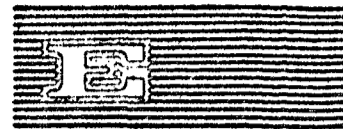


UNITED NATIONS
ECONOMIC
AND
SOCIAL COUNCIL



GENERAL
E/CN.12/920/Add.1
September 1971
ORIGINAL: SPANISH

ECONOMIC COMMISSION FOR LATIN AMERICA

THE TRANSFER OF TECHNICAL KNOW-HOW IN THE
MACHINE-TOOL INDUSTRY IN BRAZIL

PART TWO: THE EXAMPLE OF BRAZIL

prepared by

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Note: This report forms part of a study undertaken by the Economic Commission for Latin America (ECLA), the Interamerican Development Bank (IDB) and the Division of Public Finance and Financial Institutions of the United Nations Department of Economic and Social Affairs on the problems of the transfer of industrial technology in Brazil.

72-10-2578



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Part Two

Chapter I

BASIC DATA ON MANUFACTURERS OF MACHINE TOOLS AND THE METAL-TRANSFORMING SECTOR

(a) Development of the machine-tool industry

Brazil's machine-tool construction sector showed the first signs of life shortly before the Second World War, when it began to produce a few simple units of limited technical and economic significance. Soon after, a more definite development became apparent when a group of about ten small manufacturers became interested; this occurred as a result of the world conflict, which encouraged and practically forced Brazil to develop a maintenance service of its own so as to ensure the continued operation of the country's industry. At first, the manufacture of machine tools, which was a spontaneous offshoot of an industrial sector that was still embryonic and therefore obviously dependent upon a rather weak infrastructure, found itself in a situation that in many ways, mutatis mutandis, resembled that of other countries during the second half of the nineteenth century.

On the other hand, the fact that a sector is late in beginning to organize itself - in this case over a hundred years late - does give it certain undeniable initial advantages that may or may not subsist as time goes on. This brings with it one great convenience, the possibility of ignoring the details of machine design and of merely copying existing and already tested products or using them as the basis for a more simplified version. When the sector began to operate in Brazil, the first task was to choose a few types of machine to be copied, concentrating exclusively on the manufacturing aspect and thus disregarding the accumulation of K.H. about design. Naturally, this simplification of the sector's over-all problem brought some advantages with it, since the successive stages in the

/establishment of

establishment of the sector described in Part One were run through more rapidly. There is also one serious disadvantage to the mere copying of something that already exists, i.e., it delays thorough understanding of the thing that is being copied. In other words it means remaining somewhat apart from the process of invention, which, in the long run, is the only feasible and intelligent solution for a large country. Thus the concept of imitation, adopted by manufacturers themselves, became the hallmark of the sector's growth. There is nothing wrong with this in itself; but something that is worth considering more carefully is the level at which the trend occurred.

Although the import facilities that were granted after the war acted as an incentive for the machine-tool industry by constantly stepping up demand for machine-tools, they also made it more difficult to consolidate recently established innovations; and so some manufacturers lost interest, while those that stood their ground were left with few technological and economic options to choose between: they had either to produce simple low-cost machines for the small and medium-sized users with very little capital, or they had to try to compete, from a position of inferiority, on a world market where demand was, generally speaking, for products of a higher technological level. Obviously, they chose the first solution, and they pursued their objective with considerable vigour, but without much initiative in terms of technological content. Consequently, they did not go on to copy more complicated designs at a somewhat higher technological level, which meant that many of the short-term advantages that would normally have accrued failed to materialize. And once the pattern of copying at a rather low technological level is set, there comes a point when it starts acting as a brake on development - as indeed happened.

Although the 1950s saw a marked increase in the number of small and medium-sized enterprises, there were already signs of the emergence of a large-scale manufacturing industry producing consumer durables and capital

/goods whose

goods whose demand for domestic machine-tools was virtually negligible. As this sector, and particularly the motor-vehicle industry, progressively expanded during the decade, the technological shortcomings of domestic machine-tools, owing precisely to the manner and circumstances in which they had evolved, became increasingly apparent. There can be no doubt at all that, had the sector, in its initial phase - while remaining imitative - aimed at a higher technological level, it would have been in a far better position to keep up with the growth of demand. Notwithstanding certain exceptions, the current situation of the sector is lagging behind the average level of consumption in all areas; more important, the sector does not have the resources, i.e., the necessary K.H., to react spontaneously and independently to changes in consumption patterns which are bound to become more marked as time progresses.

The shortage of supply can be put down to one specific factor, namely, the small average size of manufacturing enterprises, which was due to the fact that, in this field, the simple technologies usually tend to be developed in small workshops. It is also true that, when interest in the sector is aroused under such conditions as those described above, there is little immediate incentive for large-scale enterprises, initiatives come to nothing, and the resulting technical level is as unsatisfactory as the size of the enterprises. It matters little, at this stage whether this is cause or effect; suffice it to emphasize that in every sector, and particularly in that of machine-tools, there should be a certain optimum relationship between the size of the enterprise and the technical level which, save in exceptional circumstances, it should be able to achieve at specific stages of its development. Consequently, the very circumstances that had served initially as a powerful incentive because of the speed with which they developed proved in point of fact to be a brake on technological progress and, in the long run, a definite handicap on utilization of capacity (low productivity). This can clearly be seen from the fact that, quite apart from design K.H., enterprises that are not large enough also lack other forms of K.H., as will be seen from the following section.

/These essentially

These essentially technological considerations lost some of their force, of course, towards the end of the 1950s as a result of the great strides made by the activities employing machine-tools in Brazil and the accompanying boom, which led to a boost in the production of a great variety of goods by every possible means, regardless of cost and of broader considerations such as productivity and sometimes even quality as well. This was undoubtedly a wonderful period, characterized as it was by a rarely equalled vitality and by advantages and handicaps that often went hand in hand. Such then, in broad outline, was the pattern of development of the sector that will now be analysed in greater detail.

(b) Current statistical data for the sector

The first statistical data to be accurately and systematically compiled appeared in an ECLA study published in 1961 ^{1/}. The most important figures for that year can be summarized as follows:

Total number of enterprises operating in the branch	99
Number of enterprises with sales amounting to more than 5 per cent of the total sales of the sector	90
Total number of persons employed	4,780
Average number of persons employed per enterprise (90)	53.1
Value of production, in dollars	26,500,000
Production, in tons	13,250
Production, number of machines	15,517
Average weight of production, in tons per machine	0.854

During 1969 these figures were brought up to date as a result of a further sectoral survey carried out by the Institute for Applied Socio-Economic Research (IPEA) ^{2/}. While the consumer sector has made considerable strides in every respect, supply has failed to keep pace. Thus, in 1968, the figures under the heads listed above were as follows:

^{1/} ECLA, The machine-tools industry in Brazil (E/CN.12/633), November 1962.

