the total for the country.[6/] A total figure of 137 364 units was thus obtained for the inventoried machine-tools installed in Brazil in 1960 for use in productive operations (see table 9). As mentioned above, this total does not include machines used for maintenance and repair work in other industrial sectors (e.g., textiles, food processing, glass, rubber, etc.).

2. Evaluation of the findings of the survey

The figures obtained for the size and composition of the country's inventory of machine-tools can be, if not confirmed, at least evaluated in respect of their order of magnitude, not by the procedure followed in computing them but by comparison with other statistics. As this was the

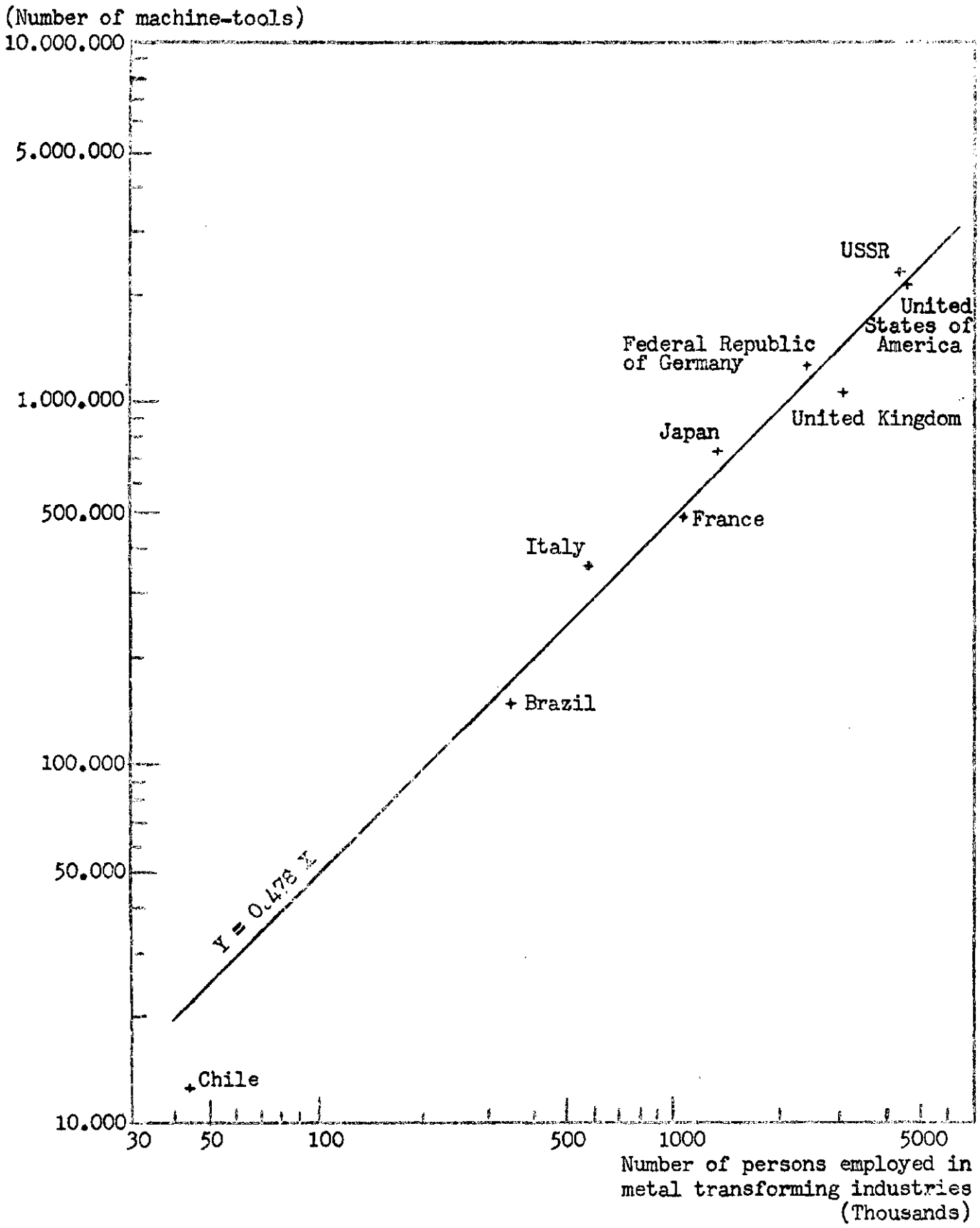
6/ In this case no adjustment for differences between the average size of the establishments in São Paulo and of those in the rest of the country had to be taken into consideration, since the differences observable for each group are small, and fluctuate in both directions, so that for the four groups as a whole, the figure is the same for the State of São Paulo as for the rest of the country, i.e., 74 persons per establishment in 1958.

/Figure I

Figure I

RATIO BETWEEN NUMBER OF MACHINE-TOOLS AND NUMBER OF PERSONS EMPLOYED IN THE METAL TRANSFORMING INDUSTRIES

Logarithmic scale



/Table 7

Table 7

BRAZIL: AVERAGE SIZE OF ESTABLISHMENTS IN THE SURVEY UNIVERSE AND IN THE SAMPLE, 1960

Major group	Number of persons employed	Number of establishments	Number of persons per establishment
I. Manufacture of metal products			
Universe	59 000	1 113	53
Sample	29 098	173	168
Not covered by the survey a/	29 902	940	32
II. Manufacture of machinery, excluding electrical machinery			
Universe	51 237	899	57
Sample	40 779	313	130
Not covered by the survey a/	10 458	586	18
III. Manufacture of electrical and communications machinery, apparatus and appliances			
Universe	46 711	425	110
Sample	26 830	80	335
Not covered by the survey a/	19 881	345	58
IV. Manufacture of transport material			
Universe	93 226	823	113
Sample	70 516	166	418
Not covered by the survey a/	22 710	657	35

a/ Including establishments which did not reply to the questionnaire and those not incorporated in the sample.

/Table 8

Table 8

INVENTORY OF MACHINE-TOOLS IN THE STATE OF SAO PAULO, 1960

Type of maquine	Major groups				Total
	I	II	III	IV	
	Manufacture of metal products	Manufacture of machinery, excluding electrical machinery	Manufacture of electrical and communications material	Manufacture of transport material	
Lathes	6 553	7 691	3 240	10 724	28 208
Milling machines	513	1 681	435	2 085	4 714
Drilling machines	4 544	4 732	2 628	6 675	18 579
Boring machines	48	170	45	424	687
Shapers and planers	1 539	1 647	550	1 519	5 255
Threading machines	323	280	252	765	1 620
Broaching machines	22	39	25	362	448
Gear-cutting machines	a/	218	27	510	755
Metal-cutting machines (saws)	1 526	1 437	691	2 163	5 817
Grinding machines	263	842	357	2 109	3 571
Tool-grinding machines	160	423	171	840	1 594
Total for chip-producing machines	15 491	19 160	8 421	28 176	71 248
Presses	8 201	1 747	3 224	5 816	18 988
Forging machines	47	42	a/	271	360
Machines for forming, bending and cutting sheet	1 362	1 135	807	806	4 110
Total for forming machines	9 610	2 924	4 031	6 893	23 458
Grand total	25 101	22 084	12 452	35 069	94 706

a/ Fewer than 10 units.

/Table 9

Table 9

BRAZIL: TOTAL INVENTORY OF MACHINE-TOOLS, 1960

Type of machine	Major groups				Total	
	I	II	III	IV		
	Manufacture of metal products	Manufacture of machinery, excluding electrical machinery	Manufacture of electrical and communications material	Manufacture of transport material	Number	Percentage
Lathes	11 298	9 860	4 263	15 104	40 525	29.5
Milling machines	884	2 155	572	2 937	6 548	4.8
Drilling machines	7 834	6 067	3 459	9 401	26 761	19.5
Boring machines	83	218	59	597	957	0.7
Shapers and planers	2 653	2 112	724	2 139	7 628	5.6
Threading machines	557	359	332	1 077	2 325	1.7
Broaching machines	38	50	33	510	631	0.4
Gear-cutting machines	a/	279	36	718	1 033	0.8
Metal-cutting machines (saws)	2 631	1 842	909	3 046	8 428	6.1
Grinding machines	453	1 079	470	2 970	4 972	3.6
Tool-grinding machines	276	542	225	1 183	2 226	1.6
Total for chip-producing machines	26 707	24 563	11 082	39 682	102 034	74.3
Presses	14 140	2 240	4 242	8 191	28 813	20.9
Forging machines	81	54	a/	382	517	0.4
Machines for forming, bending and cutting sheet	2 348	1 455	1 062	1 135	6 000	4.4
Total for forming machines	16 569	3 749	5 304	9 708	35 330	25.7
Grand total	43 276	28 312	16 386	49 390	137 364	100.0

a/ Fewer than 10 units.

/first survey

first survey carried out in Brazil, there is no benchmark whereby to measure the validity of the figures or ascertain the rate of growth of the machine inventory over the years and the modifications that have taken place in its structure; the comparison in question can therefore only be made with data for other countries.

Brief preliminary reference must first be made to international comparisons. The statistics published in the field of machine-tools are very incomplete, and most of them are not prepared on bases sufficiently similar to allow of direct comparison. Consequently, the remarks which follow are subject to the necessary reservations, although the figures given have been adjusted wherever possible in order to secure a higher degree of comparability. Thus, for example, when reference is made to the inventory of machine-tools, what is usually meant - particularly in this study - is the number of machines in use for production purposes, those used for maintenance and replacement being therefore excluded. Again, it is important to know which types of machines are included in the inventories taken in countries with which the comparison is made. As will have been noted in the preceding section, the survey carried out in Brazil excludes a series of machines which are usually taken into account in inventories (gear-finishing machines; boring and lapping machines; machines for strips and special wire shapes; riveters; extruding presses; die casting machines; machines for moulding plastics, etc.) and which represent from 10 to 15 per cent of the total.

On the basis of the statistical data available, two types of comparison can be made whereby the magnitude of the Brazilian inventory of machine-tools can be quantitatively assessed: one relating to the size of metal transforming industries, measured by the number of persons employed in them, and another relating to the gross industrial product.

The first of these implies determining the number of machines in use, in relation to the personnel employed. As can be seen in table 10, this ratio is fairly constant, and does not seem to vary greatly from one country to another in consequence of structural, technological and other differences. Of course, the observations recorded are too limited for

/any general

any general conclusion to be drawn from this comparison, besides which there is no way of judging whether the slight differences registered are due precisely to such causes or to statistical deficiencies. In general terms, however, they are consistent with the assumption usually adopted in the metal transforming industries, to the effect that the ratio between the number of machine-tools in service and the personnel employed is 50 machines to every 100 persons (1 machine to 2 persons). This is more clearly evident in figure II, where the inventory of machines is related to the personnel employed in the transforming industries and where the regression curve plotted corresponds to the equation $y = 0.478\ x$, which would seem to indicate an average ratio of 47.8 machines per 100 persons (1 machine to 2.1 persons). Given this over-all ratio, it may be concluded that Brazil's estimated inventory of machine-tools - taking into account the above-mentioned adjustments for machines not included in the survey - is within an order of magnitude compatible with the size of its metal transforming industries, and is likely to be on the low side.

A comparison between the number of machines and the gross industrial product leads to a conclusion similar to the foregoing, namely that Brazil's position is below to the regression curve plotted (see figure III and table 11). In this case it was thought needful to exclude the United States, since its advanced industrial development and the high degree of automation and productivity characterizing its metal transforming processes, which have resulted in a decrease in its inventory of machine-tools in recent years, preclude all possibility of comparison with the countries selected. Again, it might perhaps be felt that the curve best representing this ratio would be a parabola sloping sharply within the range of industrial product magnitudes recorded in the countries taken into consideration, and gradually flattening out as higher industrial product levels were reached.

/Table 10

Table 10

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	152 474 a/	353	2.3
Chile	12 044	44	3.6

Sources: For machine-tool inventories: Chile, Instituto Chileno del Acero, Equipo de máquinas-herramientas en la industria metalúrgica nacional, 1962; other countries, A. Garanger, Petite histoire d'une grande industrie, according to statistics for the countries concerned.

For number of persons employed: Chile, op.cit.; other countries, International Labour Organisation, Year book of labour statistics, Geneva, 1960, and Organization for Economic Co-operation and Development, Industrias mecánicas y eléctricas.

/Figure II

Figure II

RATIO BETWEEN NUMBER OF MACHINE-TOOLS PER THOUSAND INHABITANTS AND PER CAPITA GROSS PRODUCT OF THE INDUSTRY

Natural scale

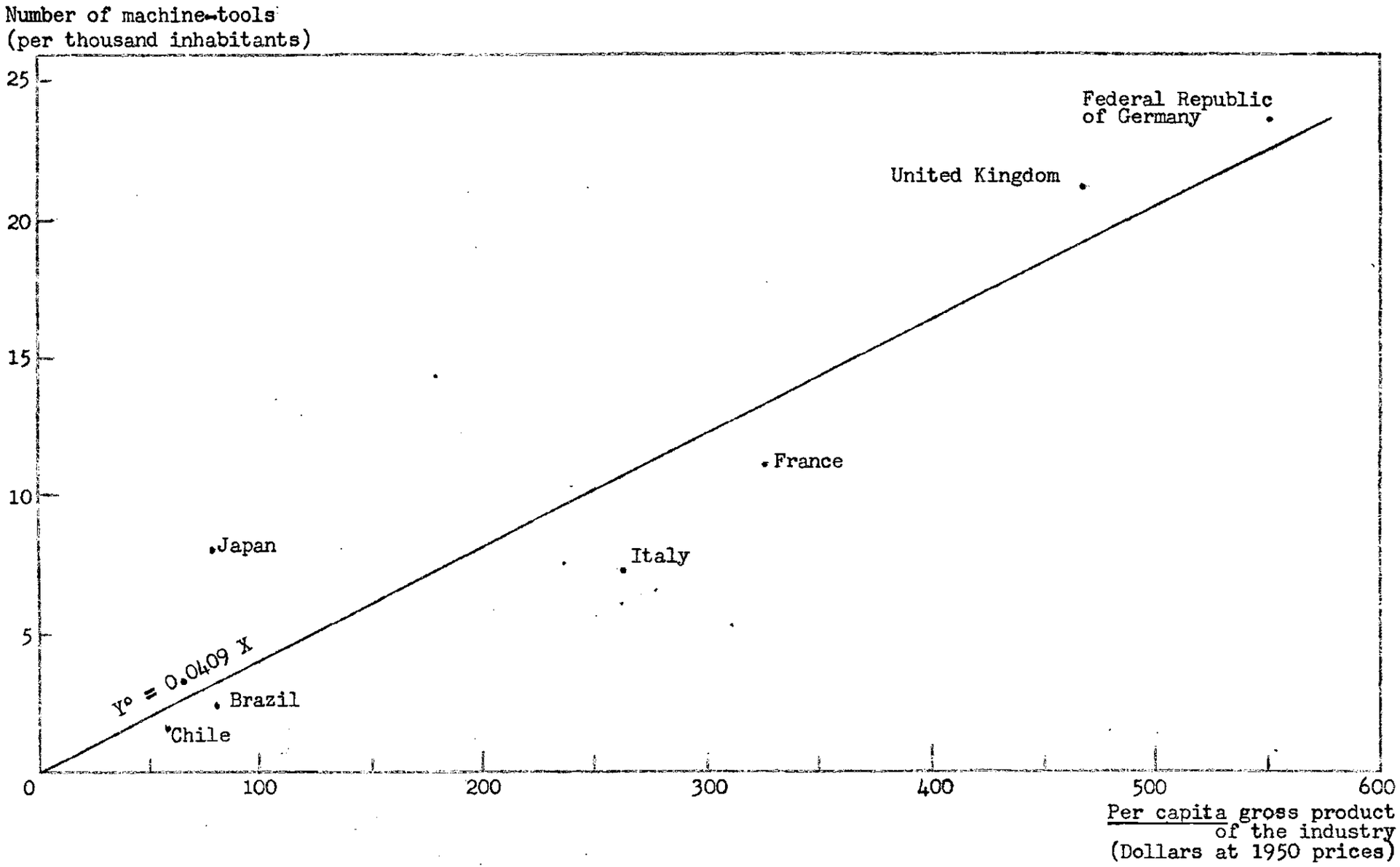


Figure III

RATIO BETWEEN NUMBER OF MACHINE-TOOLS PER HUNDRED PERSONS EMPLOYED AND SIZE OF ESTABLISHMENT

Natural scale

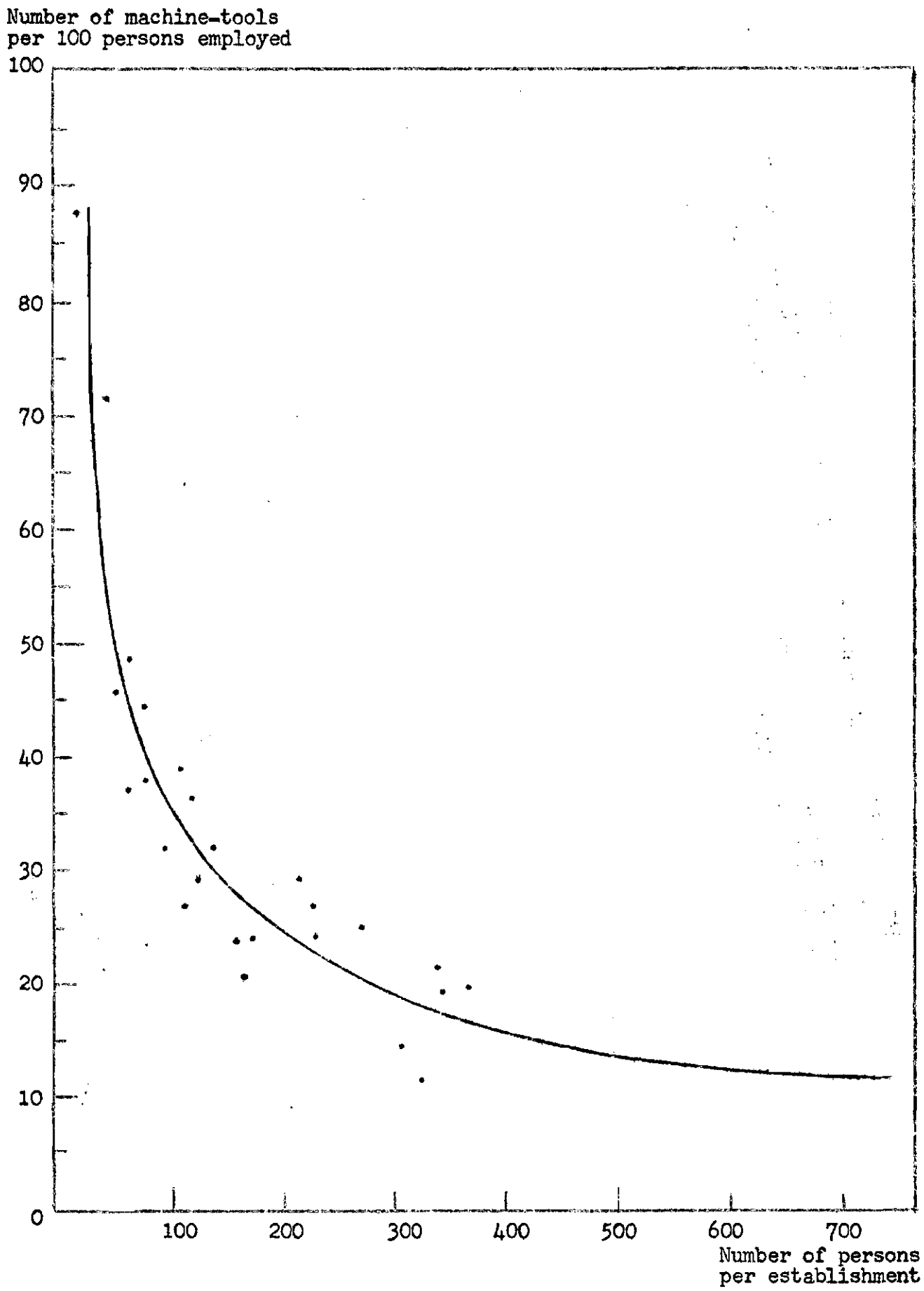


Table 11

INVENTORY OF MACHINE-TOOLS AND GROSS INDUSTRIAL PRODUCT
IN SELECTED COUNTRIES

Country	Number of machines per thousand inhabitants	Per capita industrial product in 1959 (Dollars at 1950 prices)
United States of America	12.6	627.6
United Kingdom	21.2	467.6
Federal Republic of Germany	23.6	549.0
France	11.1	326.3
Italy	7.4	263.2
Japan	8.1	77.2
Brazil	2.2 a/	81.9
Chile	1.6	54.7

Sources: Machine-tool inventory: as for table 10.
Industrial product: Chile and Brazil, figures based on ECLA estimates; other countries, OECD, Comparative national products and price levels, 1958, and Statistical Bulletin, No.4, 1960.

a/ Adjusted to include machines not covered by the survey.

Although these two comparisons cannot be regarded as conclusive, they do clearly show that the estimated inventory of machine-tools in Brazil would seem to be of a reasonable size in relation to the dimensions of its metal transforming industries, and that the estimate in question probably errs on the conservative side, partly because establishments employing fewer than 5 persons are not taken into account in the inventory.

/A comparison

A comparison of the composition determined for the inventory of machine-tools in Brazil with the corresponding data for other countries (see table 12) gives rise to certain observations which are of interest in relation to the present situation and the trends or changes which may logically be expected during the next few years.