^{2/} IPEA, preliminary version, Rio de Janeiro, December 1969.

/Total number

Total number of enterprises operating in the branch	83
Number of enterprises with sales amounting to more than 5 per cent of the total sales of the sector	71
Total number of persons employed	5,661
Average number of persons employed per enterprise (71)	79.7
Value of production, in dollars	28,275,000
Production, in tons	15,113
Production, number of machines	15,059
Average weight of production, in tons per machine	1.030

Though a comparison of the figures for the two years does not altogether reflect the real situation in the sector, it is of some significance, especially when seen in the light of the progress made in the user sector.

This progress was particularly apparent in the motor-vehicle industry and, more generally, in the way mass-production enterprises tended to grow in size. At the same time, there was a reduction in the absolute and relative share of artisan-type enterprises and small industries in the sector. This had a definite impact on the structure of demand, which is already beginning to follow a more comprehensive pattern than in the past in that there is now a demand for a wider range of types and models of machines, for machines with a larger unit weight and more power and a better performance per kilogram, and for a greater number of semi-automatic and automatic, as opposed to all-purpose machines. Some enterprises in the sector did not know how to adapt themselves to the new requirements of demand and others were genuinely incapable of doing so, simply because the sector had developed in such a way that it lacked the necessary entrepreneurial structure (apart of course from a few rare exceptions) and, therefore, also lacked local inventors and innovators, and financial resources. This can clearly be seen from the figures showing the share of the domestic sector in the consumption of machine tools in 1968 ^{3/}.

^{3/} Ibid.

	<u>Percentage</u>
Number of machines	81.0
Weight	52.3
Value	38.4
Exclusively domestic technological category	20.3
Domestic and imported technological category	23.6

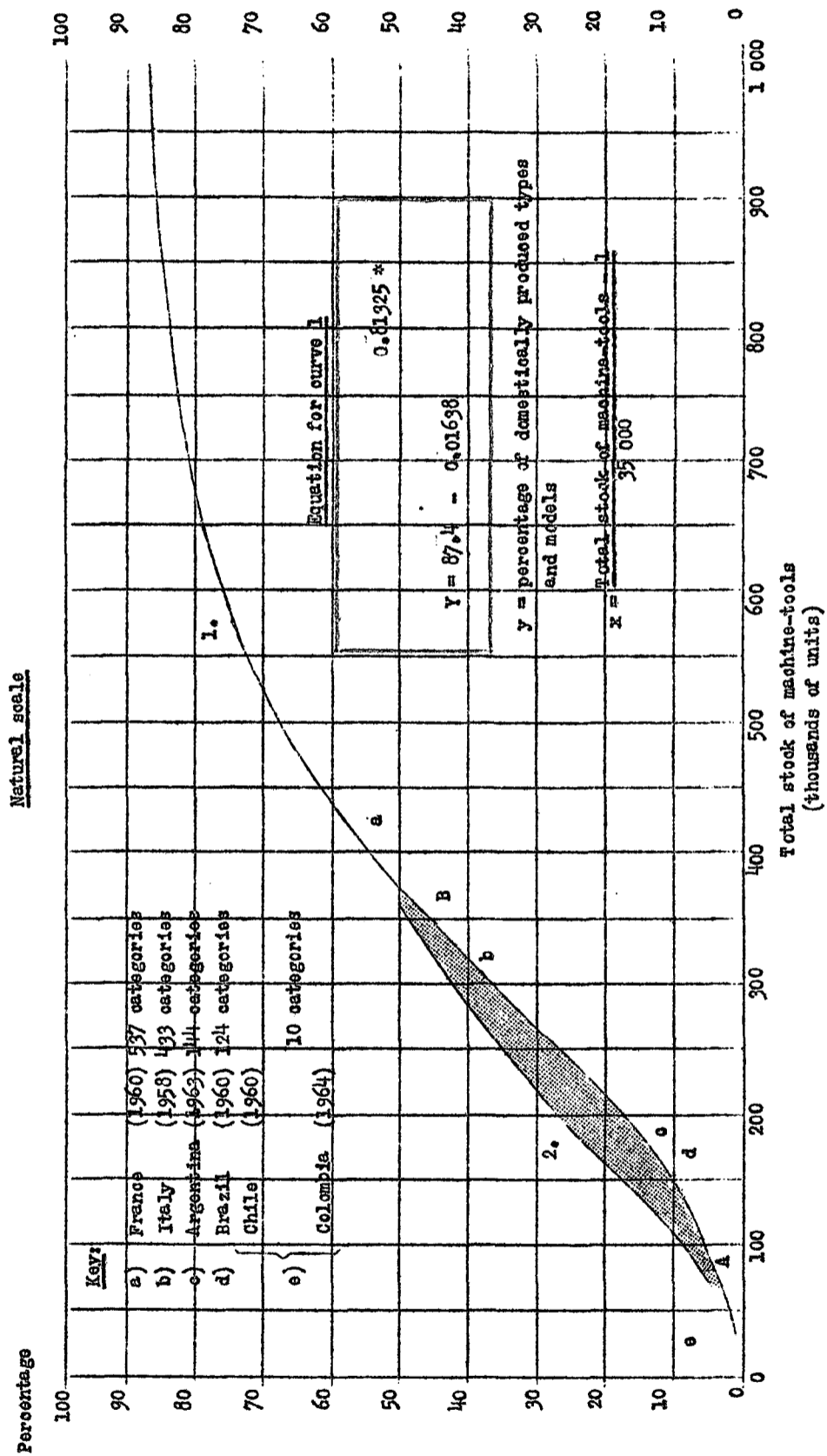
Thus, the average weight of domestic machines added to the total stock in 1968 was 1.03 tons as opposed to 4.00 tons for imported machines; the average value of locally manufactured units was 1,939 dollars as opposed to 13,271 dollars for imports. These figures speak for themselves.

"Technological category" is used here to denote the various types and models of machine tools into which world supply is subdivided in the ECLA document "Criteria y antecedentes para la programación de la industria de máquinas-herramientas" (E/CN.12/L.15), pp. 3 et seq.; this classification, in the revised form used in the recent IPEA analysis, sets the machine-tool universe at 1,024 basic types and models. The general view it provides of the technical situation of the sector clearly indicates a lack of balance between domestic supply and imports, and therefore also in consumption. However, an accurate assessment of their respective positions and the gap between them at any given moment is only one aspect of the analyses that can be carried out, since the extent to which one lags behind the other seems more or less alarming according to whether it relates to a dynamic situation or not. In the present case, the dynamic side is to be found in a marked growth of the machine-tool industries which shows every sign of continuing at this high level.^{4/} In order to simplify matters, the lag in supply could be identified with the variety of technological categories (types and models of machines) produced in the country; according to the ECLA study referred to above, this should follow the trend outlined in figure I of that document, which for convenience's sake is reproduced below. On the basis of curve 1,

^{4/} Comprising the four ISIC divisions 35, 36, 37 and 38, with the addition of metal furniture under division 35 and certain activities from division 39, such as the manufacture of watches and clocks, musical instruments, etc.

/Figure I

Figure I
 RATIO BETWEEN THE TOTAL STOCK OF MACHINE TOOLS AND THE PERCENTAGE OF DOMESTICALLY PRODUCED TYPES AND MODELS



/domestic supply

domestic supply for 1968, expressed in terms of range of technological categories, was only 16 per cent of the machine-tool universe when it could have been around 28 per cent on the basis of the size of the total stock for that year, which consisted of about 264,000 units. Between 1960 and 1968, the aggregate volume of technological types provided by domestic manufacturers did not expand so fast as the total stock. Although the range of technological categories consumed in 1968 was only 36 per cent of the machine-tool universe - which is rather a narrow range in view of the size of the total stock. The share contributed by domestic supply could have been smaller than that suggested by curve 1 - but this does not in any way alter the fact that domestic supply is insufficient.

The foregoing shows that the point has been reached where it is no longer possible to disregard a definite sectoral trend which is bound up with a series of other events which dictate its direction and importance. This suggests that specific measures must be taken to ensure that the technological gap between domestic supply and the machines purchased by local users remains within reasonable bounds; expressed as percentages, these could be somewhat lower than the optimum figures, according to curve 1 by around 5 per cent when the total Brazilian stock is 200,000 units up to a maximum of 15-25 per cent when it reaches the 500,000 level. This would be an absolute minimum; if it fell below this, domestic machine-tool manufacture would be following a most undesirable trend, from the point of view of economic strategy, which would have an adverse effect on the sector's balance-of-payments position and drive too many users to take their custom away from the domestic centres of machine-tool production.

(c) Current statistics for the user sector and projections to 1980

A few data must be provided on the above points so as to give a better idea of the problems facing manufacturers and to provide a frame of reference for other considerations.

/In 1960

In 1960 the metal-transforming sector employed some 350,000 persons using 150,000 machines, the value added of which amounted to 880 million dollars.

The IFEA survey referred to above gives the following up-to-date figures for 1968 (round figures excluding artisan-type industry):

Number of persons employed	547,300
Stock of machine-tools	243,800
Number of persons per machine	2.25
Value added in millions of dollars	2,365.0

It is clear that, in terms of size, the metal-transforming industry is assuming respectable proportions that justify a high-level discussion of the sector and of the subject of this study. This stands out even more clearly from the figures for the industry's estimated growth up to the end of the 1970s. According to the IFEA survey, the projected figures for 1980 are:

Number of persons employed	1,116,000
Stock of machine-tools	513,400
Number of persons per machine	2.17
Value added in millions of dollars	6,692.5

The interesting thing from the point of view of this analysis is to note that the growth of the user between 1960 and 1968 followed the over-all trend that was to be expected; in other words, the average size of the enterprises increased, as did the mass production of many major products and the variety of articles produced. This trend will be even more marked during the 1970s, especially as regards the diversification of production. These elementary but fundamental considerations point to the vitality of the user sector and to the importance of the machine-tool market available to local manufacturers. Attaining the targets contained in the projections would involve spending some 1,160 million dollars in order to cover machine-tool requirements between 1969 and 1980, corresponding to an addition of

/270,000 units

270,000 units with a total weight of 457,000 tons. These figures do not allow for the requirements of artisan-type workers and industries or activities classified as such, which are small in any event. Briefly stated, the user sector has an annual consumption that is now approaching 100 million dollars in value and is expected to rise above that figure before the end of the 1970s.

Once the over-all figures for the user sector have been clearly established, it will be easier to appreciate the responsibilities now facing domestic machine-tool manufacturers in the field of technology and to see why, at this point, the sector cannot afford to lose any more ground or to adopt a mistaken product strategy by isolating itself too much from certain technological innovations now being introduced in the industrialized countries.

Finally, because of the significant level already attained, mention should also be made of the gross domestic product. According to the IPEA projections, the gross domestic product was about 27,900 million dollars in 1968, and should rise to 59,000 million by 1980.

Chapter II

PRESENT STATE OF INTERNAL KNOW-HOW

(a) Size of enterprises in 1968

The survey of the situation in 1968 revealed no great changes in relation to the structure in 1960. There was, in fact, some progress in average terms, but it was still insufficient and less than the recommendable minimum. The eighty-three machine-tool enterprises were distributed as follows, according to their activity in the sector:

Table 1
ACTIVITY OF ENTERPRISES IN THE MACHINE-TOOL SECTOR, 1968

Percentage of total sales of enterprises	Number of enterprises
100	40
75 to 99	6
50 to 74	8
5 to 49	17
Total	71
Under 5	9
Special cases where activity is less than 5 per cent, but the machine-tool section is separate from the rest of the enterprise	3
Total	<u>83</u>

Source: IPEA, preliminary version, Rio de Janeiro, December 1969.

If the classification by size is limited to enterprises devoting more than 5 per cent of their activities to the machine-tool sector, the following structure is obtained.

/Table 2

Table 2
 SIZE OF ENTERPRISES AND NUMBER OF PERSONS EMPLOYED, 1968

<u>Persons employed</u>	<u>Number of enterprises</u>	
	Actual size (staff employed in machine- tool manufacture and other activities)	Equivalent size in the sector (staff employed exclu- sively in machine-tool manufacture)
Up to 9	6	13
10 to 24	15	19
25 to 49	16	14
50 to 99	13	12
100 to 249	14	9
250 to 499	2	3
500 to 990	2	-
Over 1,000	3	1
<u>Total</u>	<u>71</u>	<u>71</u>

Source: IPEA, preliminary version, Rio de Janeiro, December 1969.

Since some of the manufacturers are engaged to a widely varying extent in industrial activities other than the production of machine-tools, it is necessary, in order to obtain a clearer idea of the sector's actual potential, to take into account the personnel engaged exclusively in the manufacture of machine-tools, represented in this case by the second column in table 2. Obviously 58 enterprises, or 82 per cent of the total, are not large enough for these activities, since they employ under 100 persons. Thus, most of the technical responsibility falls on the 9 medium-sized and 4 large-scale enterprises. This category would actually have to include the three special cases of enterprises whose activity is less than 5 per cent but which operate a well-organized and well-equipped section separately from the rest of their production activities.

It is not difficult to foresee the consequences of such a structure, particularly as the users have set themselves ambitious industrial targets, many of them international in scope.

/A logical

A logical result of the inadequate size of most of the 71 enterprises is that barely 21 employ engineers and draughtsmen, 3 have engineers but no draughtsmen, 19 have draughtsmen but no engineers, and 28 employ neither.