(a) The composition of the Brazilian inventory - 74.3 per cent of cutting and 25.7 per cent of forming machine-tools - seems reasonable for its present state of development, by comparison with the other countries appearing in table 12.

(b) In respect of the first group of machines, it is interesting to call attention to the higher proportion of lathes, drills, planers and saws shown in the inventory, since this is characteristic of an industrial structure in which activities with low volumes of output and using all purpose machinery predominate.

(c) Noteworthy in the forming machine-tools group is the large number of presses, which is reflected in a high percentage of machines of this type, exceeding that registered in Chile, Italy and the United States. This is no doubt partly because the most widely used types and models of presses have been manufactured in Brazil for many years now, so that the industry has been able to obtain these machines with relative ease, which has encouraged the development of the stamping sector, especially as regards light equipment for use in the production of articles made from tinplate and from thin sheet in general. Furthermore, in some operations presses are used instead of other machine-tools.

(d) Accordingly, it may logically be assumed that as the metal transforming industries progress, the trend of this inventory will be towards a reduction of the proportion of universal machines in favour of other types required for longer production series and for the application of more advanced technologies. Thus, there is a reasonable likelihood of the replacement of planers by milling-machines, as well as the incorporation of larger quantities of rectifiers, boring-machines, tool-grinders, gear-cutting machines and, in general, machines for specialized production instead of the universal type.

/Table 12

Table 12

COMPOSITION OF MACHINE-TOOL INVENTORIES IN SELECTED COUNTRIES
(EXCLUDING MAINTENANCE)
(Percentages)

Type of machine	Brazil 1960	Chile 1960 a/	Federal Republic of Germany b/ 1938	Italy 1958 c/	United Kingdom 1961 d/	United States 1958 e/
Lathes	29.5	28.2	25.9	24.4	23.1	18.8
Milling machines	4.8	5.5	9.6	8.5	10.5	9.0
Drilling machines	19.5	19.7	18.9	18.9	19.7	18.3
Boring machines	0.7	0.6	1.3	1.9	2.3	2.3
Shapers and planers	5.6	5.4	4.8	4.5	2.8	2.5
Threading machines	1.7	3.1	3.1	2.8	3.4	2.9
Broaching machines	0.4	0.3	0.1	0.4	0.5	0.6
Gear-cutting machines	0.8	0.8	1.4	1.9	2.5	2.2
Metal-cutting machines (saws)	6.1	2.8	4.0	4.0	4.3	4.9
Grinding machines	3.6	7.1	4.1	5.9	14.2	15.0
Tool-grinding machines	1.6	1.4		2.8	3.1	3.4
Total for chip-producing machines	74.3	74.9	73.2	76.0	86.4	79.9
Presses	20.9	16.6	17.1	10.8	8.9	14.4
Forging machines	0.4	1.4	1.8	1.4	1.4	1.0
Machines for forming, bending and cutting sheet	4.4	7.1	7.9	11.8	3.3	4.7
Total for forming machines	25.7	25.1	26.8	24.0	13.6	20.1
Number of machines	137 364	10 214	1 146 002	308 484	1 113 330	1 955 035
Other machines f/	-	830	267 539	54 327	132 856	262 707
Grand total	-	12 044	1 413 541	362 811	1 246 186	2 217 742

a/ Institute Chileno del Acero, op. cit.
b/ Survey taken on 15 May 1938.
c/ Central Institute of Statistics, Rome, September 1960.
d/ Metalworking Production, 29 December 1961.
e/ American Machinist, 17 November 1958.
f/ Machines not taken into consideration in the present study.

/Clearly, then,

Clearly, then, the size and structure of Brazil's inventory of machine-tools as estimated for 1960 places it within a range of magnitudes compatible with the dimensions of the country's metal transforming industries and with the level of its industrial development.

It would be desirable, however, both for the purposes of estimating future machine-tool requirements and in order to improve the degree of comparability with other countries, to adjust these figures by the introduction of two significant modifications: first, the inclusion of machines not covered by the survey, and, secondly, the extension of the machine inventory to establishments employing fewer than 5 persons.

With respect to the first type of adjustment, the machines not taken into account probably represent, as mentioned above, approximately 10 per cent of the total inventory; this would imply increasing the estimated figure by 11 per cent.

The second adjustment might conceivably be based on the number of persons employed in the smaller establishments according to the figures published in the Industrial Register of the National Statistical Council for 1958. In that year, metal transforming enterprises employing fewer than 5 persons accounted for 76.7 per cent of total number of the establishments, and their personnel represented 2.3 per cent of the labour force employed by the bigger enterprises. If this same proportion is applied in respect of the year 1960, it can be estimated that 8 034 persons were employed in establishments with a staff of under 5. Enterprises of this size, with an average of 2.2 persons per establishment, show ratios in the neighbourhood of 1.5 machines to every employed person; the number of machines installed in establishments employing fewer than 5 persons would thus work out at about 12 050.

Given these adjustments, the machine-tool inventory in 1960 would total 164 524 units, and its composition would be as shown in table 13. To present a fuller picture of the situation, an estimate of machine-tools used for maintenance and repairs in other sectors (for example, textiles, food processing, rubber, glass, chemicals, etc.) is included in the same table. For the purposes of this estimate, the ratios recorded in other countries between these machines and those used for production were taken

/Table 13

Table 13

BRAZIL: TOTAL INVENTORY OF MACHINE-TOOLS, 1960

Type of machine	Number of machines in establishments employing		Total		Maintenance a/		Grand total	
	More than 5 persons	Fewer than 5 persons	Number	Percentage	Number	Percentage b/	Number	Percentage
Lathes	40 525	4 820	45 345	27.6	16 040	39.0	61 385	29.9
Milling machines	6 548	600	7 148	4.3	2 630	6.4	9 778	4.8
Drilling machines	26 761	2 420	29 181	17.7	7 815	19.0	36 996	18.1
Boring machines	957	-	957	0.6	80	0.2	1 037	0.5
Shapers and planers	7 628	1 810	9 438	5.7	3 990	9.7	13 428	6.5
Threading machines	2 325	-	2 325	1.4	620	1.5	2 945	1.4
Broaching machines	631	-	631	0.4	41	0.1	672	0.3
Gear-cutting machines	1 033	-	1 033	0.6	165	0.4	1 198	0.6
Metal-cutting machines (saws)	8 428	1 200	9 628	5.9	4 113	10.0	13 741	6.7
Grinding machines	4 972	-	4 972	3.0	411	1.0	5 383	2.6
Tool-grinding machines	2 226	-	2 226	1.4	125	0.3	2 361	1.1
Total for chip-producing machines	102 034	10 850	112 884	68.6	36 030	87.6	148 914	72.5
Presses	28 813	600	29 413	17.9	2 960	7.2	32 373	15.7
Forging machines	517	-	517	0.3	125	0.3	642	0.3
Machines for forming, bending and cutting sheet	6 000	600	6 600	4.0	2 015	4.9	8 615	4.2
Total for forming machines	35 330	1 200	36 530	22.2	5 100	12.4	41 630	20.2
Machines inventoried	137 364	12 050	149 414	90.8	41 130	100.0	190 544	92.7
Machines not inventoried c/	15 110	-	15 110	9.2	-	-	15 110	7.3
Grand total	152 474	12 050	164 524	100.0	41 130	100.0	205 654	100.0

a/ Representing 25 per cent of the total of 164 524 machines.

b/ On the basis of the composition of the Chilean inventory of machines used for maintenance purposes.

c/ Machines not covered by the survey, such as honing and lapping machines; machines for strip and special wire shapes; riveting machines; extrusion presses; die-casting machines; plastic-moulding machines, etc.

/into account.

into account. Unfortunately, little information is published on this subject, and the only data available on the occasion in question were those for the United States[7] and for Chile.[8] In these countries, the number of machine-tools used for maintenance and repair fluctuates between 20 and 25 per cent of the production machines. For Brazil, a proportion of 25 per cent was adopted to determine the number of machines used for maintenance, and to this group a percentage composition was assigned which was estimated on the basis of the structure of the Chilean maintenance inventory, with minor changes. Thus, the total number of machine-tools in use in Brazil in 1960 would seem to have been 205 654 units.

As mentioned above, in this survey no account was taken of a question which is significant in connexion with a machine-tool inventory - that of its age; for a substantial proportion of Brazil's inventory of machines was considered to have been installed during the last few years, although some of them had been purchased second hand abroad. However, the data collected suffice for a rough estimate of the age of the inventory. In 1955-60, 84 367.2 tons of machine-tools were brought into Brazil, or the equivalent (assuming a unit weight of 2.5 tons) of a out 33 750 units. Moreover, during the same period the domestic industry manufactured 46 937 machines, which implies that in those six years 80 687 machine-tools in all were incorporated into the Brazilian inventory.

If this figure is compared with the total number of machines installed in Brazil at the end of 1960 - 205 654[9] - it may be deduced that 61 per cent of the machine-tools composing the Brazilian inventory are probably more than 6 years old (see again table 13). In the four years immediately preceding that date, 32 174 tons of machine-tools were imported while it may be assumed that during the same period domestic output amounted to

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7/ "Inventory of Metal-working equipment", American Machinist, 17 November 1958.

8/ Instituto Chileno del Acero, Equipo de máquinas-herramientas en la industria metalúrgica nacional, February 1962.

9/ Machine-tools for maintenance and repair work are included in this comparison, since a high percentage of domestic output is used for such purposes.

/approximately 16 000

approximately 16 000 tons, so that, given a unit weight of 1.5 tons, about 32 100 machines were installed between 1951 and 1954. Hence the conclusion may be drawn that 45 per cent of Brazil's inventory of machine-tools is more than 10 years old, which indicates that the stock in question is fairly new. For purposes of comparison, it may be pointed out that in Chile 52 per cent of the equipment is over 10 years old, and that in the United Kingdom and the United States the corresponding proportions are 59 and 60 per cent, respectively.

The figures for the above-mentioned countries are not entirely comparable with those for Brazil, since they do not include machines used in maintenance work, which are generally older than production machines. But this fact lends additional force to what has just been said of the age of the Brazilian inventory.

If this line of reasoning is carried farther back than 1950, it can be established that between 1941 and 1950 about 43 000 machines were incorporated into the inventory by virtue of imports amounting to 23 554 tons and domestic output estimated at 2 500 tons per annum. Thus, the machine-tool inventory in 1960 might be broken down roughly as follows:

Under 10 years old	55 per cent
From 10 to 20 years old	21 per cent
Over 20 years old	24 per cent

In any future studies that may be undertaken in this field, special attention should be devoted to the age of equipment, since information on this point will enable more precise criteria to be applied in replacing the inventory, which can thereby be maintained at satisfactory levels of productivity and efficiency.

/Chapter III

Chapter III

MACHINE-TOOL REQUIREMENTS IN 1962-71

The quantity of machine-tools that will be required in the decade under consideration will be closely linked to the over-all level of development attained by Brazil and, in particular, to the evolution of the metal transforming industries, which are the main consumers. The present study assumes that the annual growth rate of the gross domestic product will be 5.7 per cent, and that the metal transforming industries' share in the product will increase from 5.4 per cent in 1960 to 8 per cent in 1971. Thus, given a specific rate of economic growth and a definition of the industrial sector's contribution to this process, the problem is to translate these economic development prospects into terms of machine-tool requirements.

In several studies carried out in other countries, in which consideration is given to the problem of estimating future machine-tool requirements, various procedures or criteria applied for this purpose are put forward. Among them, the following four are worthy of mention:

(a) Establishment of the ratio between the number of machines and the number of personnel employed in the metal transforming industries;

(b) Determination of a coefficient relating the value of the machines purchased to the value of the products manufactured by this sector;

(c) Application of machine-tools/output coefficients, established at the level of the products themselves or of branches of industry;

(d) Determination of the ratio between the inventory of machines and apparent consumption of steel.

The procedures indicated under (a) and (d) lead to a direct estimate of the number of machines, whereas (b) and (c) establish their value, which subsequently has to be converted into terms of units. The adoption of any one of these methods is determined on the one hand by the availability of basic statistical data which will make the application of such indices feasible, and, on the other, by the actual possibility of using these ratios in the country under study, since as a rule they have been established for countries with an advanced industrial structure. Moreover, the coefficients in question - particularly those corresponding to procedures (b), (c) and (d) - far from remaining constant, are subject to sharp variations, since they are

/closely bound

closely bound up with all sorts of factors such as the level of industrial development, the structure of the metal transforming industries, the degree of integration achieved, automation, age of the machines in use, etc., and this makes it difficult to apply them, or at any rate to adapt them, when there are very marked differences between the country for which they were established and the one in which it is desired to use them. The first procedure - relating the number of machines to the personnel employed - seems to be the least affected by the above-mentioned factors (see section 2 of the present chapter). Thus, it was decided to adopt this criterion for the purpose of determining machine-tool requirements in Brazil for the period 1962-71, and to reserve methods (b) and (d) as controls, with due allowance for their limited applicability to the case of Brazil. Method (c) was rejected altogether, since the available data precluded complete coverage of the whole field of the metal transforming industries, and also because the coefficients established for the United States revealed a structure in respect of the number of machines per unit manufactured which was incompatible with the situation in Brazil.

1. Determination of the machine-tool industry in 1971

The first step was to determine manpower requirements in each of the twenty groups into which the metal transforming industries were sub-divided. As the basic statistics related to the State of São Paulo, an estimate was first formulated for this state and then extrapolated for the rest of the country. In general terms, a linear projection of past trends was adopted, the appropriate adjustments being introduced in those groups which will undergo significant changes during the next few years (for example, manufacture of Diesel engines, ball bearings, tractors, heavy machinery in general and electrical equipment, shipbuilding, etc.), and in respect of which specific manufacturing projects and the respective production programmes for the coming years were known. Similarly, the manufacture of motor vehicles and spare parts was dealt with separately, since it was not considered appropriate to relate the projection to this activity in its initial period. Concurrently with the projection of manpower requirements, an estimate of the value of the corresponding output, at 1960 prices, was also prepared. The over-all results obtained can be seen in table 14.

/Table 14

Table 14

BRAZIL: PERSONNEL REQUIREMENTS AND VALUE OF PRODUCTION IN THE METAL TRANSFORMING INDUSTRIES, 1960-71

(Value of production in millions of cruzeiros at 1960 prices)

	1954	1955	1956	1957	1958	1960	1966	1971
Group I. Manufacture of metal products								
State of São Paulo								
Personnel requirements	43 687	38 965	43 851	45 038	55 003	59 000	78 871	95 569
Value of production	31 164	28 644	32 841	33 046	40 652	48 270	86 336	133 423
Brazil								
Personnel requirements	...	83 363	92 098	89 439	98 844	107 947	140 519	167 801
Value of production	...	57 270 a/	64 459 a/	60 531	69 150	88 316	153 819	234 265
Group II. Manufacture of machinery and equipment, excluding electrical machinery								
State of São Paulo								
Personnel requirements	24.984	29 689	32 890	31 661	40 285	51 237	82 495	105 877
Value of production	14 684	15 893	17 959	19 765	23 780	33 117	71 750	117 326
Brazil								
Personnel requirements	...	41 069	44 210	42 953	51 389	64 052	96 961	121 719
Value of production	...	20 850	23 272	24 514	26 632	41 400	84 332	134 880
Group III. Manufacture of electrical and communications material								
State of São Paulo								
Personnel requirements	25 061	27 713	32 647	31 660	40 581	46 711	69 813	89 774
Value of production	21 374	28 720	35 691	37 180	40 025	55 373	110 973	182 045
Brazil								
Personnel requirements	...	35 223	42 493	42 903	53 038	61 400	90 544	115 540
Value of production	...	33 084	42 065	45 587	47 216	72 786	143 927	234 262
Group IV. Manufacture of transport material								
State of São Paulo								
Personnel requirements	19 113	21 513	25 520	33 798	52 888	93 226	133 034	174 579
Value of production	16 458	20 632	21 245	44 785	54 588	121 466	229 946	353 965
Brazil								
Personnel requirements	...	39 976	37 708	51 148	74 330	115 889	162 321	209 387
Value of production	...	27 834	30 613	60 995	70 985	150 994	280 569	424 541
Total								
State of São Paulo								
Personnel requirements	112 845	117 880	134 908	142 157	188 757	250 174	364 213	465 799
Value of production	83 680	93 889	107 736	134 776	159 045	258 226	499 005	786 759
Brazil								
Personnel requirements	...	199 631	216 509	226 443	277 601	349 288	490 345	614 447
Value of production	...	139 038	160 409	191 627	213 983	353 496	662 647	1 027 948

a/ Estimate.

/The estimated

The estimated value of the output of the metal transforming industries is consistent with the assumptions adopted for the growth of the gross domestic product and of this industrial sector up to 1971. In that year the gross domestic product should reach 817.9 . 10^9 cruzeiros (at 1950 prices), in which the share of manufacturing industry would be 253.5 . 10^9 cruzeiros and that of the metal transforming industries 65.4 . 10^9 cruzeiros. In the latter group, the estimated value of production in 1971 would be approximately 1 027.9 . 10^9 cruzeiros (at 1960 prices), which, deflated by the wholesale price index for metals and metallurgical products, would be equivalent to 137.5 . 10^9 cruzeiros (at 1950 prices). Between 1955 and 1958 the value added in theseindustries averaged 51 per cent of the value of production, and if the same proportion is applied to the 1971 figure, value added in the metal transforming industries works out at 70.2 . 10^9 cruzeiros, which compares reasonably with that of 65.4 . 10^9 cruzeiros.

The projection of manpower requirements for these industries, in relation both to São Paulo and to the country as a whole, is also consonant with the historical growth trends apparent from the statistical data prepared by the Statistical Service of the State of São Paulo and the Brazilian Institute of Geography and Statistics (IBGE) (see figure IV).

If these two situations are taken in conjunction it can be inferred that the value added per capita should increase in real terms from 516 145 cruzeiros in 1960 to 853 210 cruzeiros in 1971, i.e., by 65 per cent. This increase, which may seem unduly large, slightly exceeds the increment registered between 1955 and 1958. During that period, the value added per capita increased at an average annual rate of 3.5 per cent, and by 1971 the rate in question should have risen to 4.6 per cent per annum. For illustrative purposes, it may be pointed out that in the United States the value added per capita in this group of industries was 9 240 dollars in 1957, whereas in Brazil it would be only 4 160 dollars in 1971, given an exchange rate of 205 cruzeiros to the dollar.

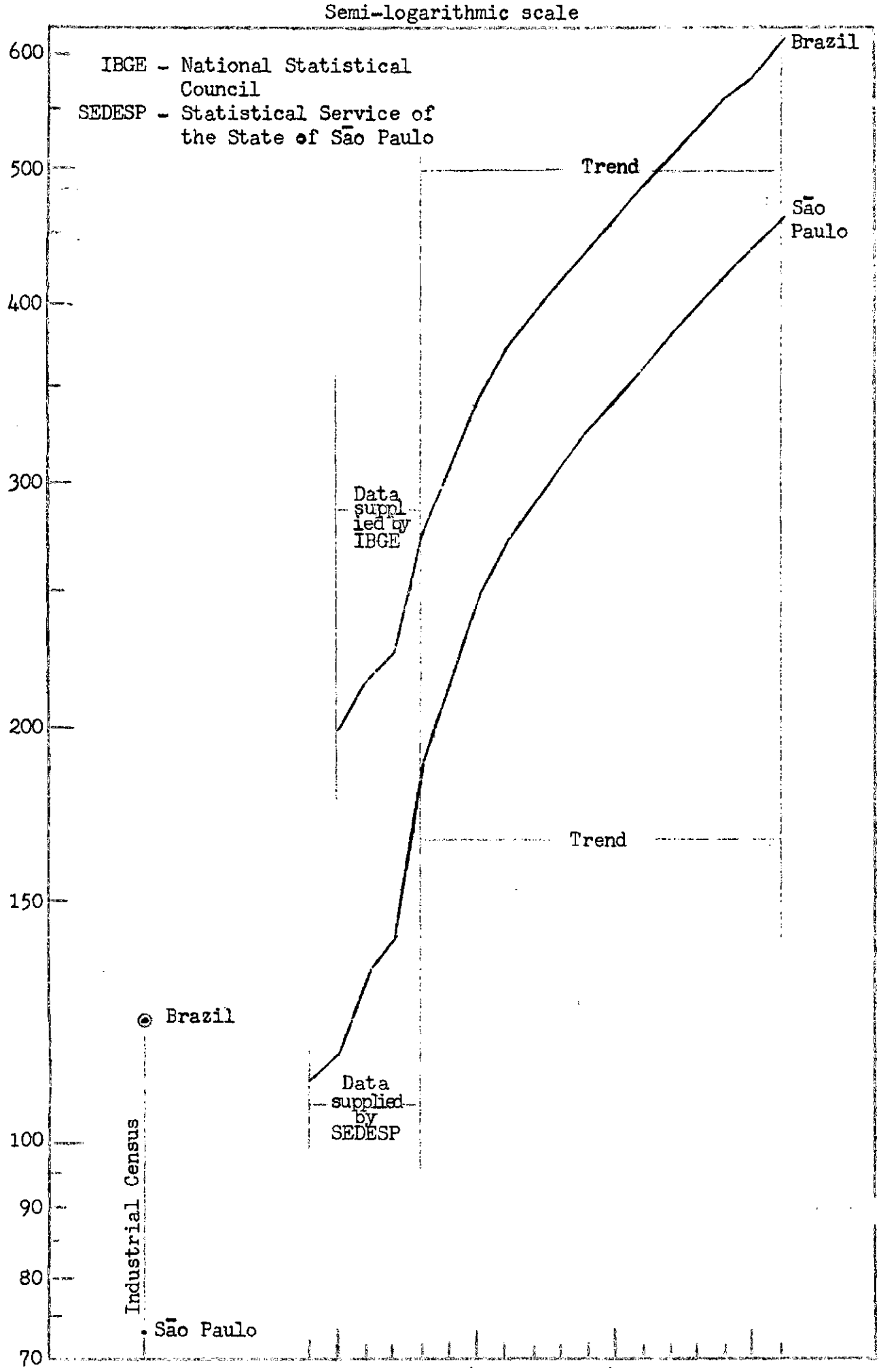
On the basis of these estimates of the manpower employed in the metal transforming industries, the number of machine-tools of the types considered in the inventory was determined by application of the ratio between the

/Figure IV

Figure IV

NUMBER OF PERSONS EMPLOYED IN THE METAL TRANSFORMING INDUSTRIES
(Thousands of persons employed)

Semi-logarithmic scale



number of persons employed in 1960 and 1971 and the number of machines existing in 1960 (see again table 9). The results thus obtained are presented in table 15. As can be seen from a comparison of these tables, the percentage composition of the two industries undergoes practically no change, and the slight variations reflect only the different rates of growth of the four major aggregates during the period in question. Obviously, however, the development of the metal transforming industries in the next ten years will involve some modification of this structure, because of the increase in demand for production machinery proper, as against the universal machines which constitute a substantial proportion of the inventory today. In view of the impossibility of quantitative and detailed measurement or assessment of the changes which will thus result from the replacement of one machine by another, it was decided to estimate - as shown in table 15 - a composition of the 1971 inventory which might be consonant with the level of industrial development in that year, taking as a frame of reference the composition observable today or in the past in more developed countries at various stages of their industrial evolution.