In 1968 the average distribution of direct and indirect personnel was 69 and 31 per cent respectively, but the proportions varied widely according to the size of the establishment: 64 and 36 per cent for those employing more than 250 persons, and 80 and 20 per cent for those employing under 50. In all but a few enterprises, the indirect personnel is insufficient for this sector's requirements.

Some observations on the production facilities available to manufacturers complete the preliminary information for developing this theme. Here too a clear distinction can be made between major industries and the rest. The former, headed by ROMI S.A., have all, or nearly all, the necessary production facilities, as shown by the high standard of their products. The rest lack the essential facilities to manufacture products of sufficiently good quality within a reasonable time. This difficulty is partly overcome by simplifying the design of the machines; but if these producers aspire to produce more complex designs, there is bound to be an obvious disproportion and some mistakes.

(b) The level reached by each type of internal K.H.

A detailed picture of the machine-tool sector can now be presented on the basis of the classification of the seventeen types of internal K.H. described in Part One and the comprehensive data obtained from all the manufacturers.

In view of the marked differences in the situations according to plant size, in the case of most of the concepts and observations relating to each type of K.H. the enterprises must be divided into those employing over 100 persons, the three special cases mentioned above, and some of the remaining smaller establishments. Meanwhile, it should be borne in mind that not all the small enterprises fall outside the sphere of technical responsibility because of the nature of the product they manufacture, particularly in the case of forming machines. Depending on the kind of observation made, therefore, account will also be taken of one or two smaller enterprises in order to broaden the information base. On the other hand, it would be best

/to exclude

to exclude ROMI, which has departments applying nearly all the different types of K.H., because of its size (over 1,500 workers), since its inclusion would distort the real average situation. This could be avoided only if ROMI were manufacturing a very wide range of products, which is not the case since it specializes in engine and turret lathes, of which it is also an important traditional exporter.

In line with the system of ratings adopted in Part One, the ratings given to the different types of K.H. in Brazil will show to what extent they fall below a normal up-to-date reference rating equal to 100.

On this basis, the position with regard to the seventeen types of K.H. can be summarized as follows:

1. Selection, definition and general conception of the product

Although the machine-tool sector is still in process of formation, with an annual output of less than 20,000 tons, there is no longer any justification for empirical and random decisions that may disregard certain elementary rules for adapting the products to real market conditions. Although it is true that no major research is necessary to establish the types or models of machines best suited to small-scale industry, this is not so for bigger industries which generally call for different technological solutions at their different levels, either because of their essential needs or because of the price they are able to pay.

The excessive number of enterprises manufacturing the same product is a clear indication of the lack of this type of K.H. and of the persistence of the unregulated production which began in the 1950s; although production is now becoming more normal, it is still out of proportion to the size of the market. These enterprises still have no properly classified technical and economic information on the user sector, which might have been obtained at least through such normal channels as their sales departments, and from documentation of a more general type such as that issued by ECLA.

As regards production strategy, Brazilian manufacturers cannot get away from the "conventional engine lathe", which for two decades sold better than any other machine on the domestic market, with the

/result that

result that approximately 30 per cent of Brazil's stock of machine tools consisted of lathes. There was not much need to map out a strategy for the product during that period, but with the gradual contraction of the market for conventional machines it became necessary to offer a wider range of types. The sector's reaction has been slow, however, and the choice of new models or types of machines at a given technological and price level has now become an imperative need which manufacturers can no longer refuse to recognize.

The knowledge of this type of K.H. possessed by technical departments and management is therefore insufficient, even in the best run plants, and it is obviously lacking altogether in the small establishments. The highest rating that could be given to it in the circumstances is 25.

2. Study and design of the product

As a natural result of the way in which manufacturing began in this sector - by imitating, copying and simplifying already existing foreign models - and because of the small scale of the operations carried on by the manufacturers, who did not keep up with the times, the initial energy and momentum gradually gave way to an evident impoverishment of the type of K.H. which is most characteristic of the sector, an impoverishment that was very widespread because of the wide range of technology offered. Unfortunately, the sector's backwardness as regards this important type of K.H. is now a serious handicap, so much so that it makes some of the experience gained in manufacturing these products almost valueless. Thus a kind of "project inferiority complex" has been created, since, because of the structure of the domestic market, a leap forward is now required to update this basic type of K.H. Such a leap is not impossible in itself, but it is held back by the limited size of most establishments. The need to maintain a reasonable team of project staff - indirect workers - cannot be met in plants which are too small in size. Nevertheless there are the beginnings of a reaction and signs of a more enterprising attitude which will probably become more marked in time. Unless more effective measures are taken to protect the sector, including action by the recently established Brazilian Machine-Tool Institute, the

/necessary K.H.

necessary K.H. will be lacking for the design of new and more complex types of models, which would give rise to other problems whose seriousness would be in direct proportion to the technological level aimed at. The only way in which the sector can keep the staff of technical draughtsmen and designers that are already required considering the total labour force and the volume of production is to reduce the number of enterprises through association, mergers or complementarity agreements, which would increase the size of each production unit.

In this case, the rating is more favourable for manufacturers of forming machines than for manufacturers of chip-producing machines, i.e., about 55 on the average. This is about the stage in project conception reached during the First World War, which means a lag of half a century. A handful of enterprises that may happen to be in a better position cannot alter the situation since in assigning this rating account is implicitly taken not only of what is being done but also of the sector's backwardness in terms of range of K.H., i.e., of the machines that were not designed and should already have been manufactured locally. This is the context in which study and design should be evaluated, since considerations of its scope or coverage must also be borne in mind.

If the situation were different, that is, if apart from the technical level of the products actually manufactured the supply were of a technological range similar to that indicated in figure I, the rating of this type of K.H. would be about 65. Speculating along these lines a rating of 65 would therefore indicate how far project conception and design is below the world technological level (but of course only in the type of K.H. which Brazil ought to develop at the present stage in the growth of its machine-tool industry, a concept which tacitly includes the consumption-import angle). The fact that the range of models offered is too limited widens the gap, which reduces the rating to 55.

This concept is also valid for the other types of K.H., and it has been described here in order to make clear the criteria that are being applied in the particular case of Brazil.

/In any

In any event, it is undoubtedly a much more complex matter to assign some of the ratings in the internal sector than in the universe, and it may give rise to controversy; the ratings are nevertheless assigned according to certain logical and historical criteria which, looked as a whole, will probably not be too unrealistic.

3. Testing

As a logical outcome of the specific situation with regard to conception and design of K.H. on the one hand, and the over-all situation of the sector on the other, there are no proper test-shops in enterprises. Since it is impossible for the enterprises themselves to bridge this gap in all types of K.H., testing should be done by some agency outside the factory, particularly a specialized institute such as the Brazilian Machine-Tool Institute. This Institute was established at the end of 1968 under the sponsorship of the Technological Research Institute (Instituto de Pesquisa Tecnológica - IPT) of the Universidade de São Paulo. It started to operate in 1969, when a plan of action was drawn up with three separate aims: first, to help machine-tool manufacturers to improve the technical standard of their products, and to provide them with assistance in the development of new types and models of machine tools, thus obviating the need for each enterprise to install its own testing department; secondly, to provide specialized training for engineers in this field; and thirdly, to carry out its own research on the subject, as part of a specific programme, which would have longer-term practical results for the sector. Thus, as this Institute exists, the rating is not so low. In view of its serious aims and the quality of its equipment and facilities, it undoubtedly belongs to the sector which thus gets a rating of 50 for this type of K.H.

4. Internal technical standards

Since this type of K.H. is a direct reflection of conception and design K.H. and its past evolution, it is essentially in process of formation. It is currently being given importance and may therefore develop rapidly; but since it started late, at the moment it is incomplete and even over-simple. It cannot therefore be given a rating of more than 25 compared with the normal 100.

/5. Specification of

5. Specification of the services of the subcontractors and of the parts and components supplied by third parties

Since the technological level of the sector is still so low, it is not surprising that this type of K.H., which is clearly defined and concentrated at more advanced stages, is applied by various scattered people, each of whom performs several different functions. Moreover, machine-tool manufacturers as a whole have not become a commercial or technical attraction to suppliers, for two main reasons: those with a higher level of K.H. - which include foreign firms - often have much larger plants than the machine-tool producers themselves and they contrive to consolidate production lines of the most saleable components in common use and pay scant attention to the sector's requirements. When they do give them any attention, they try to impose their own standards, departing as little as possible from the normal average model. On the other hand, manufacturers have not organized themselves to defend well-defined standards and concepts, either because they are not aware of the problems or because of the disproportionate cost of certain quality standards and specifications.

In this respect, small-scale manufacturers, who are not subject to any quality standards or requirements for supplies from third parties, have seriously affected the interests of the major Brazilian producers by delaying an advantageous inter-action between suppliers and manufacturers; however, inasmuch as a distinction is made between serious producers and manufacturers who merely improvise, the situation is bound to be regularized. Thus the lag in this type of K.H. is not fundamental and can certainly be remedied, particularly when the Machine-Tool Institute can produce unchallengeable arguments, proofs and certificates in support of the requirements of manufacturers, who will then be better supplied. This type of K.H. will then take on its own clearly-defined characteristics, but until then it cannot be assigned a rating of more than 25.

/6. Design of

6. Design of jigs, frames and supplementary manufacturing equipment, including tools

Various circumstances led the sector to improvise in this area, even though the scale of the production series of some models of machines would have justified a different course of action. The design, conception and use of this type of K.H. are not representative of what manufacturers are capable of doing. There are, however, some extenuating circumstances. First, manufacturers have not thought it advisable to continue producing certain models, either because of reduced customs protection or because of the modifications constantly introduced in them since they were launched on the domestic market. Secondly, the unsuitable or incomplete equipment used to manufacture these models has prevented their being sold on a wider scale. This shows that the equipment observed on visits to plants falls somewhat short of what the most important manufacturers actually intended, so that they have a better conception and grasp of the problem than would appear from the practical applications of their K.H. It should also be noted that since the sector's self-financing capacity is only modest, manufacturers have preferred to concentrate the available resources on other items. Thus, experience in the use of this type of K.H. has in general been confined to the preparation of auxiliary equipment for the manufacture of smaller and lighter parts and to the development of a simpler range of tools, more complex operations being postponed until a later stage. Therefore, the rating of this type of K.H. cannot be more than 30.

7. Methods, instruction and time-cards

The backwardness of this type of K.H. reflects the general situation of most manufacturing enterprises in Brazil. No further comment is therefore necessary, since organization in this area is along much the same lines as it was before this type of K.H. was introduced and adapted by machine-tool manufacturers. Its rating is therefore 0.

8. Planning of production, work orders and progress checks. Flow of production

Logically enough, the manufacturers' position in this respect partly reflects the lack of type 7 K.H., although the imperative need for a minimum amount of co-ordination resulted in the formation of a type of K.H. which makes it possible to control, efficiently or otherwise,

/the most

the most important aspects of macro-planning. The K.H. applied and results obtained are therefore no more than what was normal at the beginning of the 1930s, so that its rating would be around 35.

9. Purchasing

The inefficiency of the two previous types of K.H. ultimately adds to the burden of the purchasing departments. Although this is a simple type of K.H. as the range of problems encountered is not very great, production is not particularly complex and standards are simple, the buying departments are often hampered by the suppliers' lack of proper organization, whether the suppliers are salesmen or industries. Dates for the provision of services and delivery of components are not always punctually complied with, and there are no regular stocks of imported products, such as bearings. This leads to situations where manufacturers tend to improvise, with the result that the final cost of the products is higher and there is delay in delivering them to the user.

By way of enlarging on the comments on the last three types of K.H., which have several features in common, it may be said that they could not be introduced into an enterprise independently of the context of the whole metal-transforming sector to which they apply. It would therefore be useless to plan the introduction of these types of internal K.H. at a very advanced level if the K.H. of the supplying enterprises continues to be at a low level.

These are undoubtedly perfectly valid extenuating circumstances, but they indicate that the general level of the organization of Brazil's industry is not very good, or rather is extremely uneven. This is understandable since Brazil's metal-transforming industry is comparatively new, but it is none the less an obstacle to enterprises which rely on third parties for so many of the items they need, as the machine-tool sector does.

In view of the foregoing considerations, a rating of 65 may be assigned to this type of K.H.

/10. Production

10. Production, selection of production equipment, lay-out

From an over-all standpoint, the operational efficiency and capacity of this type of K.H. are similar to those found in the developed countries about 1930. This does not necessarily mean that the equipment itself is so out of date, but that the ways in which it is used, its restricted range of models, the techniques employed to obtain large flat surfaces or cylindrical surfaces with small tolerances in castings, the haphazard lay-outs, and a certain amount of improvisation in operations with delicate tools, so that manual and other adjustments are needed afterwards are out of date and, in fact, typical of that period. With the expansion of the market and a clearer definition of the conception and design types of K.H., the type discussed here could be brought up to date virtually in a decade. It should therefore be given a rating of 70, which is quite high considering past trends.

11. Intermediate checks on production and commercial parts

The difficulties involved in producing machines that conform, for instance to the Schlesinger standards, are only too well known to Brazilian manufacturers, who sometimes have to pay dear for them in working time and adjustments.

This means that they have not yet attained complete mastery of all phases and aspects of production, including labour, throughout the manufacturing process, with the result that when the machines are given their first check after assembly it cannot be said that the majority meet the standards, as they should almost automatically.

Intermediate checks are carried out somewhat systematically and according to no fixed pattern, as is shown by the fact that more minute measurements may be adopted for one series than for another. It is only fair to say that an extenuating circumstance here is the lack of homogeneity in the raw materials, semi-processed products, etc. In any event, the method normally used is to send the parts to a separate central control section, where all or most of them are checked and where there is usually no air-conditioning.