On the basis of this revised number of machines, corresponding to the list of those taken into account in the inventory and installed in establishments employing more than 5 persons, the same adjustments that were introduced in relation to the 1960 inventory should be made.[1/] It may thus be concluded that the machine-tool inventory in 1971 should number 295 316 units in the metal transforming industry, reaching a total of 369 146 units with the addition of the machines used for maintenance and repair work (see table 16). With the exlusion of the latter, the inference is that the Brazilian machine-tool inventory will probably increase between 1961 and 1971 by nearly 80 per cent, that is, at an average annual rate of 5.5 per cent, as compared with 5.7 per cent in the case of the gross domestic product and 10.2 per cent in that of the product of the metal transforming industries.

1/ In order to estimate the number of machines installed in establishments employing fewer than 5 persons, it was assumed that in 1971 the personnel employed by such enterprises would be equivalent to a slightly higher percentage of the labour force of the bigger establishments than in 1961 - i.e., 3 per cent instead of 2.3 per cent. This assumption was based on the likelihood that the development of areas in the interior of the country would lead to the establishment of a larger number of small industrial enterprises and workshops.

/Table 15

Table 15

BRAZIL: REQUIREMENTS OF INVENTORIED MACHINES-TOOLS IN 1971

Type of machine	Major groups				Total		Total, assuming a given structural evolution	
	Manufacture of metal products	Manufacture of machinery, excluding electrical machinery	Manufacture of electrical and communications material	Manufacture of transport material	Number	Percentage	Number	Percentage
Lathes	17 562	18 737	8 022	27 290	71 611	29.7	67 521	28.0
Milling machines	1 374	4 095	1 076	5 307	11 852	4.9	14 468	6.0
Drilling machines	12 178	11 529	6 509	16 986	47 202	19.6	45 817	19.0
Boring machines	129	414	111	1 079	1 733	0.7	2 411	1.0
Shapers and planers	4 124	4 013	1 362	3 865	13 364	5.5	12 057	5.0
Threading machines	866	682	625	1 946	4 119	1.7	4 823	2.0
Broaching machines	59	95	62	921	1 137	0.5	965	0.4
Gear-cutting machines	a/	530	68	1 297	1 895	0.8	2 411	1.0
Metal-cutting machines (saws)	4 090	3 500	1 711	5 503	14 804	6.1	14 468	6.0
Grinding machines	704	2 050	884	5 366	9 004	3.7	11 092	4.6
Tool-grinding machines	429	1 030	423	2 137	4 019	1.7	4 823	2.0
Total for chip-producing machines	41 515	46 675	20 853	71 697	180 740	74.9	180 856	75.0
Presses	21 980	4 257	7 982	14 799	49 018	20.4	48 228	20.0
Forging machines	126	103	a/	690	919	0.4	1 206	0.5
Machines for forming, bending and cutting sheet	3 650	2 765	1 998	2 051	10 464	4.3	10 851	4.5
Total for forming machines	25 756	7 125	9 980	17 540	60 401	25.1	60 285	25.0
Grand total	67 271	53 800	30 833	89 237	241 141	100.0	241 141	100.0

a/ Fewer than 10 machines.

/Table 16

Table 16

BRAZIL: ESTIMATE OF TOTAL MACHINE-TOOL INVENTORY FOR 1971

Type of machine	Number of machines in establishments employing		Total		Maintenance a/		Grand total	
	More than 5 persons	Fewer than 5 persons	Number	Percentage	Number	Percentage	Number	Percentage
Lathes	67 521	11 060	78 581	26.6	28 795	39.0	107 376	29.0
Milling machines	14 468	1 380	15 848	5.4	4 725	6.4	20 573	5.6
Drilling machines	45 817	5 550	51 367	17.5	14 030	19.0	65 397	17.7
Boring machines	2 411	-	2 411	0.8	150	0.2	2 561	0.7
Shapers and planers	12 057	4 150	16 207	5.5	7 160	9.7	23 367	6.3
Threading machines	4 823	-	4 823	1.6	1 110	1.5	5 933	1.6
Broaching machines	965	-	965	0.3	75	0.1	1 040	0.3
Gear-cutting machines	2 411	-	2 411	0.8	295	0.4	2 706	0.7
Metal-cutting machines (saws)	14 468	2 750	17 218	5.8	7 380	10.0	24 598	6.7
Grinding machines	11 092	-	11 092	3.8	740	1.0	11 832	3.2
Tool-grinding machines	4 823	-	4 823	1.6	220	0.3	5 043	1.4
Total for chip-producing machines	180 856	24 890	205 746	69.7	64 680	87.6	270 426	73.2
Presses	48 228	1 380	49 608	16.8	5 315	7.2	54 923	14.9
Forging machines	1 206	-	1 206	0.4	220	0.3	1 426	0.4
Machines for forming, bending and cutting sheet	10 851	1 380	12 231	4.1	3 615	4.9	15 846	4.3
Total for forming machines	60 285	2 760	63 045	21.3	9 150	12.4	72 195	19.6
Machines inventoried	241 141	27 650	268 791	91.0	73 830	100.0	342 621	92.8
Machines not inventoried c/	26 525	-	26 525	9.0	-	--	26 525	7.2
Grand total	267 666	27 650	295 316	100.0	73 830	100.0	369 146	100.0

a/ Representing 25 per cent of a total of 295 316 machines.

b/ Same breakdown adopted as for 1960.

c/ Machines not covered by the survey, such as honing and lapping machines; machines for strip and special wire shapes; riveting machines; extrusion presses; die-casting machines; plastic-moulding machines, etc.

/2. Demand

2. Demand for machine-tools in 1962-71

In order to establish machine-tool requirements during the period 1962-71 it was decided first to calculate demand between 1961 and 1971, since the inventory existing in 1960 had been determined, and to subtract from that figure the machines incorporated into the inventory in 1961 from both foreign and domestic sources. Since import statistics do not present a sufficiently detailed breakdown by types of machines, the deduction in question could only be made in the aggregate for the total number of machine-tools. To ensure that the present study supplied as much information as possible on this industrial sector, the method in question was thought preferable to the alternative of taking the 1960 inventory plus the machines added in 1961 and working only on the basis of the total figures, since the way was thus left open for subsequent revision if it should be possible to obtain 1961 import data adequately broken down by the various types of machines.

Tables 17 and 18 present the result of this calculation in the aggregate and in the form of a breakdown by types of machines, respectively, the method adopted being subtraction of the totals in table 13 from those in table 16. In order to arrive at a figure which would more fully reflect the extent of demand in 1961-71, the number of machines that would be ordered for replacement of old and obsolete units was also estimated. The term "replacement" in the present study relates to the final scrapping of a machine because it is unfit to perform any operation, and therefore excludes the successive transfers of a machine in the course of its useful lifetime, in consequence of loss of precision, yield, etc., either within one and the same enterprise or sector, or from one sector to another. In other words, the replacement figures calculated represent net requirements.

Since the age of a machine-tool is not a decisive criterion whereby to judge the need for replacement, and other questions come into play - what type of operation the machine is performing, for instance, or whether chip-producing or forming machines are involved - a conservative estimate was formulated to the effect that one-third of the machines which were more than 20 years old in 1960 would be replaced by 1971. As was pointed out in chapter II, 24 per cent of the machines were probably over 20 years old in 1960; consequently, replacement between 1960 and 1971 would represent 8 per cent of the 1960 inventory.

/Table 17

Table 17

BRAZIL: AGGREGATE MACHINE-TOOL REQUIREMENTS, 1961-71

(Number of machines)

Type of machine	Inventory 1960		Inventory 1971		Demand			
	Metal transforming industries	Maintenance	Metal transforming industries	Maintenance	Metal transforming industries	Maintenance	Replacement	Total
Chip-producing machines	112 884	36 030	205 746	64 680	92 862	28 650	14 420	135 932
Forming machines	36 530	5 100	63 045	9 150	26 515	4 050	2 035	32 600
Total number of machines inventoried	141 414	41 130	268 791	73 830	119 377	32 700	16 455	168 532
Machines not inventoried	15 110	-	26 525	-	11 415	-	-	11 415
Grand total	164 524	41 130	295 316	73 830	130 792	32 700	16 455	179 947

/Table 18

Table 18

BRAZIL: BREAKDOWN OF MACHINE-TOOL REQUIREMENTS, BY TYPES OF MACHINE
1961-71

Type of machine	Metal transforming industries	Maintenance	Replacement	Total
Lathes	33 236	12 755	6 425	52 416
Milling machines	8 700	2 095	1 050	11 845
Drilling machines	22 186	6 215	3 135	31 536
Boring machines	1 454	70	30	1 554
Shapers and planers	6 769	3 170	1 595	11 534
Threading machines	2 498	490	245	3 233
Broachin machines	334	34	15	383
Gear-cutting machines	1 378	130	65	1 573
Metal-cutting machines (saws)	7 590	3 267	1 650	12 507
Grinding machines	6 120	329	160	6 609
Tool-grinding machines	2 597	95	50	2 742
Total for chip-producing machines	92 862	28 650	14 420	135 932
Presses	20 195	2 355	1 185	23 735
Forging machines	689	95	50	834
Machines for forming, bending and cutting sheet	5 631	1 600	800	8 031
Total for forming machines	26 515	4 050	2 035	32 600
Machines inventoried	119 377	32 700	16 455	168 532
Machines not inventoried	11 415	-	-	11 415
Grand total	130 792	32 700	16 455	179 947

/On the

On the basis of these hypotheses, total demand for machines between 1961 and 1971 was estimated at about 180 000 units, of which approximately 80 per cent would be chip-producing machines and the remaining 20 per cent machines used for forming operations.

As will be recalled, when the various possible procedures for estimating machine-tool requirements were discussed in the previous section, it was mentioned that two of them would be used to appraise the order of magnitude of the figures arrived at by the method chosen. The first of these procedures relates to the ratio between the value of the sales of the metal transforming industries and the value of the machine-tools purchased by them. The data available in this connexion were registered early in the fifties,[2/] and are as follows: Federal Republic of Germany, 2.3 per cent; France, 2 per cent; United Kingdom, 1.7 per cent; and United States, 2.5 per cent. According to the projection of the value of production in these four sectors, between 1961 and 1971 its cumulative value would amount to 36 000 million dollars,[3/] while the machine-tools to be purchased (excluding those for maintenance purposes) would total 470 million dollars,[4/] hence the machines purchased by the industry would represent in Brazil's case 1.3 per cent of the value of the products it manufactured, a ratio which might be considered low by comparison with that registered in the countries mentioned. It must be borne in mind, however, that in the period for which these ratios were established the countries in question were engaged in reconstituting and expanding their machine-tool inventories after the effects of the war.

By means of the second procedure - relating steel consumption to the number of machines in existence - fairly reasonable comparisons are also arrived at (see table 19), in the light of which both in 1960 and in 1971 the figures for Brazil are seen to be within the range of values shown by countries at different levels of industrial development.

2/ Commission de modernisation et d'équipement des industries de transformation, Rapport du Groupe de Travail Machines-Outils, France 1955.

3/ On the assumption that the average exchange rate in 1960 was 205 cruzeiros to the dollar.

4/ This represented 147 247 machines with a unit weight of 1.6 tons and an average value of 2 dollars per kilogramme.

/Table 19

Table 19

PERCENTAGE RELATIONSHIP BETWEEN CONSUMPTION OF STEEL AND INVENTORY OF MACHINE-TOOLS IN SELECTED COUNTRIES

Country	Year	Steel consumption equivalent in terms of ingots (Thousands of tons)	Inventory of machine-tools[a] (Units)	Steel consumption per machine (Tons)
United States	1957	97 178	2 200 000	44.2
Soviet Union	1957	49 337	2 350 000	21.0
Federal Republic of Germany	1959	25 387	1 300 000	19.5
United Kingdom	1959	17 478	1 100 000	15.9
Japan	1957	12 627	750 000	16.8
France	1959	11 971	500 000	23.9
Italy	1959	7 088	363 000	19.5
Brazil	1960	2 850	164 524	17.3
	1971	6 100	295 316	20.7
Chile	1960	266	12 044	22.1

a/ Excluding machines used for maintenance purposes.

Hence the estimate of demand for machine-tools in 1961-71 would seem to lie within a reasonable order of magnitude.

Additions to the inventory in 1961 (imports and domestically-manufactured machinery) will have to be subtracted from the estimated number of machines in order to determine requirements for 1962-71, the period under consideration in the present study. In 1961, 15 517 machines with a weight of 13 249.9 tons were manufactured in Brazil and 14 009.8 tons were imported, which would imply, if the average weight of the imported machines is assumed to be 2.5 tons, a total of 21 121 machine-tools. As insufficient details on the proportion represented by imports were available, the subtraction in question can only be made globally for the total, estimated at 179 947 units, and the resulting figure for demand in 1962-71 is 158 826 machine-tools.

/Chapter IV

Chapter IV

IMPORTS OF MACHINE-TOOLS

Table 20 shows imports of machine-tools since 1951 in as great detail as the existing statistics permit. Those effected in the years 1959 and 1960 and eight months of 1961 are grouped in accordance with the tariff classification adopted under the new Tariff Act in force since 1958, and the relevant figures were obtained directly from the Statistical Service of the Ministry of Finance, specially for the present study. The information to hand is not sufficiently complete for trends in imports of specific machines and changes in the composition of the volume of imports to be established; in addition, the period for which the fullest details are available is completely untypical, inasmuch as it witnessed the installation of the motor vehicle industry. However, there are some interesting general features to be noted.

Brazil's imports of machine-tools in 1951-56 averaged 7 379 tons and 15.4 million dollars annually; to estimate the figures for 1951-54 the same average value per kilogramme was adopted as that registered for 1955-56 - i.e., 2.09 dollars.

During the succeeding five years, as a result of the establishment of the motor vehicle industry, the volume of such purchases abroad substantially expanded, increasing from 10 872 tons in 1957 to 27 384 in 1959, when imports in the motor vehicle sector reached their peak. From that date onwards, imports declined, falling to 14 010 tons and 37.6 million dollars by 1961. They consisted of equipment for certain enterprises manufacturing vehicles and spare parts, and for tractor manufacturers, who were just launching their production programmes. By 1962 import levels are likely to be considerably lower than the average for 1951-56 (see table 21).

The figures for 1957-61 - the period in which the concentration of imports was greatest - represent annual averages of 17 256 tons, valued at 39.6 million dollars, amounts which substantially exceed those registered in previous years.

/Table 20

Table 20

BRAZIL: IMPORTS OF MACHINE-TOOLS, 1951-61

(Volume in tons; c.i.f. value in thousands of cruzeiros for 1951-54 and in thousands of dollars for 1955-61

Type of machine	1951		1952		1953		1954		1955		1956	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
1. Lathes	2 214	84 694	2 406	103 777	842	41 591	1 547	110 419	1 665.8	3 619.1	1 575.0	3 027.0
(a) Engine lathes (up to 4 000 kg)												
(b) Engine lathes (over 4 000 kg)												
(c) Automatic lathes												
(d) Copying lathes												
(e) Types of lathe other than those specified above, weighing up to 3 000 kg												
(f) Types of lathe other than those specified above, weighing over 3 000 kg												
(g) Unspecified												
2. Shapers and planers	...	...	...	...	208	6 531	347	17 013	196.7	287.0	245.3	282.4
(a) Shapers (up to 500 kg)												
(b) Shapers (over 500 kg)												
(c) Reciprocating-table planers												
(d) Planers with working table for metal working (up to 2 000 kg)												
(e) Planers with working table for metal working (over 2 000 kg)												
(f) Types of shapers and planers other than those specified above (up to 2 000 kg)												
(g) Types of shapers and planers other than those specified above (over 2 000 kg)												
(h) Unspecified												
3. Milling machines	...	...	...	...	368	22 683	707	62 451	585.2	1 640.0	755.9	1 782.3
(a) Automatic milling machines												
(b) Other types												
(c) Unspecified												
4. Drilling machines	...	...	...	...	...	...	...	...	495.2	897.0	755.8	1 199.2
(a) Radial (up to 2 000 kg)												
(b) Radial (over 2 000 kg)												
(c) Boring and bench drilling machines (up to 1 000 kg)												
(d) Boring and bench drilling machines (over 1 000 kg)												
(e) Types of boring and drilling machines other than those specified above (up to 1 000 kg)												
(f) Types of boring and drilling machines other than those specified above (over 1 000 kg)												
(g) Unspecified												
5. Cutting machines (saws)	...	...	...	...	1	160	137	8 758	87.8	149.8	50.5	87.4
(a) Circular saws												
(b) Band saws												
(c) Multiple saws												
(d) Unspecified												
6. Threading machines	...	...	...	...	40	2 036	64	7 309	63.2	213.7	24.2	71.7
(a) Automatic threading machines												
(b) Other types												
7. Grinding machines	...	...	...	...	...	...	...	...	632.8	1 518.7	741.6	1 820.4
8. Shearing machines	...	...	...	...	239	10 259	344	15 403	183.4	303.6	86.5	144.2
(a) Shearing for cutting material with a minimum thickness of 10 mm. and a minimum length of 2 metres												
9. Other machine-tools for metal working	7 063	270 076	9 039	359 571	2 811	97 889	3 024	2 095	2 034.9	4 088.2	1 917.7	4 175.4
(a) Threading machines												
(b) Combination planers												
(c) Bench or floorstand snag grinder (up to 500 kg)												
(d) Bench or floorstand snag grinder (over 500 kg)												
(e) Machines for curbing, bending, straightening, rolling or similar operations (up to 9 000 kg)												
(f) Machines for curving, bending, straightening, rolling or similar operations (over 9 000 kg)												
(g) Forging machines												
(h) Stamping machines (up to 5 000 kg)												
(i) Stamping machines (over 5 000 kg)												
(j) Wire forming machines												
(k) Other machines												
(l) Unspecified												
Total	9 277	354 770	11 445	463 348	4 829	192 635	6 653	457 148	5 944.6	12 717.1	6 152.5	12 590.0

Table 20 (concluded)