/Generally speaking

Generally speaking, only some of the material from the suppliers is checked, whether it be raw materials or simple or complex commercial parts. This is easy to understand since the standards which the material should meet in order to be accepted are as yet few and far between or conspicuous by their absence.

What happens in practice is that, in the case of some materials, the manufacturer is not always in a position to choose the best supplier for want of competition in specialized items, and he is forced to accept whatever is available. An over-all analysis shows that the results obtained by the manufacturer by applying this type of K.H. are not so good as might be expected judging from his background and training.

In view of the fact that enterprises can now supplement their own resources by using specialized equipment placed at their disposal by the Brazilian Machine-Tool Institute, there has been an improvement in this type of K.H., which can be given a rating of 70.

12. Assembly, painting, test-running and checking of the finished product

On the whole, the assembly sections of the sector are at something of a disadvantage as regards lay-out, organization, space, premises and equipment. Thus the different stages of assembly, checking and test-running are sometimes mixed up or reflect a number of limitations as indicated above, some of which will gradually be overcome as the size and sales of machine-tool companies increase. There are not many special assembly units, or places for running-in or testing parts of machines, which in a sense is the result of the limited range of techniques and the lack of complexity of the products. On the other hand, the care taken in the final assembly is reasonable but time-consuming, owing to the excessive number of adjustments, which the section still undertakes to bring the product into line with Schlesinger and/or other standards. Manufacturers are constantly faced with the problems of a big labour turn-over and the training of skilled manpower. This type of K.H. cannot, therefore, be given a rating of more than 70.

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/13. Industrial

13. Industrial accounting, production costs

Acceptable progress has been made recently in over-all terms, which is an important step forward. The K.H. in this branch is quite out of date, however, as regards the details on which to base a series of critical analyses of the efficiency of the various processes or working sections for each individual product. Over-all accounting is generally adopted, partly because of the limitations of the preceding types of K.H., particularly 7 and 8, and partly because of the reluctance of manufacturers of capital goods to adopt post-war administrative techniques, which are considered too expensive in comparison with a small volume of sales. While this may be true, obviously it is always possible to find less costly compromise solutions, which would at least indicate any problem that needs considering and the general trend. If this type of K.H. is not developed, the manufacturer will find it difficult to know when to modernize his sections, replace his production equipment, staff, etc., and to set realistic goals for the expansion of his firm. Therefore, little progress has been made with this type of K.H. and there is little to say in its favour, so that it can be given only a lowish rating - not more than 50.

Lastly, it must be emphasized that the present products are not very complex, which means that the K.H. does not have to be very complex either, but it would be asking for trouble to attempt to manufacture more sophisticated products and still use the same accounting procedures as at present.

14. Commercial and technical sales organization

In the comments on this subject a somewhat unusual fact cannot be overlooked: the increasing scatter of consumer centres over such an extensive area as Brazil. Although nearly 75 per cent of the production of the metal-transforming industry, and therefore of the consumption of machine tools is concentrated in the State of São Paulo, other centres are constantly emerging or are slowly but steadily growing; and this is making contact between machine-tool manufacturers and users increasingly difficult. For example, it is quite usual for a manufacturer in or near São Paulo to have to maintain relations with
/customers in

customers in Porto Alegre to the south and in the new industrial areas of the North-east region, which are nearly 4,000 kilometres apart; and between the two, there are a great many consumer areas of differing size which, taken as a whole, are quite important. In the circumstances, the obstacles facing this type of K.H. are clearly far from inconsiderable, and are indeed somewhat out of proportion to the actual size of the industry.

The K.H. used for sales organization is quite obsolete; it might be acceptable for a market covering the State of São Paulo alone, but it is inadequate for the coverage of all the consumer centres; that is to say, individual enterprises have neither the means nor the ideas that would enable them to deal with all possible contacts and sales throughout the country. This type of K.H. is misapplied, so that it cannot provide any effective and continuing guidance for management and better production planning. A fuller knowledge of the facts, together with an essentially dynamic approach, should already have convinced the major enterprises considered in this study that it is imperative to organize a sales pool along the lines followed by manufacturers in other and even much smaller countries, as the only way to reach more users, standardize supply conditions, improve the technical approach to consumers (for which expert salesmen would have to be recruited) - in a word, to provide better service without additional cost to the customer. No firm could possibly do all this on its own, for the cost would be prohibitive. As can be seen, the outlook is by no means bright, since the outdated techniques - similar to those of the 1920s - that are applied produce even more negative effects than usual in the Brazilian setting.

A rating of not more than 50 must therefore be assigned to this type of K.H.

15. Advertising, exhibitions, etc.

Because the budget for these activities is so small, they are anything but thriving. Thus the sector has no specific K.H. of this type since it is split up among several persons, including the sales personnel. Generally speaking, the technical literature and the

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/reference material

reference material on productivity are neither plentiful nor attractively presented. All the K.H. on this subject has a rather elementary psychological approach, and steps should be taken to improve it in the near future, but without spending a disproportionate amount of the companies' resources. The rating for this type of K.H. is 50 also.

16. Technical assistance to purchasers

The same problems as those arising in connexion with K.H. 14 are found here. Nevertheless, an effort is being made to fulfil this difficult function as efficiently as possible. With the constant improvements in air and land transport and telecommunications, emergency technical assistance can now be provided under more favourable conditions than even in the recent past. Obviously, both regular and emergency services would be greatly facilitated by a pool-type sales organization, which would have the additional advantage of reducing costs. In the light of the efforts made and the extenuating circumstances applicable here, a rating of 70 may be given to the level of activity in this area.

17. Business management

Although, as the above ratings of the various types of K.H. show, the sector in general is not very up to date, it has been quite a struggle to attain the present level. For the leading industries, the past decade represents what may be the most critical period in their history; this contrasts with the position of the smaller enterprises, which, with few exceptions, had a fairly easy start but are now at a disadvantage and unable to cope with the complexities of the problems they have to face.

Thus, instead of being an all-embracing management science, this type of K.H. has taken on the characteristics which were of prime importance during the consolidation period, i.e., the ability, intelligence and will to achieve a minimum plant size together with a certain industrial prestige. From this standpoint, the bases for this type of K.H. can be considered to have been properly laid; but not soundly enough, considering that the level of technology in the sector as a whole is below that required by present-day users. This calls for the following comment: either there could have been more of the developed industries, or these industries might have attained a larger size, or, lastly, they might have been both more numerous and larger.

/If in

If in terms of technological range - which includes more complex types and models than those currently manufactured - supply fell short of requirements, this in fact means that for one reason or another a force was lacking in the sector. In other words, this type of K.H. may be considered to be incomplete, either because it is not sufficiently widespread or because manufacturers have been unable to go beyond the minimum size adopted in the consolidation stage, the first factor being the more probable of the two.