Type of machine	1957		1958		1959		1960		1961			
									January-August		Annual total	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
Lathes	2 120.1	4 605.7	1 794.0	4 685.4	4 068.2	12 886.7	2 424.4	7 755.2	1 486.4	4 269.8	2 911.5	8 641.6
(a) Engine lathes (up to 4 000 kg)					199.5	536.6	216.2	545.8	131.3	320.4		
(b) Engine lathes (over 4 000 kg)					166.3	436.6	69.1	143.9	51.4	88.1		
(c) Automatic lathes					1 243.2	4 278.2	555.6	1 841.4	274.3	1 122.2		
(d) Copying lathes					142.0	448.6	153.9	524.7	95.2	441.4		
(e) Types of lathe other than those specified above, weighing up to 3 000 kg					639.2	2 484.5	439.3	1 727.3	193.3	644.3		
(f) Types of lathe other than those specified above, weighing over 3 000 kg					1 072.6	3 040.2	873.4	2 452.2	740.9	1 653.4		
(g) Unspecified					605.5	1 662.0	116.9	519.9	-	-		
Shapers and planers	240.2	395.7	395.1	568.9	528.9	961.7	451.4	847.5	460.6	927.8	756.1	1 457.8
(a) Shapers (up to 500 kg)					8.1	11.3	10.6	14.1	8.9	26.0		
(b) Shapers (over 500 kg)					64.7	156.2	62.5	111.2	49.3	83.8		
(c) Reciprocating-table planers					6.9	24.6	29.2	64.5	71.7	102.3		
(d) Planers with working table for metal working (up to 2 000 kg)					-	-	6.7	10.4	1.8	4.0		
(e) Planers with working table for metal working (over 2 000 kg)					194.1	256.8	83.9	111.2	102.7	190.5		
(f) Types of shapers and planers other than those specified above (up to 2 000 kg)					4.7	7.4	13.7	42.4	0.8	2.1		
(g) Types of shapers and planers other than those specified above (over 2 000 kg)					243.1	492.7	243.6	492.4	225.4	519.1		
(h) Unspecified					7.3	12.7	1.2	1.3	-	-		
Milling machines	1 117.1	2 815.2	1 433.6	4 185.7	2 867.3	8 583.9	1 503.4	4 683.0	1 419.5	4 452.2	2 288.6	7 308.1
(a) Automatic milling machines					754.2	2 614.7	369.9	1 269.2	255.0	672.7		
(b) Other types					1 895.9	5 242.6	1 088.8	3 214.5	1 164.5	3 779.5		
(c) Unspecified					214.6	727.2	46.7	179.3	-	-		
Drilling machines	1 080.9	2 500.8	1 927.8	5 834.1	3 257.6	8 115.6	2 065.3	4 865.3	1 561.7	3 724.3	2 696.8	6 973.6
(a) Radial (up to 2 000 kg)					62.8	152.0	74.7	171.1	63.5	157.8		
(b) Radial (over 2 000 kg)					333.3	558.8	468.9	650.5	308.6	575.5		
(c) Boring and bench drilling machines (up to 1 000 kg)					21.2	69.1	12.0	40.1	50.4	151.8		
(d) Boring and bench drilling machines (over 1 000 kg)					102.2	180.5	64.6	164.0	84.6	210.2		
(e) Types of boring and drilling machines other than those specified above (up to 1 000 kg)					176.1	564.6	94.0	254.0	116.8	309.6		
(f) Types of boring and drilling machines other than those specified above (over 1 000 kg)					2 341.2	5 865.8	1 248.3	3 421.8	917.7	2 277.0		
(g) Unspecified					216.8	744.8	192.8	254.0	20.3	42.4		
Cutting machines saws	123.7	258.4	88.7	286.7	148.6	390.3	73.4	214.4	91.8	206.3	174.9	470.9
(a) Circular saws					83.4	180.6	52.7	126.3	68.6	127.5		
(b) Band saws					25.3	75.6	12.4	50.6	11.5	38.5		
(c) Multiple saws					38.0	72.9	8.6	33.3	11.7	40.3		
(d) Unspecified					19.9	61.2	1.7	4.2	-	-		
Threading machines	53.5	181.9	132.6	373.5	251.1	873.8	181.5	673.7	131.1	325.3	182.0	497.6
(a) Automatic threading machines					60.8	193.9	130.9	392.9	54.4	115.8		
(b) Other types					190.3	679.9	50.7	280.8	76.7	209.5		
Grinding machines	1 013.9	2 661.6	1 277.2	2 921.4	2 380.6	7 050.6	1 431.4	4 664.6	1 142.1	3 169.3	2 042.0	6 069.0
Shearing machines	448.9	726.1	309.6	545.8	480.3	795.3	518.9	915.7	249.7	405.6	391.5	655.7
(a) Shears for cutting material with a minimum thickness of 10 mm. and a minimum length of 2 metres					480.3	795.3	518.9	915.7	249.7	405.6		
Other machine-tools for metal-working	4 673.5	9 053.0	8 129.2	15 499.1	13 391.7	22 423.0	9 874.7	15 380.3	1 555.0	3 896.9	2 566.4	6 395.9
(a) Threading machines					189.3	517.7	82.6	221.0	5.1	45.9		
(b) Combination planers					145.9	361.1	95.8	33.6	6.8	17.5		
(c) Bench or floorstand snag grinders (up to 500 kg)					870.3	1 507.7	483.7	949.9	315.8	984.4		
(d) Bench or floorstand snag grinders (over 500 kg)					1 089.8	2 076.2	1 114.6	2 184.6	94.1	298.1		
(e) Machines for curving, bending, straightening, rolling or similar operations (up to 9 000 kg)					404.0	1 018.2	313.5	907.9	52.6	124.8		
(f) Machines for curving, bending, straightening, rolling or similar operations (over 9 000 kg)					797.4	1 287.7	758.3	1 295.2	513.2	1 055.1		
(g) Forging machines					1 264.7	1 891.4	232.5	390.3	151.2	450.4		
(h) Stamping machines (up to 5 000 kg)					145.8	421.9	70.3	235.2	1.4	10.5		
(i) Stamping machines (over 5 000 kg)					1 220.3	2 288.0	1 240.8	1 628.4	6.8	14.5		
(j) Wire forming machines					182.0	452.2	178.1	228.3	32.7	171.7		
(k) Other machines					3 247.1	6 043.2	4 151.4	5 018.4	66.9	187.4		
(l) Unspecified					2 675.1	4 557.4	1 213.1	2 293.5	309.4	593.6		
Total	10 871.8	23 198.4	15 487.8	34 990.6	27 384.1	62 080.9	18 526.4	40 099.9			14 009.8	37 570.2

Table 21

BRAZIL: IMPORTS OF MACHINE-TOOLS

(C.i.f. values)

Period	Weight (Tons)		Value (Thousands of dollars)	Dollars per kilogramme
	Total for period	Annual average		
1951-54	32 174	8 043	a/	
1955-56	12 097	6 048	25 307	2.09
1957-60	72 270	18 067	160 370	2.22
1961	14 010	14 010	37 570	2.68

a/ Value in dollars unknown.

The price-per-kilogramme indices are relatively low if the fact that these statistics also include machine accessories is taken into account. The average of 2.9 dollars per kg noted for 1955-56 - a period in which imports are considered to have been normal, and therefore to have consisted of new machinery - is lower than the corresponding figure for 1957-60, when equipment for the motor vehicle industry was brought into the country, despite the fact that the latter included substantial proportions of reconditioned machines. In 1961, the index under discussion rose to 2.68, because of the reduced incidence of reconditioned machines on the total, most of the shipments having consisted of orders outstanding in respect of long-term purchases of new machinery.

In 1951-56 imports of machine-tools tended to remain stationary, which implied a fair division of the market between domestic production and imports. Had it not been for the entry into operation of Brazil's motor vehicle industry, which altered the existing pattern of the metal transforming industry, the share of imports in the internal market would undoubtedly have been smaller, since there had been a noteworthy expansion of domestic production of the types of machine-tools for which there was most demand on the market, such as lathes, drilling machines, presses, shapers and planers, cutting machines (saws) and machines for sheet.

/In 1956-60,

In 1956-60, imports classified as "miscellaneous", "others" and "unspecified" were predominant, and in 1958 and 1960 actually accounted for over 50 per cent of the weight imported, no doubt partly because equipment for the manufacture of vehicles, in view of its special characteristics, was difficult to fit in to the classification of conventional types of machines.

The inclusion of these three groups in the percentage breakdown of imports made it difficult to analyse the behaviour of imports of those types of machinery which are also manufactured in Brazil. Their exclusion simplified the study of the trends followed by the conventional types (see table 22).

Lathes

Average imports of lathes had been gradually declining since 1957, but in that year an upward movement began. The lack of detailed statistics for the years prior to 1959 precludes analysis of the participation of the various types of lathes within such imports. The data available for 1959 bear witness to a preponderance of automatic types, followed by the machines classified under the head of "others (over 3 000 kg)", which include most of the vertical and turret lathes. In 1961, however, when the machines imported for the motor vehicle and spare parts industry - a consumer of automatic lathes - exerted less influence, the incidence of machines weighing more than 3 000 kg increased, and the volume of imports in the year in question exceeded previous figures, doubtless because of the expansion of the various branches of the heavy industry sector (see table 23).

The other types of lathes which were affected by the expansion of the above-mentioned industrial sector accounted for moderate proportions of imports in 1961, falling below their 1959 levels.

It may be noted that imports of engine lathes weighing less than 4 000 kg did not vary during the years 1959-60, because the impact of the sudden increase in demand was absorbed by domestic factories which had had idle capacity. The share of this type of machine in imports is also moderate, rising slightly each year; and the same is true of copying lathes.

/Table 22

Table 22

BRAZIL: BREAK DOWN OF IMPORTS, 1955-61

(Percentages in terms of weight)

Type of machine	1955		1956		1957		1958		1959		1960		1961	
	a/	b/	a/	b/	a/	b/	a/	b/	a/	b/	a/	b/	a/	b/
Lathes	28.0	42.7	25.6	37.2	19.5	34.2	11.6	24.4	14.9	29.1	13.1	28.1	20.8	25.8
Shapers and planers	3.3	5.0	4.0	5.8	2.2	3.9	2.6	5.5	1.9	3.7	2.4	5.2	5.4	6.6
Milling machines	9.8	14.9	12.3	17.9	10.3	18.1	9.3	19.6	10.5	20.5	8.1	17.4	16.3	20.0
Drilling machines c/	8.3	12.6	12.3	17.9	10.0	17.5	12.4	26.0	11.9	23.2	11.1	23.8	19.2	23.5
Cutting machines (saws)	1.5	2.3	0.8	1.2	1.1	1.9	0.6	1.3	0.6	1.2	0.4	0.9	1.2	1.5
Threading machines	1.1	1.7	0.4	0.6	0.5	0.9	0.8	1.7	0.9	1.8	1.0	2.1	1.3	1.6
Grinding machines	10.6	16.1	12.1	17.6	9.3	16.3	8.2	17.3	8.7	17.0	7.7	16.5	14.6	17.9
Shears	3.1	4.7	1.4	2.0	4.1	7.2	2.0	4.2	1.8	3.5	2.8	6.0	2.8	3.4
Presses									7.5	-	7.1	-	0.1	-
Forging machines									4.6	-	1.3	-	1.8	-
Others	34.3d/	-	31.1d/	-	43.0d/	-	52.5d/	-	36.7	-	45.0	-	16.5	-
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a/ Percentage of total.

b/ Excluding presses, forging machines and "others".

c/ Including boring machines.

d/ Including presses and forging machines.

/Table 23

Table 23

BRAZIL: IMPORTS OF LATHES

Type of lathe	1959		1960		1961 a/	
	Tons	Percentage	Tons	Percentage	Tons	Percentage
Engine lathes (up to 4 000 kg)	199.5	4.9	216.2	8.9	260.0	8.8
Engine lathes (over 4 000 kg)	166.3	4.1	69.1	2.9	101.0	3.5
Automatic	1 243.2	30.6	555.6	22.9	535.7	18.4
Copying	142.0	3.5	153.9	6.4	186.3	6.4
Others (up to 3 000 kg)	639.1	15.7	439.3	18.1	378.6	13.1
Others (over 3 000 kg)	1 072.6	26.4	873.4	36.0	1 449.9	49.8
Unspecified	605.5	14.8	116.9	4.8	-	-
Total	4 068.2	100.0	2 424.4	100.0	2 911.5	100.0

a/ The estimate of the annual total was based on the percentage breakdown registered from January to August.

Domestic manufacture of the various types of lathes satisfied rather more than 64 per cent of consumption in 1961; this was a slightly higher percentage than in 1955, when the corresponding figure was 61.7 per cent.

Shapers and planers

Brazil's imports of shapers and planers are steadily increasing year by year, despite the development of domestic production of these machines. Without the influence of the motor vehicle sector, which was also responsible for the peak demand in 1959, when 528.9 tons were brought into the country, imports decreased in 1950, only to increase again in 1961, in consequence of purchases of equipment for the basic and machine industries (see table 24).

Although shapers are manufactured on a large scale in Brazil, they still appear among the country's imports, with slight annual increments. During the 1958-60 period of additional demand there was no need to resort to imports, in view of the country's own installed capacity.

The production capacity of domestic industry in respect of the various types of lathes is such that it can satisfy about two-thirds of current requirements.

/Table 24

Table 24

BRAZIL: IMPORTS OF SHAPERS AND PLANERS

Types of shapers and planers	1959		1960		1961 a/	
	Tons	Percentage	Tons	Percentage	Tons	Percentage
Shapers	72.8	13.8	73.1	16.2	95.5	12.6
Table planers	201.0	38.0	119.8	26.5	289.3	38.3
Others (over 2 000 kg)	243.1	45.9	243.8	54.0	370.0	48.9
Unspecified	12.0	2.3	14.9	3.3	1.3	0.2
Total	528.9	100.0	451.4	100.0	756.1	100.0

a/ The estimate of the annual total was based on the percentage breakdown registered from January to August.

Milling machines

The average annual rate of increase of imports of milling machines, which was 35.2 per cent in 1953-56, rose from 1957 onwards, reaching 40.6 per cent (see table 25).

The level of imports registered in 1961 - 2 289 tons - must be regarded as abnormal, since in 1960, when influence was still being exerted by equipment for the motor vehicle group (vehicles, tractors and spare parts), imports had fallen to 1 503 tons, which is still a large quantity in comparison with the average of 604 tons per annum registered in 1953-56.

Since milling machines are unquestionably among those for which demand is tending to increase repidly in consequence of current technological developments in the metal transforming industry in Brazil, the rate of growth of imports will probably continue to be high if the evolution of domestic production of such machines does not keep pace with demand.

The contribution of domestic production of milling machines to the supply of internal consumer requirements has notably increased in recent years, rising from 6.7 per cent in 1955 to 11.2 per cent in 1961 (in terms of weight); nevertheless, as will be seen later, this is a sector which in the future will have to diversify and supplement its current lines of manufacture, in order to secure a larger share in the satisfaction of domestic consumption.

/Table 25

Table 25

BRAZIL: IMPORTS OF MILLING MACHINES

Type of milling machine	1959		1960		1961[a]	
	Tons	Percentage	Tons	Percentage	Tons	Percentage
Automatic	754.2	26.3	369.9	24.6	411.1	18.0
Others	1 898.3	66.2	1 083.8	72.1	1 877.5	82.0
Unspecifield	214.6	7.5	49.7	3.3	-	-
Total	2 867.1	100.0	1 503.4	100.0	2 288.6	100.0

a/ The estimate of the annual total was based on the percentage breakdown registered from January to August.

Drilling and boring machines

The available import statistics classify drilling and boring machines together. Such imports have mainly consisted of machines weighing over 1 000 kg; under this head, of course, are included boring machines, which must represent a major proportion of the import tonnages shown, together with the special multi-tool drilling machines used by the motor vehicle industries (see table 26).

The percentage share of machines weighing over 1 000 kg is much higher than that of other groups. The 1 731 tons registered in 1961, which exceeded the weight of imports in the previous year when the effects of the period 1957-60 were already on the wane, should be considered normal, mainly on account of the re-equipment needs of the basic industries. The same is true of machines weighing less than 1 000 kg.

In the past three years imports of radial drills have shown a relatively homogeneous rate of increase, which showed down in the last year of the period.

The proportion of consumption of machines in this group satisfied by domestic industry - approximately 25 per cent - was particularly low, because heavy drilling and boring machines were not manufactured.

/Table 26

Table 26

BRAZIL: IMPORTS OF DRILLING AND BORING MACHINES

Type of machine	1959		1960		1961 a/	
	Tons	Percentage	Tons	Percentage	Tons	Percentage
Over 1 000 kg	2 443	75.0	1 313	63.6	1 731	64.2
Under 1 000 kg	197	6.0	106	5.1	289	10.7
Radial	396	12.2	543	26.3	642	23.8
Unspecified	221	6.8	103	5.0	35	1.3
Total	3 257	100.0	2 065	100.0	2 697	100.0

a/ The estimate of the annual total was based on the percentage breakdown registered from January to August.

Cutting machines (saws)

The statistics available for cutting machines, except as regards 1959-61, present import figures for metal and wood-cutting saws in the aggregate. Given the stage of development of the manufacture of machines for the wood products industry, it would seem justifiable to assume that the tonnages shown for circular saws and band saws alike relate to metal-cutting machines (see table 27).

In 1958-61 - for which period data broken down by types of saws are available - the annual increase in such imports average 9.3 per cent, and the largest volume corresponded to metal-cutting circular saws, whose share in 1959 was about 65 per cent, rising to 85.6 per cent in 1961.

An upward trend is observable in the market for circular saws, in view of the use of higher-powered chip-producing machines and the consequent need for greater raw materials cutting speeds, such as are incompatible with the use of the conventional type of reciprocating saw. The relatively limited use of forgings in Brazil is another factor influencing the increased consumption of cutting-machines.

The capacity of the domestic industry at present sufficies to supply about 66 per cent of consumption of the various types of machines belonging to this group.

/Table 27

Table 27

BRAZIL: IMPORTS OF CUTTING MACHINES (SAWS)

Type of saws	1959		1960		1961[a]	
	Tons	Percentage	Tons	Percentage	Tons	Percentage
Circular saws	83.4	64.9	52.7	78.9	130.7	85.6
Band saws	25.3	19.7	12.4	18.6	21.9	14.4
Others	19.9	15.4	1.7	2.5	-	-
Total	128.6	100.0	66.8	100.0	152.6	100.0

a/ The estimate of the annual total was based on the percentage breakdown registered from January to August.

Grinding machines

Like milling machines and boring machines, grinding machines are among the types whose percentage share in imports has increased most in the last few years. They have become more widely used of late, and the virtual non-existence of domestic production - which began in 1955 and supplies only a modest proportion of the market - has necessitated recourse to imports for the satisfaction of requirements.

Between 1955 and 1961 domestic consumption of the machines in question increased by 230 per cent, from 636 tons to 2 099 tons. By the end of that period the initial efforts of domestic manufacturers, although laudable had not yet succeeded in satisfying as much as 3 per cent of consumption.

Other machines

Imports in this group, comprising mainly machines for forming operations and those unspecified, increased from 2 218 tons in 1955 to 2 958 tons in 1961, i.e., by about 33 per cent. In the intervening years, considerably larger volumes were registered, especially in 1959, when the total was 13 872 tons. In relation to an apparent consumption which doubled during the period in question, domestic industry increased its share from 44 to 63 per cent.

/As was

As was mentioned at the beginning of the present chapter, imports of machine-tools have fluctuated sharply in the last seven years, mainly owing to the establishment of the motor vehicle industry and the expansion of the various branches of the heavy metal transforming sector. After reaching their peak in 1959, they gradually declined until in 1961 they reached a level 135 per cent above that registered in 1955. It is impossible to forecast their evolution in the next few years, since, although the periods stipulated for the importation of machinery in connexion with the motor vehicle industry have expired, other programmes have recently been approved for initial undertakings in the fields of shipbuilding, the manufacture of heavy Diesel engines, tractors and ball bearings, etc. But these new lines of manufacture will not have so powerful an impact on imports as the establishment of the motor vehicle industry. It must also be borne in mind that part of the machinery for these programmes had already been imported in 1961.

Between the years referred to, the share of domestic industry in internal consumption was maintained at about 48 per cent, that is, if the beginning and end of the period under analysis are considered, for in the year of maximum imports it dropped to 25 per cent.

Chapter V

DOMESTIC PRODUCTION OF MACHINE-TOOLS

The manufacture of machine-tools in general began in Brazil during the Second World War. At that time the difficulties attendant on importing constituted a powerful incentive to the recrudescence of various undertakings in this sector and the emergence of new enterprises, whereby the most urgent requirements could be met, particularly in respect of machines for maintenance purposes.

The War once over, however, with the lifting of import restrictions, and in the face of certain instability of demand for domestically-produced machine-tools, some industries which a state of emergency and a series of noteworthy efforts had called into being no longer found sufficient inducement to continue in the same branch of manufacture, and changed over to another activity. On the other hand, the metal transforming industries were progressively consolidated and strengthened until by 1950 an embryo market had been created which held out prospects of significant future development. It was thus that machine-tools, which until then had been associated mainly with the idea of maintenance operations, began to assume importance as elements in the manufacturing process. Interest in local production of machine-tools was thus reawakened, so that by 1935 domestic output had exceeded 5 000 tons.

The subsequent establishment of the Executive Group of the Motor Vehicle Industry (GEIA), with the ensuing application of its plans and their dynamic effects on other sectors, should be regarded as the true prelude to the consolidation of a large, up-to-date and diversified machine-tools market, such as that found in Brazil today. Suffice is to mention in this respect that in the seven years preceding 1961 the domestic market absorbed from 90 000 to 100 000 machines. As a natural consequence, this new incentive gave rise to new undertakings, in addition to those which since the Second World War had successfully withstood critical periods and continued to supply the domestic market. At the present time, the machine-tools industry comprises about 114 establishments, employs nearly 5 000 persons and produces an annual output which has exceeded 13 000 tons, with an approximate value of 26 million dollars.

/1. Survey

1. Survey of production

Owing to the lack of adequate statistical data on the manufacture of machine-tools, a survey had to be carried out among the manufacturers operating in Brazil, the number of enterprises totalling, as far as could be ascertained, 114 establishments. This survey was carried out by means of personal visits to the factories, and specially prepared questionnaires were used whereby certain general data could be obtained on the industrial establishments themselves and on the machines in use, as well as on the quantities of each type manufactured since 1955 (in terms of units and of weight), the main characteristics of the machines currently manufactured, and the entrepreneurs' plans for the future.

Out of the total of 114 establishments visited, 104 were classified, including 5 which in 1961 were engaged in perfecting prototypes of machine-tools to be put on the market in 1962. The establishments analysed are those in which production of machine-tools is either the sole activity or supplementary to other lines of manufacture, and exclude a few of an artisan nature which only occasionally produce a short series of machines, usually of a simple type, for consumers making no very great demands in respect of quality and precision. Among those covered by the survey are 9 whose activity in this branch of industry represents less than 5 per cent of the value of total sales, and which were excluded from some comparisons.

Thus, the considerations formulated below relate to 90 manufacturers with regard to geographical distribution and number of machines in use; to 99 establishments where manufacturing data are concerned; and to 104 enterprises in respect of the types of machines currently produced.

2. The domestic machine-tools industry

(a) General characteristics

(i) Location. The data collected clearly show that the choice of sites for the industrial establishments manufacturing machine-tools was closely associated with the expansion of the metal transforming industries. The State of São Paulo is where 88.8 per cent of these establishments are situated, while the same state absorbs 72 per cent of the domestic labour force employed in the metal transforming sectors (see table 28).

/Table 28

Table 28

BRAZIL: GEOGRAPHICAL DISTRIBUTION OF ESTABLISHMENTS MANUFACTURING MACHINE-TOOLS, 1961

State	Persons employed		Industrial establishments	
	Number	Percentage of total	Number	Percentage of total
São Paulo	4 527	94.7	80	88.8
Rio Grande do Sul	176	3.7	6	6.6
Santa Catarina	40	0.8	2	2.3
Guanabara	37	0.8	2	2.3
Total	4 780	100.0	90	100.0

Within the State of São Paulo, the greatest concentration of machine-tool manufacturers is observable in the state capital itself and in the municipalities of Santo André, São Bernardo do Campo and São Caetano do Sul (ABC), where the proportion found is 83.7 per cent, with 67 establishments. In the interior of the state, the factories are situated mainly along the Jundiaí-São Carlos line, and it is in this area that the highest production capacity per establishment is registered. The enterprises concerned number 13 and empliy 2 437 persons in all, i.e., 51 per cent of the total for the country as a whole. Communications between this area and the leading consumer centres are good, and transport of the heavy tonnages produced presents no difficulties.

The plants in the capital and in the ABC area employ 2 090 persons - 43.7 per cent of the total for Brazil - in 67 establishments, which are thus a good deal smaller than those in the interior. From the point of view of expansion, the location of some of these implies serious drawbacks in the way of want of space both for increasing current production lines and for manufacturing heavier machinery, since adjacent lots are not available, and even if they were, anti-economic investment would be entailed. Decentralization of these establishments in the direction of the outskirts of Greater São Paulo should therefore be contemplated, since such a measure would enable more efficient organization and layout to be achieved. This

/does not

does not apply to the firms located in the interior of the state, which, from the point of view of the space required for future expansion, are in a more privileged position.

In the south of Brazil, the manufacturers of machine-tools in Rio Grande do Sul and Santa Catarina have so far supplied most of the requirements of the local market, which, together with that of São Paulo, ranks as the oldest in the country.

The participation of the south of Brazil - which at present is modest, since the area accounts for only 8.9 per cent of the total number of establishments and 4.5 per cent of the total number of personnel employed - will undoubtedly increase in the course of the next few years through the operation of various favourable factors which are beginning to make their influence felt. These include the quality of the labour employed, whose efficiency and low turnover play an important part; the development of local industries; the ease with which technical and commercial contacts with the State of São Paulo can be maintained; and the improvement of communications between the South and the other consumer centres. To judge from the new projects under way and the prototypes already tried out, a dynamic spirit prevails, especially in the Porto Alegre area, which could be highly beneficial to this sector. As in other countries that have had to tackle the same problems in the past, the decentralization of this branch of the metal transforming industry is generally a factor making for progress and encouragement.

The factories situated in areas other than those mentioned concentrate on specialized lines of production or supply the local market.

To sum up, the principal areas in Brazil in which this sector is significant are three in number: the first, along the Jundiaí-São Carlos line in the State of São Paulo; the second, the state capital and the ABC area; and the third, that part of the Porto Alegre district which falls within a radius of 200 kilometres from the capital.

(ii) Structure. Not all the establishments manufacturing machine-tools devote their entire efforts to this activity, and other products of the metal transforming industries appear in their manufacturing programmes in

/varying proportions.

varying proportions. One reason for this is that most of the enterprises in question first became interested in the production of machine-tools when they had already developed a certain tradition in other metal transforming sectors which they did not wish to abandon; and another is that in some cases the consumers of these machines have themselves begun taking steps to produce them, as is not surprising in view of the rapidity with which the machine-tool sector has increased in recent years. This last category includes five enterprises covered by the survey which in 1961 were engaged in perfecting machine-tool prototypes to be put on the market in 1962.

This situation is clearly reflected in table 29, which presents a breakdown of establishments by their extra and intra-sectoral activities and by types of machine. It reveals how high a proportion of the establishments classified as manufacturing machine-tools maintain other lines of production - from 46.5 to 100 per cent, according to the type of machine concerned. In the table under discussion, references to lines of manufacture within the sector relate to different categories of machines, not to the machine specified; in other words, if four of the establishments manufacturing shapers and planers are said to maintain two lines of production, this must be taken to mean that they produce another type of machine-tool alongside shapers and planers, rather than that they make two models of the latter. It may also be seen from the table that 72 of the 99 firms manufacture a single type of machine-tool, while the remaining 27 maintain two or more lines of production within this sector.

/Table 29

Table 29

BRAZIL: ORGANIZATION OF PRODUCTION OF MACHINE-TOOLS, 1961

Type of machine	Number of establishments	Production		Breakdown of establishments by activities				
		Tons	Units	One line of manufacture within the sector	Two lines of manufacture within the sector	More than two lines of manufacture within the sector	One or more lines of manufacture outside the sector	Works include foundry
Lathes	24	5 265.0	4 638	16	4	4	16	4
Milling machines	14	289.8	278	7	3	4	9	4
Drilling machines	17	794.9	5 311	5	5	7	13	7
Shapers and planers	18	1 369.4	937	11	4	3	10	7
Threading machines	3	35.0	53	1	-	2	3	-
Cutting machines (saws)	12	342.4	1 296	7	3	2	8	4
Grinding machines	4	57.1	79	2	1	1	3	-
Tool-grinding machines	4	69.3	101	1	1	2	3	-
Presses	22	3 890.0	2 139	15	5	2	12	5
Pneumatic hammers	1	24.8	7	1	-	-	1	-
Machines for sheet	15	1 071.2	667	6	6	3	7	3

Of the 99 industrial establishments considered, 62.5 per cent accounted for no less than 75 per cent of this activity's trade transactions; the remaining 37.5 per cent contributed smaller proportions (see table 30).

/Table 30

Table 30

BRAZIL: BREAKDOWN OF INDUSTRIAL ESTABLISHMENTS BY PERCENTAGE OF ACTIVITY DEVOTED TO MACHINE-TOOLS, MEASURED IN TERMS OF ANNUAL SALES TURNOVER, 1961

Industrial establishments		Manufacture of machine-tools
Number	Percentage	(Percentages)
62	62.5	75 - 100
14	14.2	50 - 74
8	8.1	25 - 49
6	6.1	5 - 24
9	9.1	Under 5
99	100.0	

The distribution of these establishments by size constitutes another interesting feature of the activity under consideration. The figures given in table 31 relate to the number of persons employed in the manufacture of machine-tools, and therefore exclude personnel employed in the manufacture of other products within the same enterprise.

/Table 31

Table 31

BRAZIL: BREAKDOWN OF ESTABLISHMENTS MANUFACTURING MACHINE-TOOLS, BY SIZE, a/ 1961

Size of establishments (Number of persons employed)	Number of establishments	Percentage	Number of persons employed	Percentage
More than 1 000	1	1.1	1 290	27.0
500 - 999	-	-	-	-
250 - 499	1	1.1	402	8.4
100 - 249	6	6.7	954	20.0
50 - 99	14	15.6	976	20.4
25 - 49	18	20.0	580	12.1
10 - 24	30	33.3	459	9.6
Fewer than 9	20	22.2	119	2.5
Total	90	100.0	4 780	100.0

a/ Excluding 9 enterprises whose production of machine-tools represents less than 5 per cent of their annual sales turnover. Data as at 31 December 1961.

A comparison between Brazil and other countries in respect of the breakdown of establishments by size (see table 32 and figure V) reveals the trend of this sector's evolution as a consequence of the increase in the tonnage produced, especially where the smaller establishments are concerned.

Experience shows that a high level of productive efficiency in this sector is beginning to be obtained in factories employing 100 persons or more, where the products manufactured have a certain degree of complexity and a high standard of quality. This would seem to be the case in France, the United Kingdom and the United States, where between 20 and 30 per cent of the factories fall within the 100-500 size range (see again table 32). These percentages apparently remain stable, in association with outputs of about 40 000 - 50 000 tons and upwards.

/Figure V

Figure V

PERCENTAGE BREAKDOWN OF ESTABLISHMENTS MANUFACTURING MACHINE-TOOLS IN BRAZIL AND SELECTED COUNTRIES AT A MORE ADVANCED STAGE OF INDUSTRIAL DEVELOPMENT

Natural scale

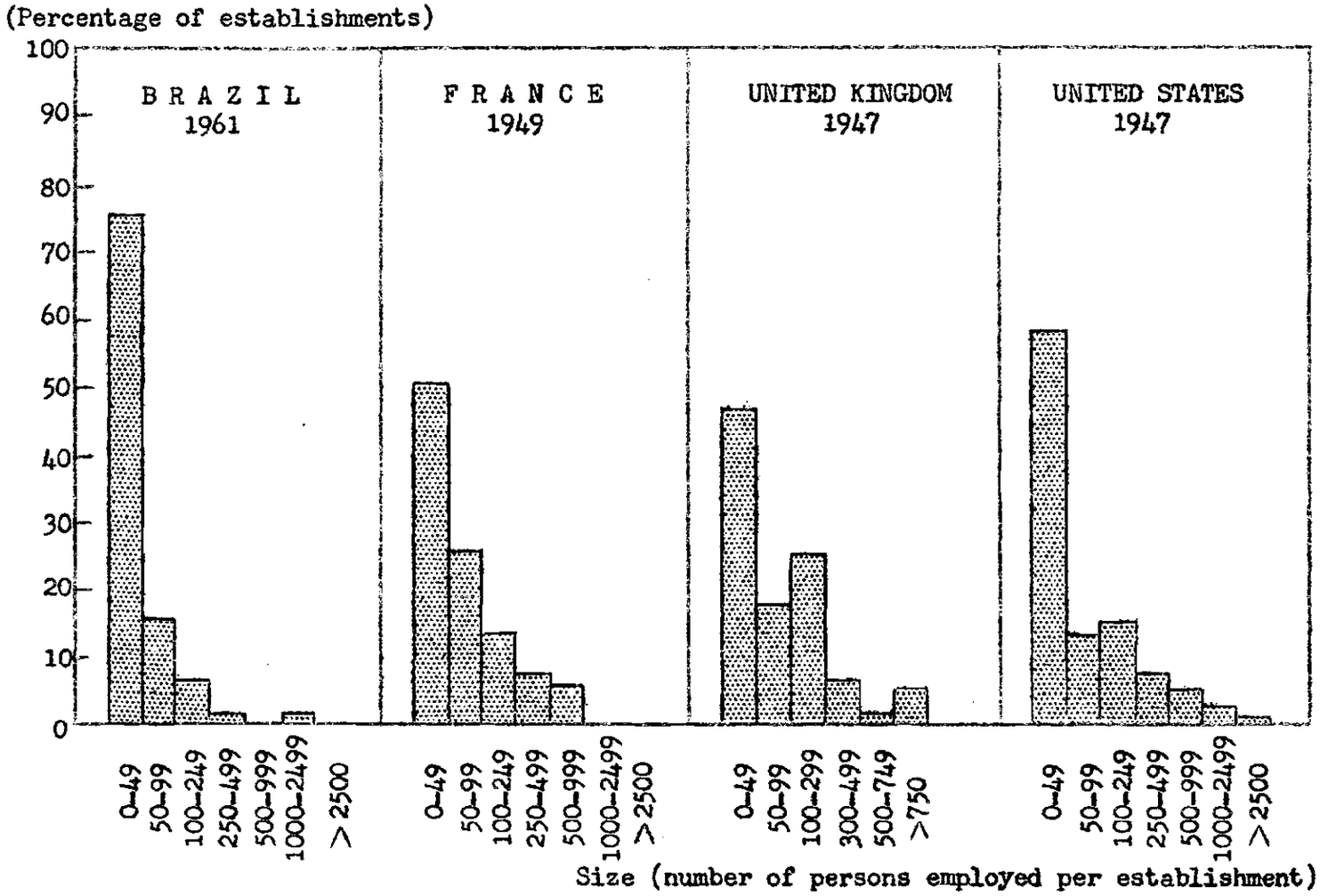


Table 32

BRAZIL AND SELECTED COUNTRIES: PERCENTAGE DISTRIBUTION OF ESTABLISHMENTS MANUFACTURING MACHINE-TOOLS

Size of establishments (Number of persons employed)	Brazil		France		United States		United Kingdom		
	Number of establishments	Percentage	Number of establishments	Percentage	Number of establishments	Percentage	Size	Number of establishments	Percentage
0- 9	68	75.5	60	50.0	431	57.9	0- 49	104	46.4
50- 99	14	15.6	30	25.0	95	12.8	50- 99	38	17.0
100- 249	6	6.7	16	13.4	106	14.2	100-299	55	24.6
250- 499	1	1.1	8	6.6	53	7.1	300-499	13	5.8
500- 999	-	-	6	5.0	34	4.6	500-749	3	1.3
1 000-2 499	1	1.1	-	-	20	2.7	750 or more	11	4.9
2 500 or more	-	-	-	-	5	0.7			
Total	90	100.0	120	100.0	744	100.0		224	100.0

Sources: For Brazil: findings of the 1961 survey; for France, 1949: Mission aux Etats-Unis de l'industrie de la machine-outil, November 1949 - January 1950; for the United States: Census of Manufactures 1947; for the United Kingdom, 1947: A. Garanger, op.cit.

The structure of the machine-tools industry in Brazil, where only 7.8 per cent of the establishments under consideration fall within the size range indicated, will have to develop along new lines if output tonnages are to be higher than at present and the demands of the consumer industries with respect to quality and diversity of types are to be met. According to the projections formulated in the present study, Brazil should produce a yearly output of about 20 000 tons by 1970-71, and should therefore aim at remodelling the size structure of the industry so that it more closely approaches that found in the more highly industrialized countries. At this stage, it might be considered that satisfactory progress had been made if by the time the above-mentioned level of production had been reached about 15 to 20 per cent of the establishments employed more than the minimum of 100 persons, with an average of 200 persons per establishment.

/(iii) General

(iii) General data for the sector. To give an over-all idea of the sector's production potential, some of the most characteristic data relating to the industrial establishments concerned are presented below:

Number of persons employed[1/]	4 780	
Installed capacity	12 571	h.p.
Value of production 1961	26.5	million dollars
Annual per capita production	5 544	dollars
Per capita capacity available	2.63	h.p.
Number of persons employed per establishment	53.1	
Installed capacity per establishment	139.7	h.p.
Value of production per establishment	294 400	dollars

Prices per kilogramme vary a good deal in the case of domestically-manufactured machines, partly because of the different types produced and partly because of the divergent sales methods adopted (through distributors, directly to the consumer, for cash down or on deferred payment terms). Moreover, the continual fluctuations in internal prices and the time-lag before exchange rates are brought up to date cause sharp variations in the cruzeiro/dollar relationship. Thus, in order to estimate the value of domestic production, an average price of 2 dollars per kg was adopted.

In view of the heterogeneous sizes of the industrial establishments in this sector, a few remarks must be made on the average values per establishment quoted above, since there is one group of enterprises whose size, organization, efficiency and technical level put a considerable distance between them and the over-all averages in question. The eight establishments which employ more than 100 persons together account for 55.4 per cent of total employment and 63.6 per cent of installed capacity, which means that the per capita capacity available is about 3 h.p., whereas in the other 82 establishments it is only 2.1 h.p. The capacity available per direct operative is even higher in the former group, because of the lower direct/indirect labour ratio. On the assumption that direct operatives constitute about 55 per cent of the personnel employed, available capacity amounts to about 5.5 h.p. per operative - almost twice as much as in the smaller establishments. This advantage is reflected, inter alia, in a satisfactory level of production capacity, in contrast with the situation in the other group.

1/ Including operatives and technical and administrative personnel.

/(b) Inventory

(b) Inventory of machine-tools in establishments manufacturing same

Table 33 presents an inventory of the equipment used in domestic manufacture of machine-tools by the 90 producers whose share in the sector's activity constitutes more than 5 per cent of their annual sales turnover.

In addition, there are 61 forming machines installled in these establishments in the aggregate, bringing the total up to 2 527. The firms employing more than 100 persons possess 28 units of this type.

As the size distribution of the enterprises in question is so irregular and the proportion of firms employing fewer than 50 persons is high, it is difficult to make an over-all analysis of this inventory in such a way as to give a faithful interpretation of the machine-tool industry's real situation. The equipment to be found in about 9 per cent of the establishments, representing approximately 29 per cent of the total number of machines, is comparable to that of manufacturers in more highly industrialized countries; most of the remaining firms, in contrast, have only unsatisfactory and makeshift production facilities at their disposal (see again table 33). The eight establishments employing more than 100 persons belong to the first group.

In the case of this group production equipment is complete, efficient and up-to-date, as can easily be seen from the high figures relating to the use of boring machines, milling machines of various types, threading machines, broaching machines, grinding machines, gear-cutting machines and special machine-tools. There is no lack of technical knowledge of the kind required for correct utilization of the machines, and it is thus possible to overcome those machining difficulties which characterize the manufacture of machine-tools once the Schlesinger or Salmon standards are aimed at.

In addition to the satisfactory situation as regards equipment, jigs, fixtures, special tools, and metrological and control instruments are used, both in the intermediate stages of machining and during the final process of assembly, in accordance with the standards referred to above. Consequently, the designs of the machines is more complex, and those manufactured by the group under discussion differ from the rest in that they are more complete, offer better working facilities, have higher power, bigger transmission fields, and superior productivity in relation to others of the same type.

/Table 33

Table 33

BRAZIL: INVENTORY OF MACHINE-TOOLS IN THE INDUSTRIES MANUFACTURING SAME, 1961

Type of machine	All establishments		Establishments employing more than 100 persons	
	Number	Percentage	Number	Percentage of total
Lathes	893	36.2	245	27.4
Milling machines	225	9.1	88	39.1
Drilling machines	459	18.6	88	19.2
Boring machines	63	2.6	33	52.4
Shapers and planers	377	15.3	86	22.8
Threading machines	18	0.8	8	44.4
Broaching machines	5	0.2	4	80.0
Gear-cutting machines	55	2.2	38	69.1
Cutting machines (saws)	158	6.4	36	22.8
Grinding machines	136	5.5	64	47.1
Tool-grinding machines	77	3.1	32	41.6
Total	2 466	100.0	722	29.3

It may also be noted that in these enterprises - which employ 2 646 persons in all - the proportion of indirect personnel ranges from 30 to 52 per cent, i.e., it is within the limits that should be considered essential for success in this difficult speciality. The manufacture of machine-tools of more advanced and complex design calls for more project engineering and research, and, consequently, for a greater number of indirect personnel working on the planning of production, quality controls, and the making of tools and jigs.

Lastly, stress must be laid on the marked creative vitality displayed by this group of firms, whose projects keep pace with the requirements of the domestic market and the constant technological advances achieved in the

/sector concerned.

sector concerned. Studies aimed at perfecting machine parts, to which the patents registered and experiments with new models bear witness, are a commonplace today, and have indeed been so since 1950.

In contrast, the position of the smaller enterprises leaves a good deal to be desired as regards their manufacturing equipment, which is lightweight and incomplete, while indirect technical services are neglected. This is sufficient indication of the category and quality of the machine-tools manufactured.

Hitherto, however, market requirements in respect of quality, types and prices of machine-tools have also assumed two very different forms, according to whether the prospective consumers are industries at a more advanced stage of technical development, or establishments - usually on a small or medium scale - whose technological level is lower and whose supply of capital is limited.

To meet the needs of the former, the more advanced group of domestic manufacturers is in a position to deliver high-quality goods conforming to the specifications required, within their current lines of manufacture; the latter, on the other hand, preferring as they do machines of low cost (less than 2 dollars per kg as a rule) and hence also low in weight, power and precision, are supplied, in the main, by the small manufacturers. Thus, some justification for such producers' limited manufacturing resources is to be found in the nature of market demand, at all events up to the present.

But as the Brazilian machine-tool inventory increases, and approached 300 000 units, in order to attain low production costs together with an improvement in the quality of the final product, it will be essential for the technology of production to develop as well, and, consequently, for most of the small establishments manufacturing machine-tools to make progress along the same lines.

The technical and manufacturing potential achieved by the leading group in this sector in Brazil at present - and by the manufacturers of lathes and presses in particular - reaches international standards comparable with those registered in the more highly industrialized countries for manufacturers capable of supplying substantial machine-tool inventories.

/The considerable

The considerable size of the Brazilian inventory, together with its annual natural growth rate of about 5.5 per cent, suggests the need for at least some of the small-scale enterprises to increase their dimensions, with all the structural changes which this implies.

What has been said of the small-scale enterprises and the equipment they use should be regarded rather as a word of warning for the near future than as a criticism reflecting on the past. The comments which follow are valid for most of the small establishments, and afford some justification for such an attitude.

Boring machines, for example, by means of which heavy asymmetrical parts can be machined at different levels, are replaced by devices which do not permit attainment of the close tolerances acceptable for internal diameters and distances between axles. Again, the very limited use of cylindrical grinding machines for internal and external diameters suggests that series couplings are unlikely to achieve ISO 6 and 7 quality, obviously to the detriment of both surface finish and the precision of the couplings themselves.