It is therefore impossible to evaluate this type of K.H. on the basis of only the best examples of industrial establishments. As was indicated in connexion with study and design K.H., account must also be taken of the sector's out-of-date technological range, even though this may seem a little severe. Moreover, it would not do to overlook some indirect factors connected with customs and sectoral policy which have discouraged the channelling of a larger volume of human and financial resources into the manufacture of machine tools.

Giving the various direct and indirect factors involved in this complex K.H. their due weight, as far as possible, 55 seems a reasonable rating.

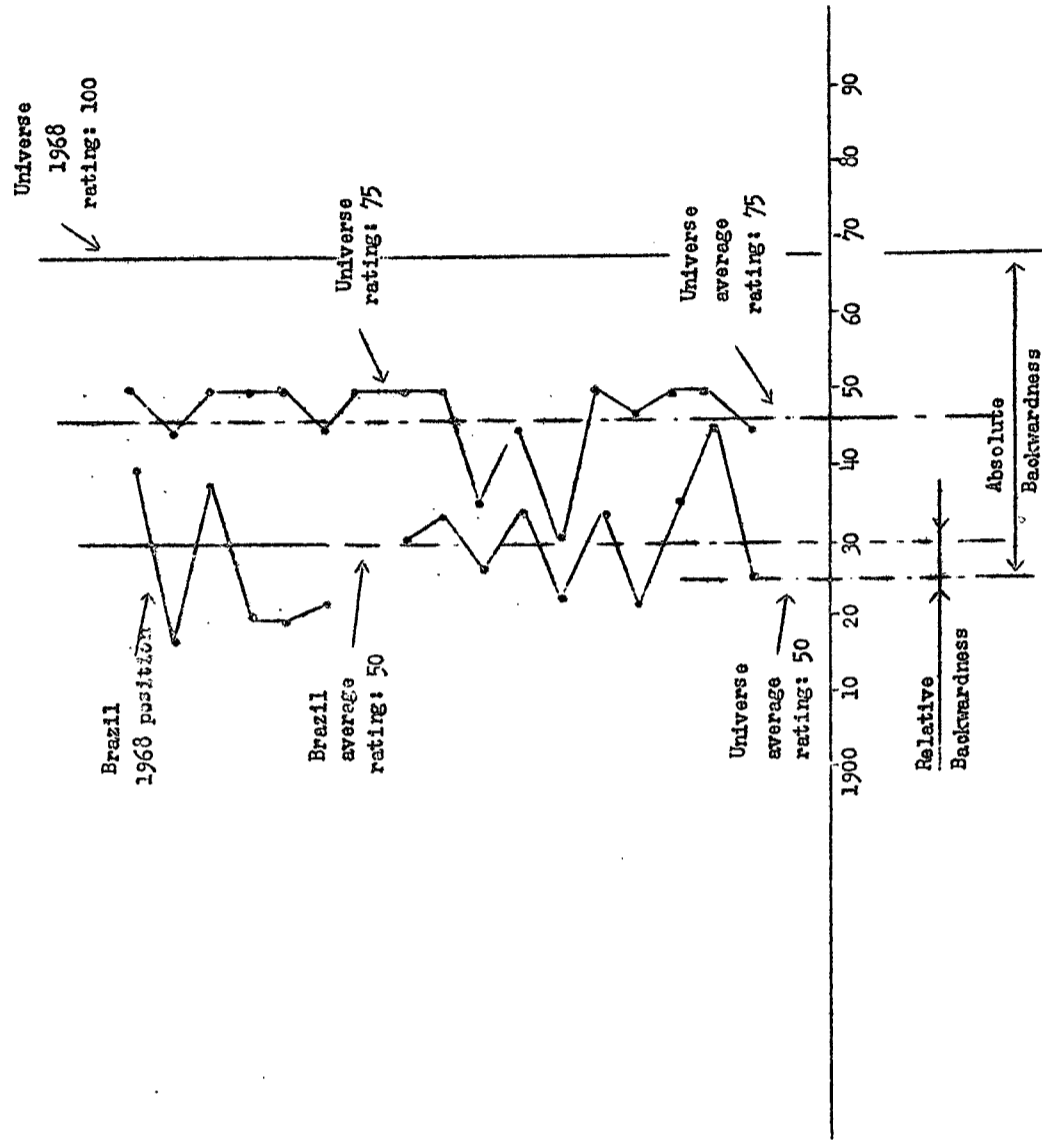
From the individual assessments of the seventeen types of internal K.H. it would seem that this sector is nearly forty years out of date in the way it operates and the K.H. it applies. Figure II shows the results of the research, and table 3 the ratings and the years to which they correspond.

Even though this conclusion may seem surprisingly pessimistic, it is not really so looked at in a historical context. In fact, if it is considered that the machine-tool industry made its first timid appearance in Brazil just before the Second World War - 1936 for calculation purposes - it is easy to see that it took only thirty-two years to reach an average rating of 50 for sixteen out of the seventeen types of internal K.H. listed above, while the universe took approximately 185 years (1740-1925) to reach the same level. This means that when the industry was established advantage was taken of past K.H., which was absorbed in much less time than it had actually taken to develop since its first appearance. The 32/185 ratio is therefore undoubtedly a credit to the Brazilian industry, since it reached

/Figure II

Figure II

BRAZIL: POSITION OF INTERNAL KNOW-HOW, 1968



1. Selection of the product
2. Study and design of the product
3. Testing
4. Standards
5. Services of subcontractors
6. Indirect manufacturing equipment
7. Method
8. Planning
9. Purchasing
10. Production
11. Intermediate checks
12. Assembly
13. Costs
14. Sales
15. Advertising and exhibitions
16. Assistance to purchasers
17. Business management

/Table 3

Table 3
BRAZIL: LEVELS REACHED BY INTERNAL KNOW-HOW, 1968

Types of K.H.	Rating	Year ^{a/}
1	25	1940
2	55	1917
3	50	1938
4	25	1920
5	25	1920
6	30	1922
7	-	-
8	35	1931
9	65	1934
10	70	1927
11	70	1935
12	70	1923
13	50	1935
14	50	1922
15	50	1935
16	70	1948
17	55	1925
Average	50	1930

^{a/} Based on table 3 of Part One, with lineal extrapolation.

/a rating

a rating of 50 over a period which was 5.8 times shorter than that of the universe, a conclusion which calls for discussion.

Without going deeply into a question which is outside the scope of the present study, everything seems to point to the fact that, on the basis of the reasoning set forth in the present chapter and in the introductory discussion in Part One, the idea that the gap between developed and developing countries is steadily widening, which has been supported by a chorus of writers, is a somewhat arbitrary contention, or at any rate too sweeping a generalization. It is true that big countries with large populations, and great drive and vision, are more likely than others to show dynamic trends and a certain flexibility in many sectors of activity; but this prerogative is not theirs alone. The subject dealt with here may be taken as a valid example; at least there is no distortion due to preconceived ideas either for or against.