Similarly, the problem of machining small and large flats is generally tackled with unsuitable machine-tools. Limited use is made of milling machines, for which shapers are usually substituted, with poor results in respect of production time, precision and quality of surface finish. For machining larger parts, the table planers used, besides offering few facilities, are so light that the weight of the part being machined is disproportionate to the design of the planer and the work bench. Significant deformation may thus take place in the course of machining.

Other machine-tools and equipment which, to judge from the survey, are not usually found among the machining plant of the smaller establishments are the following:

Gear-cutting machines of the Fellows and Maag types, and with gear generators

Gear-grinding machines

Milling machines for slot axles

Grinding machines for grooved shapes

Broaching machines for internal grooved shapes

/Special machines

Special machines for long thread cutting

Heavy drilling machines

Grinding machines for long bed rails

Dynamic balancers

Group of units for tempering bed rails and benches

Measuring instruments for testing Schlesinger and Salmon standards.

Generally speaking, the above-mentioned machines and equipment are essential requisites for the production of good-quality machine-tools, especially those in the chip-producing category. The latter, which also include finishing machines, offer a wider range of types and designs than forming machines. Hence their manufacture calls for a more varied inventory of machine-tools. Furthermore, the acceleration of cutting speeds in the case of both rotary and alternating machine-tools is compelling manufacturers to use increasingly difficult and complex manufacturing techniques, applicable only if special and costly equipment is available.

In the manufacture of machine-tools, more perhaps than in other sectors of the metal transforming industry, the relationship between minimum size of establishment and quality and complexity of product takes precedence of the relationship between size of establishment and series produced.

This fact, taken in conjunction with the domestic manufacture projections formulated in the present study, makes it plain how necessary it is that by the end of the period under study the proportion of machine-tool enterprises employing, on an average, some 200 persons each should be about 15 to 20 per cent, either as a result of the expansion and modernization of the industries already established, or by virtue of the installation of new enterprises.

(c) Types of machine-tool manufactured in Brazil

In compiling the list of machine-tools manufactured in Brazil, the output taken into account was that of 104 firms, i.e. including the five which in 1961 were engaged in perfecting prototypes of machines to be put on the market in 1962. The dimensions given represent each machine's maximum working capacity.

/I. Machines

I. Machines for chip-producing operations

1. Bench lathes (diameter, up to 250 mm; distance between centres, 600 mm)
2. Single-pulley lathes (distance between centres, up to 4 000 mm)
3. Engine lathes (diameter, up to 600 mm; distance between centres, 2 000 mm)
4. Medium-weight engine lathes (distance between centres, 2 000 to 4 000 mm)
5. Heavy engine lathes (up to 15 tons; distance between centres, 4 000 to 7 500 mm)
6. Extra heavy engine lathes (up to 61 tons; distance between centres 10 000 mm. There are possibilities of manufacturing these lathes with higher tonnages and longer distances between centres)
7. Bench turret lathes
8. Hand-fed, single-pulley, hexagon turret lathes (spindle bore diameter, up to 2 inches ; weight 1 ton)
9. Hand-fed, single-pulley, frontal turret lathes (spindle bore diameter, up to 2 inches)
10. Light hand-fed hexagon turret lathes (up to 1.5 tons).
11. Medium weight hand-fed hexagon turret lathes (up to 3.2 tons; lathe swing, 500 mm, and length 940 mm)
12. Heavy hand-fed hexagon turret lathes (up to 11 tons; lathe swing, 800 mm, and length up to 1 780 mm)
13. Frontal or plateau lathes (lathe swing, 2 500 mm; 5 h.p., and weight up to 6 tons)
14. Special semi-automatic lathes for small parts (up to 2 inches)
15. Automatic lathes with radia, slides (spindle bore diameter, up to 1 inch; weight up to 1 ton)
16. Semi-automatic lathes for second operations
17. Universal bench milling machines (up to 0.3 tons)
18. Light universal milling machines (up to 0.8 tons and 1.5 h.p.)

/19. Universal

19. Universal milling machines with Morse cone No. 4 and 5 (up to 5 h.p., and weight between 1.5 and 3 tons)
20. Milling machines with automatic work cycle (table), simplex and duplex types (up to 3 h.p. and weight 1.5 tons)
21. Hand-fed bench drilling machines
22. Bench drilling machines with automatic feed
23. Hand-fed pedestal drilling machines (diameter capacity up to 1 1/2 inches)
24. Pedestal drilling machines with automatic feed (maximum diameter 1 1/2 inches)
25. Multi-spindle bench and pedestal drilling machines (up to 2 h.p.)
26. Radial drilling machines with arm length up to 1 250 mm (maximum diameter, 35 mm, for steel)
27. Shapers with stroke length from 300 to 1 200 mm, including a hydraulic model
28. Table planers (up to 5 h.p.; table, 1 000 x 3 400 mm, or over; weight 7.5 tons. Hydraulic models are also manufactured in a smaller size)
29. Semi-automatic and automatic threading machines for internal threads (diameter, up to 1/2 inch)
30. Threading machines with flat dies (up to 1 1/2 inches)
31. Threading machines with cylindrical dies (working pressure up to 20 tons)
32. Hydraulic broaching machines, simple horizontal type (up to 20 tons)
33. Alternating saws for metal cutting
34. Partially hydraulic alternating saws for metal cutting (up to 12 x 12 inches)
35. Completely hydraulic circular saws with automatic feed (diameter, up to 130 mm)
36. Band saws, horizontal and vertical types
37. Hand and semi-automatic universal grinding machines, with mechanical and hydraulic controls (distance between centres, up to 1 500 mm)

/38. Grinding

38. Grinding machines for flats (table, 135 x 600 mm; up to 3.5 h.p.; also with electromagnetic table)
39. Universal tool-grinding machines
40. Special grinding machines for tungsten carbide tools
41. Special machine-tools for long series composed of machining units up to 5 h.p. One-stage or revolving-table type
42. Axle centerers

II. Machines for forming operations

1. Hydraulic presses (up to 1 600 tons)
2. Eccentric presses, inclinable (up to 100 tons)
3. Eccentric presses, fixed, with intermediate gears (up to 160 tons)
4. Friction presses (up to 400 tons)
5. Pneumatic forging machines (up to 500 kg)
6. Forging machines (up to 150 kg)
7. Drop forging machines (up to 250 kilogrammetres)
8. Shears (length, up to 3 000 mm; thickness, 1/2 inch)
9. Bending presses (length, up to 3 600 mm; thickness, 5 mm; pressure, up to 75 tons)
10. Machines for cutting shapes, universal type.

The number of variants of the types of machine-tools listed above is particularly high in respect of lathes, drilling machines and saws, and forming machines in general. It should be taken for granted, for example, that, as regards presses, a wide range of capacities is manufactured, from 2.5 tons to a maximum of 100 tons; and the same applies to the other machines. In the categories of chip-producing and forming machines, respectively, lathes and presses are the most highly developed and the most advanced from the technical standpoint in respect of types, models, weight and power per unit, quality and productivity. The progress achieved in the manufacture of these machines during the past decade was so remarkable that for several years now exports have been registered; this applies particularly to lathes, which have found a market not only in Latin America and the Middle East, but also in European countries with a long-standing tradition in the manufacture of machine-tools.

/Milling machines

Milling machines are important items whose share in the composition of machine-tool inventories is usually about 8 to 10 per cent. Although a great variety of types and models of machines of this kind exists, domestic manufacture is confined to six models. It should be stressed here not only that the manufacturers are lagging behind in this sector, but that the national inventory too is deficient, milling machines being little used in Brazil.

Next in importance to milling machines come grinding machines, of which again only a few models are manufactured, whereas a wide and varied range of types is available on the world market. Here too a comparison between the Brazilian inventory and that of other countries (see again table 12) reveals an anomalous situation which suggests the urgency of the need to embark upon local manufacture of several basic models. Boring machines and gear-cutting machines are not manufactured in Brazil, and have to be imported.

Generally speaking, the list of the types of machine-tools currently manufactured in Brazil is somewhat incomplete in relation to the significance already attained by the national inventory in respect of numbers and variety of types. Nevertheless, considering that the sector is in some instances very young and inexperienced and that the annual volume of output is a little over 10 000 tons, the manufacture of 52 types of machine-tools in about 150 leading models represents a fairly satisfactory situation.

Given the country's present stage of development and the growth projections for the next few years formulated in relation to the various sectors of the metal transforming industry, the Brazilian inventory will exceed 300 000 units in 1971. Clearly, then, the sector will need to increase the number of models progressively year by year so that some balance is maintained between the evolution of the inventory and the domestic supply of basic types. Otherwise, if Brazil's own technological resources did not suffice to feed the inventory of machine-tools, a difficult situation might arise because of the amount of foreign exchange that would be needed to import the requisit machines, and in consequence, over the long term, the expansion of the metal transforming industries would be slowed up.

/It must

It must be borne in mind, however, that no country is completely independent as regards the manufacture of all types of machine-tools - not even those with inventories of over 2 million machines - and that the necessity for international trade in this field is almost a basic principle. The items concerned, however, are as a rule specialized machine-tools, domestic production of which has no attractions from the economic or technical standpoint, and are very seldom the simpler basic types manufactured in longer production series.

Recommendations for the manufacture of new models that might be put on the market by 1971 are formulated in chapter VI, which deals with the growth prospects of the domestic industry.

(d) Volume of output

The survey of Brazilian production of machine-tools presented here, and covering the period between 1955 and 1961, is the first to have been undertaken in the country.

The figures for the years 1955, 1956 and 1957 must be regarded as approximate, since in some cases the answers to the questionnaire were incomplete, and either the number or the weight of the machines manufactured had to be estimated. In any event, these estimates do not greatly affect the conclusions drawn from the figures in question.

The findings of the survey with regard to chip-producing machines, forming machines, and the total accumulated during the period 1955-61 are given in tables 34, 35 and 36, respectively.

The tables in question give a clear idea of the tremendous effort put forth by the manufacturers of machine-tools, since in only six years the annual tonnage produced was increased by 260 per cent, reaching cumulative figures in excess of 60 000 tons, and equivalent to more than 62 000 units. This volume of production undoubtedly did much to account for the fact that the Brazilian inventory almost doubled between 1955 and 1961.

/Table 34

Table 34

BRAZIL: PRODUCTION OF CUTTING MACHINES FOR CHIP-PRODUCING OPERATIONS

(Weight in tons)

Type of machine	1955		1956		1957		1958		1959		1960		1961	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
Lathes	2 443	2 681.9	3 072	3 305.3	2 583	2 814.9	3 149	3 673.9	3 053	3 902.6	3 766	4 295.2	4 638	5 265.0
Bench lathes			20	2.4	20	2.4	10	1.2	-	-	600	78.0	720	83.6
Engine lathes	1 949	2 382.4	2 444	2 914.1	1 958	2 391.5	2 386	3 067.2	2 341	3 369.8	2 238	3 545.6	2 500	4 196.7
Frontal or plateau lathes	7	42.0	10	52.0	9	54.0	8	48.0	10	56.0	10	56.0	13	62.0
Turret and semi-automatic lathes	487	257.5	597	336.3	579	356.1	708	534.2	670	456.0	849	566.5	1 279	813.7
Automatic lathes	-	-	-	-	6	5.4	12	10.8	12	10.8	24	21.6	76	73.0
Others	-	-	1	0.5	11	5.5	25	12.5	20	10.0	45	27.5	50	36.0
Milling machines	72	42.2	67	42.0	142	77.2	159	143.9	190	168.5	186	187.1	278	289.8
Universal	40	18.0	40	18.0	80	32.0	111	103.0	145	126.6	126	129.8	191	215.3
Vertical	11	5.7	-	-	2	2.3	7	4.6	2	1.4	6	3.0	13	6.7
Others	21	18.5	27	24.0	60	42.9	41	36.3	43	40.5	54	54.3	74	67.8
Drilling machines	614	164.9	1 341	275.2	1 522	2 842.0	2 051	360.0	2 346	430.6	2 809	525.0	5 311	794.9
Bench drills	227	12.1	347	17.8	441	27.9	761	49.4	965	76.2	1 231	104.1	3 590	245.0
Pedestal drills	387	152.8	994	257.4	1 081	256.3	1 290	311.2	1 380	354.2	1 571	411.1	1 707	526.4
Radial	-	-	-	-	-	-	-	-	-	-	1	2.3	5	11.8
Multi-spindle	-	-	-	-	-	-	-	-	1	0.2	6	7.5	9	11.7
Shapers and planers	200	408.4	384	554.7	369	578.8	446	739.5	504	892.6	765	1 079.6	937	1 369.4
Shapers	168	236.1	346	335.7	337	389.8	413	554.5	458	616.6	715	788.1	878	1 027.4
Table planers	32	172.3	38	219.0	31	186.8	33	185.0	46	276.0	50	291.5	59	342.0
Others	-	-	-	-	1	2.2	-	-	-	-	-	-	-	-
Threading machines	19	3.6	18	2.7	25	5.3	36	6.9	28	7.0	45	29.5	53	35.0
Cutting machines (saws)	113	19.5	676	203.1	588	210.1	862	273.9	873	308.6	1 210	387.4	1 296	342.4
Reciprocating saws	113	19.5	634	193.3	518	196.1	678	225.7	560	214.1	740	258.1	817	200.7
Band saws	-	-	42	9.8	70	14.0	184	48.2	313	94.5	470	129.3	478	139.6
Circular saws	-	-	-	-	-	-	-	-	-	-	-	-	1	2.1
Grinding machines	2	3.0	-	-	-	-	44	33.0	61	43.5	46	34.3	79	57.1
Plain	-	-	-	-	-	-	42	30.0	60	42.0	44	31.3	76	53.1
Universal cylindrical	2	3.0	-	-	-	-	2	3.0	1	1.5	2	3.0	3	4.0
Tool-grinding machines	-	-	-	-	-	-	22	22.0	38.0	38	69	50.7	101	69.3
Universal	-	-	-	-	-	-	22	22.0	38.0	38	54	43.2	91	64.3
Special	-	-	-	-	-	-	-	-	-	-	15	7.5	10	5.0
Special machines and machine units for special machining operations	-	-	-	-	-	-	-	-	-	-	47	18	11	41.0
Total	3 463	3 323.5	5 558	4 383.0	5 229	3 970.5	6 769	5 273.7	7 093	5 791.4	8 943	6 606.8	12704	8 263.9

/Table 35

Table 35

BRAZIL: MACHINES FOR FORMING OPERATIONS

(Weight in tons)

Type of machine	1955		1956		1957		1958		1959		1960		1961	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
Presses	818	1 390.4	1 349	2 336.9	1 146	2 157.6	1 475	2 558.8	1 360	2 465.7	1 820	3 326.3	2 139	3 890.0
Hydraulic	131	86.1	244	158.1	210	116.6	314	181.6	228	226.5	318	488.5	333	510.6
Eccentric	643	1 055.0	1 003	1 720.3	848	1 643.9	1 075	1 989.6	1 035	1 831.8	1 384	2 314.7	1 651	2 734.8
Friction	44	249.3	95	438.9	79	371.9	83	379.2	87	379.4	108	495.1	128	569.0
Upsetters			7	19.6	9	25.2	3	8.4	10	28.0	10	28.0	27	75.6
Forging machines	1	3.6	1	3.6	1	3.6	6	21.6	5	18.0	9	32.4	7	24.8
Pneumatic hammers	1	3.6	1	3.6	1	3.6	6	21.6	5	18.0	9	32.4	7	24.8
Machines for sheet	196	368.1	301	507.6	250	467.1	317	564.6	354	731.7	473	890.7	667	1 071.2
Shears	71	160.3	124	246.3	114	245.9	139	255.7	160	376.1	248	490.1	346	601.6
Bending machines	98	183.3	134	221.5	94	182.9	128	261.6	133	297.4	131	304.0	182	317.9
Bending rolls	12	12.2	16	17.6	14	15.4	26	27.6	31	33.6	63	71.2	108	126.3
Other machines for sheet	15	12.3	27	22.2	28	22.9	24	19.7	30	24.6	31	25.4	31	25.4
Total	1 015	1 762.1	1 651.0	2 848.1	1 397	2 628.3	1 798	3 145.0	1 719	3 215.4	2 302	4 249.4	2 813	4 986.0
Total for chip-producing machines	3 463	3 323.5	5 558	4 383.0	5 229	3 970.5	6 769	5 253.7	7 093	5 791.4	8 943	6 606.8	12 704	8 263.9
Total for forming machines	1 015	1 762.1	1 651.0	2 848.1	1 397	2 628.3	1 798	3 145.0	1 719	3 215.4	2 302	4 249.4	2 813	4 986.0
Total Brazilian production	4 478	5 085.6	7 209	7 231.1	6 626	6 598.8	8 567	8 398.7	8 812	9 006.8	11 245	10 856.2	15 517	13 249.9

Table 36

BRAZIL: TOTAL OUTPUT OF MACHINE-TOOLS, 1955-61

(Weight in tons)

Type of machine	Number	Percentage	Weight	Percentage
Lathes	22 704	36.3	25 938.8	42.9
Milling machines	1 094	1.7	950.7	1.6
Drilling machines	15 994	25.6	2 835.4	4.7
Shapers and planers	3 605	5.8	5 623.0	9.3
Threading machines	224	0.4	90.0	0.1
Cutting machines (saws)	5 618	9.0	1 745.0	2.9
Grinding machines	232	0.4	179.0	0.3
Tool-grinding machines	230	0.4	180.0	0.3
Special machines	58	0.1	59.0	0.1
Total for chip-producing machines	49 759	79.7	37 592.8	62.2
Presses	10 107	16.2	18 125.7	30.0
Forgine machines (Pneumatic hammers)	30	-	107.6	0.2
Machines for sheet	2 558	4.1	4 601.0	7.6
Total for forming machines	12 695	20.3	22 834.3	37.8
Grand total	62 454	100.0	60 427.1	100.0

The data on the percentage distribution of the machines used for chip-producing and for forming operations are worth analysing. During the period 1955-61, the average figures were 79.7 and 20.3 per cent, respectively. In 1960, Brazil's total stock of machine-tools, including those used for maintenance purposes but excluding those not inventoried showed a very similar distribution - 78.2 and 21.8 per cent -, which suggests that domestic production kept fairly closely parallel to the

/composition of

composition of the total stock as regards the two categories concerned. It must be pointed out, however, that during the period under discussion the proportion of output represented by chip-producing machines showed a decided upward trend, rising from 77.3 per cent in 1955 to 81.9 per cent in 1961. If similar comparisons are made on the basis of the tonnages produced, the position is reversed, and the share of chip-producing machines falls from 65.7 in 1955 to 62.3 per cent in 1961 (see table 39). The explanation lies in the fact that during this period a beginning was made on manufacture of some new types of machine-tools (such as grinding machines, tool-grinding machines, etc.), in the smaller sizes, while at the same time the manufacture of light machine-tools such as lathes and bench drills, shapers and alternating saws was intensified, with the aim of meeting the demand deriving from the manufacture of a great many light articles as well as the requirements of small-scale establishments which came into being at that time. Thus, the average unit weight of the machines manufactured dropped from 960 to 650 kg. The unit weight of forming machines was maintained at about 1 800 kg, as can be seen in tables 37 and 38.

While the changes registered in relation to these two major groups of machine-tools are broadly indicative of a gradual adjustment of domestic production to internal market requirements, it is interesting to note the much more striking modifications that have taken place within the groups themselves as this industrial activity has gradually developed.

For example, the proportion of output represented by the manufacture of lathes, which in 1955 was 54.6 per cent in terms of units, had fallen to about 30 per cent by 1961. The manufacture of drilling machines has increased to such an extent - more than eight times over in the course of the period - that the present share of this line of production has risen to 34 per cent, as against 13.7 per cent in 1955. The reason lies in the heavy demand deriving from the production of light manufactured goods for which hand drills are generally used, and also in the fact that the use of high-output drilling machines, such as, for example, the multi-spindle type, is not very common in Brazil (see table 39).

/Table 37

Table 37

BRAZIL: TREND OF AVERAGE WEIGHT OF SELECTED CHIP-PRODUCING MACHINE-TOOLS, 1955-61

(Kilogrammes)

Type of machines \ Year	1955	1956	1957	1958	1959	1960	1961
Lathes (excluding bench lathes)	1 098	1 082	1 093	1 170	1 278	1 332	1 322
Milling machines	586	627	544	905	887	1 006	1 042
Drilling machines	269	205	187	176	184	187	150
Shapers and planers	2 042	1 445	1 569	1 658	1 771	1 411	1 461
Cutting machines (saws)	173	300	357	318	353	320	264
Total for chip-producing machines	960	789	759	776	816	740	650

/Table 38

Table 38

BRAZIL: EVOLUTION OF AVERAGE WEIGHT OF SELECTED MACHINE-TOOLS FOR FORMING OPERATIONS, 1955-61

(Kilogrammes)

Machines \ Year	1955	1956	1957	1958	1959	1960	1961
Total for presses	1 700	1 732	1 383	1 735	1 813	1 828	1 819
Hydraulic presses	657	648	555	578	993	1 536	1 533
Eccentric presses	1 641	1 715	1 938	1 851	1 770	1 672	1 656
Shears	2 258	1 986	2 157	1 840	2 351	1 976	1 739
Total for forming machines	1 736	1 725	1 881	1 749	1 870	1 846	1 772
Average weight of total machine-tool output	1 136	1 003	996	980	1 022	965	854

/Table 39

Table 39

BRAZIL: COMPOSITION OF PRODUCTION OF MACHINE-TOOLS IN 1955 AND 1961

(Percentages)

Type of machine	In terms of units		In terms of weight	
	1955	1961	1955	1961
Lathes	54.6	29.9	52.7	39.7
Milling machines	1.6	1.8	0.8	2.2
Drilling machines	13.7	34.2	3.2	6.0
Shapers and planers	4.5	6.0	8.1	10.3
Threading machines	0.4	0.3	0.1	0.3
Cutting machines (saws)	2.5	8.4	0.4	2.6
Grinding machines	-	0.5	0.1	0.4
Tool-grinding machines	-	0.7	-	0.5
Special machine-tools	-	0.1	-	0.3
Total for chip-producing machine	77.3	81.9	65.4	62.3
Presses	18.3	13.8	27.3	29.4
Forging machines	-	-	0.1	0.2
Machines for sheet	4.4	4.3	7.2	8.1
Total for forming machines	22.7	18.1	34.6	37.7
Grand total	100.0	100.0	100.0	100.0

/As may

As may logically be inferred from the low percentage of milling machines both in the Brazilian inventory and in domestic production of machine-tools, output of shapers and planers expanded considerably, attaining a figure that should now be considered the maximum in percentage terms. As the manufacture of new types of milling machines is consolidated, these will come to predominate over shapers and planers, and the position will thus be reversed.

Output of saws increased more than tenfold between 1955 and 1961, which meant that their share in total production rose from 2.5 to 8.4 per cent in that period. This state of affairs is attributable to the widespread use of these machines in maintenance workshops and small-scale establishments, and also - as would seem to be the case with circular saws - to the very limited use of higher-yield machine-tools.

Production of presses was approximately trebled, but their share too, like that of lathes, dropped from 18.3 to 13.8 per cent.

Despite the substantial increments registered, there is remarkably little manufacturing activity in the field of grinding machines, tool-grinding machines, threading machines and special machine-tools, which already represent a considerable proportion of the domestic inventory, although the percentage in question is lower than in other countries.

The average weight of the machine-tools manufactured has fluctuated significantly in the course of the period (see again tables 37 and 38). Worthy of special mention is the progress achieved in respect of lathes, the average weight of which has risen by about 300 kg in the last six years; this was no doubt one of the factors responsible for the acceptance of Brazilian lathes on external markets. Noteworthy, too, is the increase of almost 900 kg in the unit weight of hydraulic presses, although this is not very clearly reflected in the over-all average for presses, because the expansion of capacity to manufacture heavier machinery is offset by an increase in output of other types, chiefly eccentric presses, in respect of which domestic industry has for many years now been supplying internal requirements of the models and sizes in most general use.

/Since the

Since the milling machines manufactured in 1955 were very simple models, their weight had almost doubled six years later. But this progress must not be regarded as sufficient, since the average weight of these machines recommendable at the country's present stage of industrialization should be in the neighbourhood of 1 500 to 1 700 kg. The introduction of new types will probably permit the attainment of this target in the course of the next ten years.

The heavy consumption of bench drills accounts for a decrease in the average weight of the drilling machine group, which was 150 kg per machine in 1961. Here too the modest share of domestic production may be noted in relation to the heavier types, for example those with capacities of up to 2 inches, the pedestal type, multi-spindle drills and radial drills.

The figures for shapers, planers and saws fluctuate mainly on account of the influence of production of the lighter types, demand for which varies greatly. Within these categories, machines of higher capacity and weight have been manufactured in Brazil.

Despite the progress achieved as regards volumes of manufacturing output and the fairly high level reached in 1961, the phase under review might be defined as the formative stage of Brazil's machine-tools sector, on the basis of an over-all evaluation, and in the sense that a considerable proportion of the establishments are equipped to cope with production in terms of quantity rather than of quality. What has been said of the manufacturers' own inventory of machine-tools is fairly conclusive in this respect.

Thus, while certain types of machine-tools, such as engine lathes, medium-weight hexagonal turret lathes and presses have already reached a high level of quality and productivity, many of the other machines are deficient on the technical side. This is because most of the small-scale manufacturers, owing to their limited production facilities, have to make the simplest models. The only advantage of such a situation is the low price of the machine-tools, which in the last analysis proves anti-economic in terms of productivity.

One obvious result of the production of a large number of simple machine-tools is the lack of extra-sectoral manufacturing enterprise in the field of supplementary equipment and accessories, which are important factors in the

/development of

development of the machine-tools sector. It must be acknowledged, however, that interest in the manufacture of highly-specialized items is warranted only when the consumer market reaches a certain minimum level. By way of illustration, a list is given below of some of the accessories which may be regarded as basic for the manufacture of good quality machine-tools with a high productivity, which at present are difficult to find on the market:

Component parts for low, medium and high-pressure hydraulic circuits
Electrohydraulic, pneumohydraulic and electropneumohydraulic equipment
Component parts for pneumatic circuits
Electric motors with brakes
Continuous speed variators, mechanical, electric and hydraulic
Electromagnetic, pneumatic, hydraulic and mechanical clutches, simple and compound, dry or oil-bath types
Revolving tables with hand dividers
Hand and automatic high-precision dividers for milling machines
Electromagnetic tables, higher-powered than those currently manufactured
Hydraulic plates for lathes.

If suitable undertakings are to be set up to supplement and support the manufacture of machine-tools, the prime requisite is that domestic manufacturers should interest themselves in producing more fully equipped machine-tools and duly exploiting the resources offered by semi-automation to improve the productivity of the machines manufactured. This is one of the most important targets to be attained by domestic industry within the next two years. In addition, as has already been pointed out, the nature of the problems connected with the technological evolution of machine-tools is such that, generally speaking, they could not be tackled competently enough by the smaller firms, unless these latter undertake the task of carrying out more advanced projects studied by third parties, or by an agency with the necessary technical qualifications, such as a Brazilian machine-tools institute.

In conclusion, the quality and types of the machine-tools manufactured must in future keep up more closely with the increasing needs of the Brazilian machine-tool inventory, as the more advanced manufacturers have done hitherto, so that definitive consolidation of the sector may be achieved.

/As regards

As regards price levels in the domestic machine-tools industry and its competitive position vis-à-vis foreign machine-tools, it is difficult at present to put forward conclusive data reflecting the real situation for each machine. In this type of industry such factors as quality, complexity, and manufacturing characteristics and techniques exert a powerful influence on manufacturing costs, and cannot be ignored in such comparisons, which as a result become immensely difficult, and in some cases even impossible, or, if a strictly comparable counterpart cannot be found, virtually devoid of significance. Locally-manufactured machine-tools show a wide range of prices according to the greater or lesser incidence of the above-mentioned factors on their manufacture, and this would make for unrealistic or meaningless results if a comparison at the level of the broad classification of machine-tools were attempted; such an undertaking would have to be carried out in relation to each individual type of machine, and for this insufficient data are available, besides which, it would be outside the scope of the present study.

Despite the price differences observable in domestic machine-tools, quotations fluctuate, broadly speaking, around an average of 2 dollars per kg, which may be considered satisfactory.

Again, since exports of particular machines, such as certain types of lathes and presses, have been achieved and some Latin American countries are displaying interest in purchasing Brazilian machine-tools, it may be deduced that their price levels fall within an acceptable range.

/Chapter VI

Chapter VI

MARKET PROSPECTS FOR THE DOMESTIC MACHINE-TOOLS INDUSTRY IN 1962-71

The period 1955-61, which immediately preceded the decade under consideration in the present study, was characterized by a substantial demand for machine-tools deriving from the establishment of the motor vehicle and spare parts industries, as well as by the development of other metal transforming activities such as ship building and the manufacture of heavy equipment, Diesel engines, ball bearings, etc. Between the years referred to, 158 718.9 tons of machinery, equivalent to approximately 101 701 units, were installed in Brazil (see table 40), These figures imply that in the course of seven years the machine-tool inventory almost doubled, increasing from 125 036 to 226 737 units, with the inclusion of machines used for maintenance purposes.

One result of this exceptional development of the metal transforming industries was a marked expansion of the volume of production of machine-tools, which in the period in question increased at a cumulative annual rate of about 14.7 per cent, rising from 5 085.6 tons in 1955 to 13 249.9 tons in 1961.

1. Present situation and technological development

Between 1955 and 1961, it fell to domestic industry to satisfy a considerable proportion of consumption, which, expressed in terms of weight, averaged about 40 per cent, fluctuating between a maximum of 54 per cent and a minimum of 25 per cent as a result of the sharp variations in imports. In numerical terms, domestically manufactured machines probably represented about 60 per cent of the total. However, as mentioned above, the contribution of domestic production to the machine inventory consisted of simple, light types with an average unit weight of 970 kg, ranging from 1 136 to 854 kg between the beginning and end of the period under review. If the average weight of imported units is estimated at 2.5 tons, the conclusion may be reached that during those seven years the Brazilian machine-tool inventory was supplied with machines of an average weight of 1.56 tons.

/Table 40

Table 40

BRAZIL: APPARENT CONSUMPTION OF MACHINE-TOOLS, 1955-61

	1955		1956		1957		1958	
	Number a/	Tons	Number a/	Tons	Number a/	Tons	Number a/	Tons
Domestic production	4 478	5 085.6	7 209	7 231.1	6 626	6 596.8	8 567	8 398.7
Percentage	65.3	46.1	74.5	53.9	60.4	37.8	58.0	35.2
Imports	2 378	5 944.6	2 461	6 152.5	4 350	10 871.8	6 195	15 487.8
Percentage	34.7	53.9	25.5	46.1	39.6	62.2	42.0	64.8
Exports	-	-	36	29.1	5	3.6	3	2.7
Apparent consumption	6 856	11 030.2	9 634	13 354.5	10 971	17 467.0	14 759	23 083.8

	1959		1960		1961		Total 1955-61	
	Number a/	Tons	Number a/	Tons	Number a/	Tons	Number a/	Tons
Domestic production	8 012	9 006.8	11 245	10 856.2	15 517	13 249.9	62 454	60 427.1
Percentage	44.6	24.7	60.2	36.9	73.4	48.5	61.3	38.0
Imports	10 954	27 384.1	7 410	18 526.4	5 604	14 009.8	39 352	98 377.0
Percentage	55.4	75.3	39.8	63.1	26.6	51.5	38.7	62.0
Exports	5	4.9	18	12.9	33	32.0*	105	85.2
Apparent consumption	19 761	36 386.0	18 637	29 369.7	21 083	27 227.7	101 701	158 718.9

a/ For domestic production: real data. For imports and exports: estimates.

/As was

As was shown in earlier chapters, the decrease in the average weight of domestically manufactured machine-tools does not imply that reductions took place in the weight of the traditionally heavier types of machines; on the contrary, the sector increased its capacity to manufacture heavier machine-tools, such as lathes (excluding bench lathes), milling machines, hydraulic presses, and, to a lesser degree, saws (see again chapter V, tables 37 and 38). But at the same time new models were put on the market, and there was an increase in the manufacture of small units to meet the needs deriving from larger volumes of production, mainly of light articles, and also to supplement imported machinery.

In those cases where progress was made in respect of the models and weights manufactured, a relatively high percentage share in the market was secured by domestically produced machine-tools, especially lathes, saws and, undoubtedly, the types of presses included under the heading "Others" for want of differentiation in import statistics (see tables 41 and 42). The proportion of requirements supplied by Brazilian shapers and planers - also about 65 per cent - is declining in relation to earlier years, and their weight has also decreased, on account of the expansion of production of the lighter types of shapers. The striking increase in the weight of milling machines is reflected in the steady growth of their share in the market, although this upward trend cannot continue unless a more complete range of models is manufactured than at present and their average weight, which has not yet reached a satisfactory level, is still further increased. The same is true of threading machines. Table 42 also bears witness to the particular deficiencies of domestic production of drilling and grinding machines, in the shape of insufficient diversity of types and light weights. Boring machines, incorporated in import statistics along with the drilling and broaching machines included under "Others", are virtually not manufactured at all. Production of broaching machines does exist in Brazil, but on what scale is not known.

/Table 41

Table 41

BRAZIL: APPARENT CONSUMPTION OF SELECTED MACHINE-TOOLS, IN TERMS OF WEIGHT, 1955-61

(Tons)

	Lathes	Milling machines	Drilling machines	Shapers and planers	Cutting machines (saws)	Threading machines	Grinding machines	Others	Total
1955									
Domestic production	2 681.9	42.2	164.9	408.4	19.5	3.6	3.0	1 762.1	5 085.6
Imports	1 665.8	585.2	495.2	196.7	87.8	63.2	632.8	2 217.9	5 944.6
Exports	-	-	-	-	-	-	-	-	-
Apparent consumption	4 347.7	627.4	660.1	605.1	107.3	66.8	695.8	3 980.0	11 030.2
1959									
Domestic production	3 902.6	168.5	430.6	892.6	308.6	7.0	43.5	3 253.4	9 006.8
Imports	4 068.2	2 867.1	3 257.6	528.9	158.6	251.1	2 380.6	13 872.0	27 384.1
Exports	4.9	-	-	-	-	-	-	-	4.9
Apparent consumption	7 965.9	3 035.6	3 688.2	1 421.5	467.2	258.1	2 424.1	17 125.4	36 386.0
1960									
Domestic production	4 295.2	187.1	525.0	1 079.6	387.4	29.5	34.3	4 318.1	10 856.2
Imports	2 424.4	1 503.4	2 065.3	451.4	75.4	181.5	1 431.4	10 393.6	18 526.4
Exports	11.9	-	-	-	-	-	-	1.0	12.9
Apparent consumption	6 707.7	1 690.5	2 590.3	1 531.0	462.8	211.0	1 465.7	14 710.7	29 369.7
1961									
Domestic production	5 265.0	289.8	794.9	1 369.4	342.4	35.0	57.1	5 096.3	13 249.9
Imports	2 911.5	2 288.6	2 696.8	756.1	174.9	182.0	2 042.0	2 957.9	14 009.8
Exports a/	32.0	-	-	-	-	-	-	-	32.0
Apparent consumption	8 144.5	2 578.4	3 491.7	2 125.5	517.3	217.0	2 099.1	8 054.2	27 227.7

a/ Including boring machines.

/Table 42

Table 42

BRAZIL: SHARE OF DOMESTIC PRODUCTION AND IMPORTS IN THE SUPPLYING OF APPARENT CONSUMPTION OF SELECTED MACHINE-TOOLS, 1955-61

(Percentages of weight)

Type of machine	1955		1959		1960		1961	
	Domestic production	Imports	Domestic production	Imports	Domestic production	Imports	Domestic production	Imports
Lathes	61.7	38.3	48.9	51.1	63.9	36.1	64.3	35.7
Milling machines	6.7	93.3	5.6	94.4	11.1	88.9	11.2	88.8
Drilling machines a/	25.0	75.0	11.7	88.3	20.3	79.7	22.8	77.2
Shapers and planers	67.5	32.5	62.8	37.2	70.5	29.5	64.4	35.6
Cutting machines (saws)	18.2	81.8	66.1	33.9	83.7	16.3	66.2	33.8
Threading machines	5.4	94.6	2.7	97.3	14.0	86.0	16.1	83.9
Grinding machines	0.5	99.5	1.8	98.2	2.3	97.7	2.7	97.3
Others	44.3	55.7	19.0	81.0	29.3	70.7	63.3	36.7
Total	46.1	53.9	24.7	75.3	36.9	63.1	48.5	51.5

a/ Including boring machines, in the case of imports.

There is another point that should be mentioned before embarking upon an analysis of the prospects for the domestic machine-tools industry as regards the supply of future requirements. It relates to this activity's rapid rate of expansion in response to the powerful stimulus of demand in 1955-61, and the part played by domestically-produced machines in the satisfaction of that demand. As already indicated, some of them have contributed, in greater or lesser proportion, to the formation of the machine-tool inventories of various industries, in conjunction with imported units. Although imports had already reached their peak in 1959, and in the next two years declined to considerably lower values - which implies the gradual removal of one of the factors affecting purchases of domestically-produced machines - production has maintained its rate of expansion.

/This might

This might mean, on the one hand, that imports have not directly accounted for the increased demand for Brazilian machine-tools, but, on the other hand, some distortion may exist in relation to imports and domestic production because the former have had to be effected, in the main, within fixed time-limits, whereas the domestically-produced machines intended to supplement imports could be ordered as and when they were needed. If this latter hypothesis were to prove valid, in proportion to its significance - which is difficult to assess in quantitative terms - the rate of growth of domestic production might slacken considerably in the course of the next few years.

Accordingly, given the disappearance of the factors that boosted consumption of machine-tools in the past six years and the restoration of a normal demand situation, unaffected by the anomalous and transient influences which operated during that period, there is clearly one indispensable prerequisite for the enlargement of the domestic industry's share in satisfying internal requirements. It must develop, not merely in the sense of manufacturing higher tonnages, but in the more important direction of making new types of machines and perfecting some of the models currently produced, in such a way as to prevent discrepancies and improve the balance between the requirements of the national inventory and the machine-tool industry's resources for meeting them.

Owing to the existence of structural and dimensional differences between the establishments included in the sample and the rest of the universe, it was impossible to keep, as would have been desirable, a detailed record of machine-tools for the total number, in relation both to the inventory and to future demand, without running the risk of misrepresenting the real situation. In any event, the results obtained are suggestive enough to indicate certain technical improvements which it would be well to introduce in some of the machines currently manufactured, and to permit the compilation of a list of the new types of machines with which the internal market should be supplied up to 1971.

/(a) Improvements

(a) Improvements upon machines already manufactured in Brazil

On the basis of the study of domestic manufacture as a whole, some general indications can be given of the most important improvements that should be incorporated in the machines currently manufactured. They may be summed up as follows:

(i) Increase in the weight of models, so that the machines can be higher-powered. This is a necessary step towards the achievement of greater productivity. It should be recalled that in 1961 the average unit weight of domestically-produced machine-tools was less than one ton, and, ideally, this figure should be raised to about 1 200-1 300 kg by 1971.

(ii) Increase in cutting speeds. The steady progress registered in recent years in local manufacture of tungsten carbide tools opens up the possibility of working with higher cutting speeds. However, it will be readily understood that there are some lines of domestically-produced machine-tools which do not permit maximum exploitation of these advantages;

(iii) Availability, in some instances, of a wider range of feed and cutting speeds. The extreme kinematic simplicity of some of the models manufactured prevents the selection of suitable feed and cutting speeds, making it more difficult to improve the work cycle;

(iv) Development of semi-automation of all types: kinematic, electric, hydraulic and pneumatic. Broadly speaking, semi-automation complicates the manufacture of machine-tools and raises their cost, but this fact is fully compensated by the increase in productivity resulting from the reduction of idle periods during the operational cycle;

(v) More widespread application of techniques for surface hardening of bed rails and benches. The diffusion of these techniques becomes necessary whenever the unit value of machines increases and it is desirable to maintain machining precision for the longest possible time within the useful life of the machine;

(vi) Better use of materials, especially with regard to the quality and stabilization of cast iron. Such measures are highly desirable in conjunction with improvements in the design of castings, both in relation to the subject of the preceding sub-paragraph and in order to ensure attainment of the control values required by the Schlesinger and Salmon standards;

/(vii) Completion

(vii) Completion of machine-tool accessories. The rational utilization of certain types of machine often depends upon the availability of a number of special accessories which facilitate or permit the machining of specific parts. Few manufacturers have taken due pains to complete the equipment of their machines in this respect;

(viii) Improvement of electric circuits. Generally speaking, special attention should be devoted to the selection of electrical equipment with a view to ensuring greater safety and protection against possible overburdening by the use of suitable materials, some of which are already available on the market;

(ix) Testing of machines by Salmon or Schlesinger standards. Obviously, the development of this sector would have to be accompanied by more widespread application of these standards - at present adopted by a mere handful of manufacturers - as a result of the more exacting requirements of market demand, and, at the same time, as a means of offering consumers a guarantee of the quality of the goods produced.

(b) New types of machines which it would be advisable to manufacture

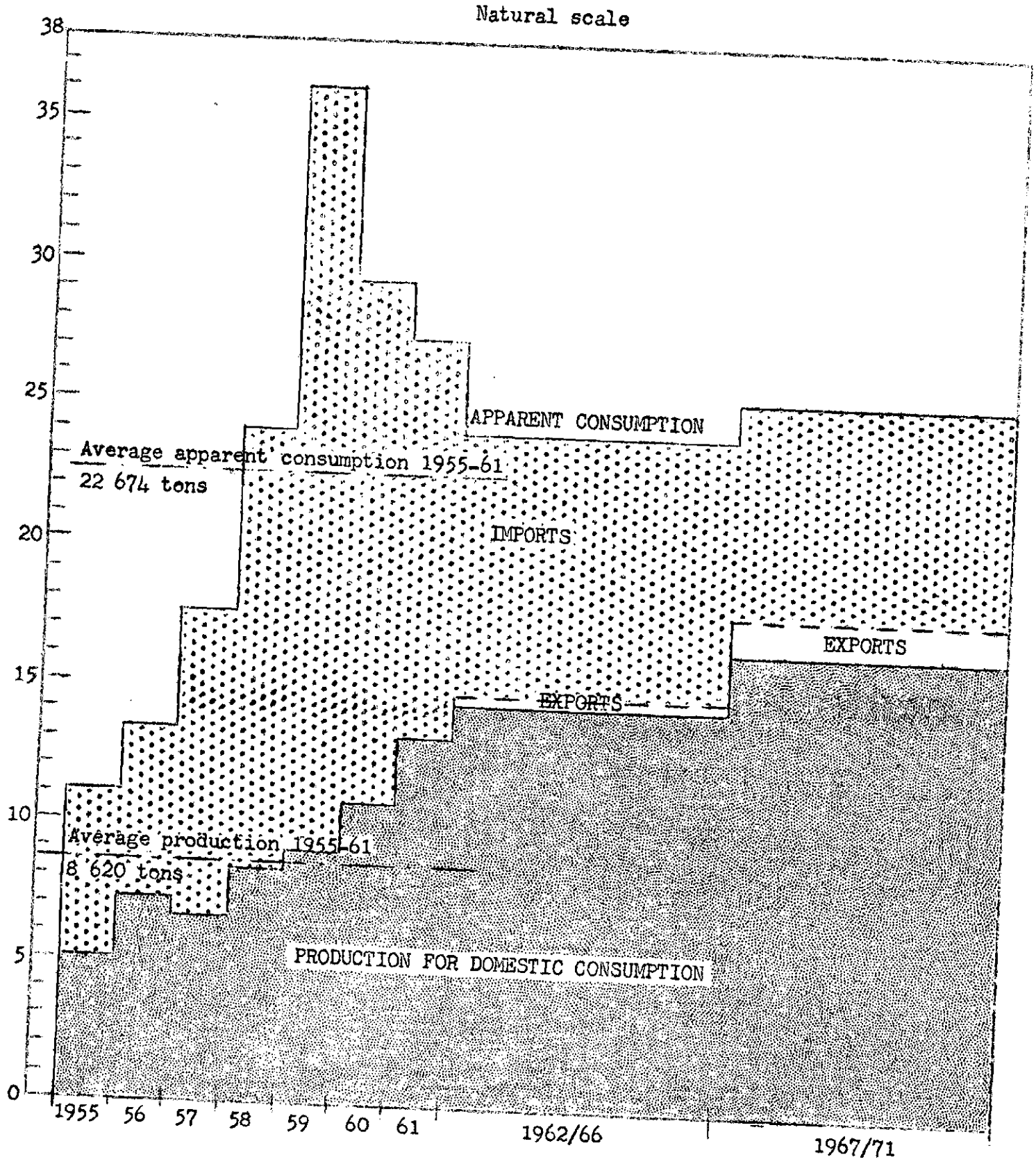
The list of the new types of machine-tools that it would be advisable for Brazil to manufacture during the next ten years was drawn up with reference to two periods, taking into account market requirements themselves and the degree of complexity characterizing the manufacture of the machines in question.

Thus, the machines for the first period correspond to more immediate market requirements, beginning with the lighter and simpler types, while those for the second period, once Brazil's total stock of machine-tools has reached approximately 300 000 units, may better be described as supplementary to the types included in the first group. If this programme is combined with qualitative progress in respect of the machines currently manufactured, by 1970-71 the potential of this sector should be capable of keeping pace with the development of the metal transforming industries in Brazil.

/Figure VI

Figure VI

PRODUCTION, IMPORTS, EXPORTS AND APPARENT CONSUMPTION OF MACHINE-TOOLS
(Thousands of tons per annum)



/Table 43

Table 43

BRAZIL: SUMMARY OF NEW MODELS OF MACHINE-TOOLS THAT SHOULD BE MANUFACTURED IN 1962-71

Type of machine	Number of models			Demand 1961-71 (Units)
	Total	1962-66	1967-71	
Lathes	6	3	3	52 416
Milling machines	7	4	3	11 845
Drilling machines	6	3	3	31 536
Boring machines	1	1	-	1 554
Shapers and planers	5	2	3	11 534
Threading machines	6	4	2	3 233
Broaching machines	-	-	-	383
Gear-cutting machines	2	1	1	1 573
Cutting machines (saws)	-	-	-	12 507
Grinding machines	8	4	4	6 609
Tool-grinding machines	-	-	-	2 742
Total for chip-producing machine-tools	41	22	19	135 932
Presses	Improvement and expansion of operational capacity of machine-tools used in current lines of manufacture			23 735
Forging machines				834
Machines for sheet				8 031
Total for forming machines				32 600
Grand total (including other machines not inventoried)				179 947

/Number of

	Number of models		
	Total	1962-66	1967-71
Lathes			
1. Vertical, diameter 600-750 mm, square or pentagon turret, possibly with side head variant	1	1	-
2. Multiple-tool, independent slides and hydraulic or pneumatic back centre, with possibility of pneumatic or hydraulic chucking. Semi-automatic cycles	2	1	1
3. Single mandrel, hexagon turret, automatic cycle	2	1	1
4. Copying, up to 10 h.p., for operations between centres and chucking	1	-	1
Milling machines			
5. Universal, fully equipped up to Morse cone No. 6	1	1	-
6. Vertical, up to Morse cone No.6	2	1	1
7. Production machine, simplex and duplex types, automatic cycle, spindle heads up to 10 h.p.	4	2	2
8. Cast pedestal type, different capacities up to 10 h.p., multi-mandrel variants, cross-tables, automatic feeds	4	2	2
9. Radial, with arm up to 1 750 mm	2	1	1
Shapers and planers			
10. Hydraulic shaper, 1 000 mm stroke	1	-	1
11. Plane-type milling machine, 1.2 or 3 heads, double housing, width up to 1 200 mm; electromechanical table, and possibility of using grinding heads	2	1	1
12. Vertical, up to 7.5 h.p., with index head and automatic feeds	2	1	1

/Number of

	Number of models		
	Total	1962-66	1967-71
Threading machines			
13. CRI-DAN type	1	1	-
14. Threads made by cold deforming process	2	1	1
15. For internal threads; automatic feeding of parts	2	1	1
16. Threads made by milling	1	1	-
Boring machines			
17. Horizontal type	1	1	-
Gear-cutting machines			
18. Pfauter type, with gear generator, up to module 7	1	1	-
19. Fellows type, up to module 5	1	-	1
Grinding machines			
20. Universal, distance between centres up to 1 500 mm, semi-automatic	2	2	-
21. For internal diameters up to 150 mm	2	1	1
22. For flats, Blanchard type, table up to 800 mm diameter	1	-	1
23. For flats, horizontal spindle, table up to 1 000 mm	1	1	-
24. Production machine, with angle head	1	-	1
25. Centreless type, capacity up to 75 mm	1	-	1
Special machines			
Miscellaneous heads, up to 10 h.p., for setting up special high-output machines			

/To judge

To judge from the rapidity with which new types of machine-tools have been introduced into the domestic market in the course of the last few years, the implementation of the programme outlined would not seem to be impracticable. During the first stage, up to 1966, an average of 4.4 prototypes would be produced yearly, with one project per 25 enterprises on the basis of 110 industrial establishments. In the second period, up to the end of 1971, 3.8 prototypes should be prepared each year, i.e., one new type of machine-tool for every 32 enterprises out of an estimated total of 120 firms of manufacturers.

It must be stressed, however, that since there are certain technical difficulties attendant upon the manufacture of the machine-tools mentioned, which in turn entail the use of suitable machinery that would have to be imported, the execution of the programme will depend partly upon the incentives and facilities with which government agencies are in a position to provide the sector.

2. Share in apparent consumption

In table 44 a tentative attempt has been made to sketch the possible development of the manufacture of machine-tools in 1962-71, on the basis of weight. This outline should be taken as purely illustrative, and, therefore, all due allowance should be made for the difficulty of quantifying the variables involved, especially as regards the average weight of imported and domestically-manufactured machine-tools, and, *ipso facto*, the weight of the machines which will supply the inventory.

The demand projected - 158 864 units - is estimated as equivalent to about 246 230 tons, on the assumption of an average weight similar to that registered in 1955-61. Accordingly, in the five-year period 1967-71, domestic production might supply, on an average, 65 per cent of consumer requirements, once the recommendations relating to the improvement of the machine-tools already manufactured in Brazil were implemented and new models were introduced. This further implies an increase in the average weight of domestically-produced machines amounting to about 300 kg in relation to the corresponding figure for 1955-61. It is also assumed that

/Table 44

Table 44

BRAZIL: APPARENT CONSUMPTION OF MACHINE-TOOLS, 1955-61, 1962-66 AND 1967-71

(Tons)

Period	Total production		Exports			Surplus for domestic consumption			Imports			Apparent consumption	
	Total weight	Annual average	Total weight	Annual average	Percentage a/	Total weight	Annual average	Percentage b/	Total weight	Annual average	Percentage b/	Total weight	Annual average
1955-1961	60 427.1	8 632	85.2	12	0.2	60 341.9	8 620	38	98 377	14 054	62	158 718.9	22 674
1962-1966	73 685	14 737	2 200	440	3.0	71 485	14 297	60	47 655	9 531	40	119 140	23 828
1967-1971	88 810	17 762	6 200	1 240	7.0	82 610	16 522	65	44 480	8 896	35	127 090	25 418

a/ As a percentage of total production.
b/ As a percentage of consumption.

the period 1962-71 will witness a considerable expansion of exports, which in past years have been on a very small scale, despite the fact that the quality of some machines has attained international standards. In the second half of the decade such exports might come to represent about 7 per cent of total production, a percentage which may perhaps be underestimated in view of the possibilities of supplying a substantial proportion of the market in the countries members of the Latin American Free-Trade Association, as well as in other areas, which will be opened up for this branch of industry,

Hence, by 1971 a volume of manufacturing output in the neighbourhood of 20 000 tons may be expected, i.e., 50 per cent more than in 1961. This should suffice to satisfy about 70 per cent of domestic consumption, leaving an exportable balance of approximately 10 per cent.

Given the conditions in which small and medium-scale industries are developing, on the one hand, and, on the other, the fact that many manufacturers devote part of their effort to other sectors of the metal transforming industry, it is almost impossible to determine the exact volume of investment that would be required to implement the development programme outlined, especially as the standard of quality of the end product to be manufactured plays an important part in this connexion.

/The estimate

The estimate formulated below must therefore be accepted with due caution; it is presented with the sole aim of giving some idea of the possible order of magnitude of such investment, in terms of imports of machinery and domestic manufacture of 41 prototypes of new machine-tools.

The heavy machine-tools that would be needed for machining and grinding flats for machine skeletons are estimated at 30-40 in number, and boring and jig boring machines at 40-50, so that under this head, on the basis of f.o.b. prices, investments amounting to approximately 1.7-2.3 million dollars would be required. The smaller machines might vary between 200 and 300 units, equivalent to 2.4-3.6 million dollars. The manufacture of the 41 prototypes of new machine-tools would represent about 2 million dollars, on the assumption that each cost between 40 000 and 50 000 dollars. Thus, the average figure for investment in machinery and projects would work out at about 6.1-7.9 million dollars, although it would be subject to modification according to the quality of the machine-tools to be manufactured. Of basic importance in this respect would be the existence in Brazil of an agency to guide, direct, and give technical assistance to manufacturers, so that this industrial activity might be properly channelled into those lines of manufacture that would enable it to satisfy the ever-increasing demands deriving from the growth of the national inventory of machine-tools, and to take its proper place in the industrial development of Brazil.

3. Concluding remarks

From what has been said in the foregoing chapters, it is clear that during the next ten years the development of the machine-tools industry will have to be directed towards the production of new types of machines and the improvement of some of those currently manufactured rather than instead of confining itself to an increase in annual output tonnages. Thus, the term "development" must be taken to imply a phase of consolidation whereby this activity will be enabled to keep pace in the future with the more and more exigent technological demands of the various branches of the metal transforming industries. Only when this stage is left behind will there be an adequate basis for subsequent production in excess of 20 000 or 30 000 tons per annum.

/To aim

To aim merely at expanding the volume of production would certainly lead, in existing circumstances, to a technical crisis which in the long run would be reflected in a contraction of demand for domestically-manufactured machine-tools. Consequently, this sector will only establish itself on a sound footing - especially where chip-producing machines are concerned - when there is an improvement in the quality and productivity of the machine-tools currently manufactured, such as has already been achieved in the case of the products made by the leading Brazilian manufacturers of lathes and presses.

Hence, the problems relating to higher standards of quality and the study of new manufacturing projects assume more importance than those connected with the expansion of the volume of production, and therefore, if the goal of this consolidatory stage is to be attainable, certain measures calculated to encourage manufacturers to face these greater responsibilities will have to be adopted with some degree of urgency.

Since the Brazilian inventory of machine-tools will increase in 11 years by about 180 000 units, and 50 per cent of these, or perhaps even more, will be absorbed by those of the metal transforming industries which, owing to the very nature of their products, require high-quality machines, it will be necessary for the domestic machine-tools industry as a whole to develop along the lines indicated under the four heads listed below, so that it may secure a larger share in the satisfaction of the demand projected for the forthcoming decade:

(a) The average size of manufacturing establishments should be increased;

(b) The existing machine-tool inventory of the manufacturers themselves should be enlarged and supplemented;

(c) The quality and productivity of some of the machines currently manufactured should be improved;

(d) Forty-one new models of machine-tools for chip-producing operations should be put on the market.

These targets are hardly likely to be reached unless the machine-tools industry is accorded the necessary facilities for solving the technical and financial problems involved in such a development programme. These may be summed up under the following four heads:

/(a) Long-term

(a) Long-term financing for the purchase of heavy machines, to be imported in their entirety;

(b) Medium and short-term financing for the purchase of lighter machines, most of which would also be of foreign origin;

(c) Financing for studies and construction of prototypes;

(d) Establishment of a Brazilian machine-tools institute, organized with a view to its giving technical assistance to manufacturers and in a short space of time becoming an important research centre at a level high enough for it to acquire an international reputation, like similar institutes in other parts of the world.

As regards (a), by heavy machines are to be understood primarily those used for planing, milling and grinding large surfaces and bed rails for those machine skeletons whose weight may amount to several tons. Boring and jig boring machines, which are indispensable for overcoming the difficulties of machining asymmetrical parts, are also included.

The manufacturers' own machine-tool inventory is sadly lacking in such equipment, owing to the difficulties encountered by small and medium-scale enterprises in obtaining these machines, all of which have to be imported and whose price per kilogramme and weight in tons is high, so that long-term financing is required.

The machines referred to under (b) have unit prices more within the Brazilian purchaser's reach, and could be obtained on a basis of medium and short-term financing. They are indispensable additions to the manufacturers' inventory in the interests of the quality of the machine-tools produced. They consist mainly of grinding machines of various types, special threading machines, milling machines and gear-cutting machines, most of which have to be imported.

In connexion with (c), it should be pointed out that for the purpose of producing new models the small and medium-scale manufacturers have no sufficient financial resources at their disposal to face the expenditure involved in the study and construction of prototypes, processes which take from 12 to 36 months. Such costs would also be high in the case of manufacturing under licence. Consequently, one measure that would promote

/the development

the development of the sector by encouraging the introduction of new types of machines would be the formation of a special fund for building these new models, which would have to be applied both for the benefit of domestically-produced prototypes and for the construction of the first unit manufactured under licence. Such financing might be conditional upon the approval of GEIMAPE, with the technical co-operation of a Brazilian machine-tool institute.

The proposal to establish such an institute put forward in paragraph (d), is prompted by the idea that there should be an agency in Brazil which would provide manufacturers with technical assistance to enable them to solve the complex technological problems involved in the manufacture of machine-tools at the more advanced levels, and which, at the same time, would guarantee the development of this important sector, in much the same way as national institutes or university laboratories have done in other countries.

As a large number of the establishments manufacturing machine-tools are concentrated in and around the city of São Paulo, it would be advantageous for the institute in question to operate in the state capital, so that the presence and participation of specialists in this branch of industry, including foreign experts, would also be facilitated.

The functions of the institute may be summed up under five main heads, as follows:

(a) To test machine-tools manufactured in Brazil and issue certificates accordingly. These tests would cover primarily:

(i) Conformity with Schlesinger and Salmon standards;

(ii) Machining, yield, wear-and-tear and vibration (dynamic tests);

(iii) Efficiency of the electrical system;

(iv) Efficiency and yields of hydraulic, pneumatic and combined circuits;

(v) Geometric control and operation of machine-tool parts, such as transmissions, gears, etc.;

(b) To provide, in a consultative capacity, technical assistance in respect of projects for firms needing guidance and lacking technical experts of the requisite calibre. Something has already been said of the shortage

/of indirect

of indirect personnel, and particularly of staff engaged on production engineering, in the small and medium-scale enterprises. Consequently, the construction of new models and the improvement of others will partly depend upon the efficiency with which this aspect of the institute's activities is conducted;

(c) To carry out applied mechanics studies in relation to machine-tools. This would be a form of theoretical and practical research which would call for a specialized laboratory and a small workshop for the purpose of trying out the components of more complex machine-tools. This section would also have to undertake research, study and advisory assistance with respect to types of machines, controls and accessories, selecting from among the several possibilities and alternatives those best adapted to the technical capabilities of the manufacturing establishments and the conditions or methods peculiar to Brazil;

(d) As a logical corollary of the substance of paragraph (a), the institute would seem to require an industrial metrology section, which could easily be created with little additional material. The usefulness of such an undertaking is obvious in view of the close interdependence between the technological progress of machine-tools and working tolerances, and the steady downward trend of the latter. The same applies to the quality of machined surfaces, which, as the result of technical advances, tend to show lower roughness indices;

(e) To give advisory assistance to the appropriate agencies in connexion with the granting of credits to manufacturers for the purchase of production machinery, as well as for the study and construction of new machine-tool prototypes.

By virtue of these five basic fields of activity, a Brazilian machine-tool institute would be in a position to provide the incentive to technical progress which the sector needs if it is to be able to develop on sound lines. Careful study would have to be given at a later stage to the details relating to the institute's organization, budget and juridical structure, and to the other institutional aspects of its operation.

/Annex I

Annex I

CLASSIFICATION OF INDUSTRIES COVERED BY THE INVENTORY

I. Manufacture of metal products, excluding transport machinery and equipment

1. Rolling, wire-drawing and manufacture of metal appliances from rolled or drawn products (rolled, re-rolled and drawn products in basic forms; screws, nuts and rivets; nails, springs and articles made of wire; L.P.G. containers; chains, steel cables, etc.).
2. Stamping and manufacture of containers (containers and miscellaneous articles made of tinplate; watering-cans, buckets, metal tags, buckles, press fasteners, etc.).
3. Light metal work and boilerwork (safes and strongboxes, hinges, locks, padlocks, metal structures, tanks, drums, boilers, cooking-stoves and heaters (non-electric), dome lamps, etc.).
4. Cutlery, manufacture of small arms, hand tools and hardware (saws, knives, penknives, hoes, picks, hammers; revolvers, rifles, clips, keyrings, pins; watch bracelets, lighters, etc.).
5. Processing of miscellaneous metal appliances, not included in the other categories, including enamelling, galvanizing, heat treatment, etc.

II. Manufacture of machinery, excluding electrical machinery

1. Prime movers, motors, equipment for transmissions and ball bearings[1/] (turbines, internal combustion engines, ball bearings, bases, transmission axles, etc.).
2. Machinery, apparatus and equipment for hydraulic, thermal and ventilation plant (hydraulic pumps, compressors, industrial ventilating units, refrigeration equipment, cold-storage plants, machinery for laundries, heating apparatus, etc.).

1/ Enterprises manufacturing engines for passenger cars and lorries are included in the transport sector.

/3. Machine-tools

3. Machine-tools and general industrial equipment (presses, lathes, drilling-machines, saws, shapers and planers; machines for wood manufactures, for the printing, publishing and allied industries, and for the glass, rubber and textile industries; machine parts in general).
4. Machinery and equipment for agriculture and rural industries (ploughs, tractors, hulling machines, mills, spraying apparatus, irrigation equipment, incubators, etc.).
5. Miscellaneous machinery, apparatus and equipment (weighing machines and scales; elevators, travelling cranes, winches, conveyor belts; sewing and embroidering machines, coffee mills, meat slicers, juice extractors; adding and calculating machines, cash registers and typewriters; stapling and punching machines, daters and other machinery and apparatus not classified in the other groups).

III. Manufacture of electrical[2/] and communications machinery, apparatus and appliances

1. Machinery apparatus and appliances for the production, accumulation, transmission and transformation of electric power (motors, generators, transformers, accumulators, batteries; switchboards, switches, fuses, measuring instruments, insulated wire and cable, etc.).
2. Electrical apparatus and appliances (incandescent and luminescent bulbs, heaters, irons, electric fires, cooking-stoves, washing-machines, refrigerators, ventilators, polishers; automatic record players, radio-gramophones; soldering machines, galvanoplasty equipment, etc.).
3. Communications material (radio and television transmitting and receiving sets, telephones, telegraphic equipment, amplifiers, aerials, cinematographic projectors, etc.).

IV. Manufacture of transport material

1. Ship building and repairing.
2. Manufacture of railroad equipment (goods wagons, passenger coaches, axles, wheels, couplings, bogies, brakes, etc.).

2/ Including equipment for motor vehicles.

/3. Motor

3. Motor vehicles (passenger cars, lorries, jeeps, buses, vans, etc., including the manufacture of engines).
4. Spare parts for motor vehicles (radiators, axles, wheels, canvas and metal hoods, pistons, gear-boxes and all other parts or equipment for motor vehicles, including stamped sheet components, but excluding electrical, glass and rubber parts).
5. Trailers and coachwork (coachwork for ambulances, vans, buses, trailers and semi-trailers, etc.).
6. Bicycles and motor cycles (motor scooters, tricycles, motor cycles, bicycles and spare parts for these vehicles).
7. Animal traction vehicles (carts, barrows, carriages and hearses, etc.).