A fact to be borne in mind in this case, however, is that the machine-tool sector has taken a very long time to develop and, therefore, it is particularly useful in showing that when the same process is repeated in countries where the industry is new, it may develop, at any rate at the start, much more rapidly than it has elsewhere in the past. Not all sectors take so long to emerge. Nevertheless, without further speculation, it may be affirmed that a number of sectors are developing at an accelerated pace compared with the past, both spontaneously and as a result of deliberate promotion measures (government development programmes), although their growth indexes may be lower than that calculated in this instance.

To return to the question of rating, the average of 50 corresponds to a year (1930) which is also average in the case of sixteen out of the seventeen types of internal K.H. (see table 3). This fact would appear to be of considerable practical interest, since it would suggest that the sector was five years (slightly more in fact, since one type of K.H. is not included in the calculation) behind what it should be; the universe reached a rating of 50 in 1925 or even earlier (see figure II). The difference then should indicate how backward the Brazilian sector is compared with the universe, as it does. Indeed, the figure is surprisingly accurate since it points to a backwardness which bears a direct relation to the

/technological recommendations

technological recommendations (including recommendations as to the range of products) contained in ECLA's 1961 study (E/CN.12/633) which have still not been applied. If they had been, the over-all picture would indicate that the sector was backward in absolute terms, in relation to the different types of K.H. applied in the universe, but would not reveal any relative lag. Finally, then, it would be advisable for this gap to be closed during the 1970s; but the sector must not only catch up, it must also develop at the normal rate for the decade if, by 1980, it is to be equal to the important role it will be called upon to play in the Brazilian economy. Though this means a considerable effort, it should be perfectly feasible in practice. It can to some extent be measured, since on average the rating of the general level of K.H. in the machine-tool sector moved up from 50 to 75 in only 21 years (1925-1946). Disregarding the fact that it was partly owing to the war that so much progress was made in so short a time, the sector will have to reach a rating of 62 at least by 1980 if it is to maintain its particular rate of development. The outstanding feature of the sector in the 1970s then should be the wiping out of its relative backwardness, while from 1980 onwards it ought theoretically to be able to continue developing until it reaches a position where it is relatively ahead.

(c) Internal availability of external K.H.

Unlike the foregoing, the following comments do not refer to each kind of K.H. separately, as the range of K.H. available within the country is still too limited for there to be any need to deal with each type separately. An effort will however be made to provide some indication of the levels that have been reached by the different types.

Since the original establishment and later growth of industrial activities in Brazil's metal-transforming sector, the infrastructure, and all that goes with it, has always been one of the most critical areas, whether as regards semi-manufactures and raw materials or intermediate capital goods, from simple one-piece parts to complex groups, subgroups, instruments, and so on. This can be seen clearly enough, since the question here is one of specialization - sometimes involving an intensive use of capital and engineering skill - which only receives its major boost when the market reaches a certain size, i.e., when the range of products manufactured by the machine-tool industries, and especially the large family of final capital goods, has elicited a reasonable demand.

/The first

The first sign of vitality in the manufacture of intermediate goods was closely identified with that of the final goods themselves, in view of the tendency for industries to be self-supplying as far as possible in this area so as to cut costs. The machine-tool manufacturers followed a similar pattern, and, though nowadays the trend is nothing like so strong, the same attitude still persists in some enterprises to this day.^{5/} All this tended to hamper the efficient and rapid establishment of an adequate infrastructure.

As a result, manufacturers of machine tools have not got much help from the infrastructure in the past. However, the last three years have seen a change in the attitude of the users, together with a more modern conception of the role of the machine-tool manufacturer, which, judging from the investment made, has spread to numerous sectors and gives reason to hope that former deficiencies will quickly be remedied.

In the forging and casting field, specialized enterprises of an adequate technological standard are few and far between and they are always snowed under with orders. Delivery dates are a problem for manufacturers. Brazil has enough of the best K.H. to produce castings and other parts meeting international standards of quality, but the manufacturers do not buy them regularly, either because they are still too expensive, or because delivery dates are set too far ahead, or because there is little interest in small-scale production. To avoid these drawbacks, thirteen manufacturers out of seventy-one possess their own foundries.

As for the supply of small, simple parts, manufacturers cannot yet obtain as wide a range of quality (materials and tolerances), shapes and sizes, etc. as they could in more industrialized countries, though these limitations do not in fact affect them seriously. As regards more complex components, on the other hand, the fact that the range offered is not very wide does hamper the technically satisfactory solution of certain problems. Moreover, for the reasons already given, contacts between manufacturer and supplier are not always easy. Electrical components come closest to conforming to the sector's current technical requirements, allowing for certain limitations with regard to electric motors. The components of hydraulic and pneumatic systems, which are usually manufactured under license, are not good enough to solve any but the most ordinary problems, the same applies to components for refrigerating and lubricating systems.

^{5/} Encouraged by the reform of the tax on the distribution of products, currently calculated on the basis of the value added. /As regards

As regards components of mechanical systems, accessories and some other components, local supply can only be described as modest; moreover, the import procedures are such that manufacturers cannot count on imports to make good the gaps in local supply. Thus, they are in fact unable to take advantage of all the technical and commercial opportunities or to make their choice; there is therefore no incentive for them to produce more sophisticated and/or more complex machines. Consequently, those who possess the different types of internal K.H. do not have the experience required to take full advantage of external K.H. when it is made freely available. Sooner or later, this vicious circle must be broken; one way of doing so would be to adopt a general policy favouring collective imports of complex and strategic components, which would be reflected in more helpful customs regulations than at present exist.^{6/}

^{6/} Duties on components are frequently completely out of line with those applied to final goods.

Chapter III

LOCAL RESPONSIBILITIES AND THE CONTRIBUTION OF EXTERNAL TECHNOLOGY

It is now appropriate to consider what kind of practical and specific recommendations can be made for the sector, given its role, without entirely losing sight of those aspects of the transfer of technology that are controversial in a more general context. In the paragraphs that follow the study will therefore not be confined to the level of technology that the machine-tool industry has now reached, but will consider the 1970s as a whole, since, because change is so rapid, the time variable cannot be ignored.

(a) Internal K.H. falling completely within the national purview

Given the range of the present study, it is relevant to consider internal K.H., for the fact that it is termed internal does not a priori exclude some degree of indirect use of international experience which is disseminated and passed on from one area to another through contacts and the written and spoken word. Since this occurs naturally by means of a kind of permeation or osmosis, there is no question of paying royalties or the like. This is valid for the manufacturing sector as a whole, within which the best organized enterprise, irrespective of its branch of activity, sooner or later comes to exert a beneficial influence on the less well organized enterprises.

Returning to table 5 in Part One, the situation in the sector can be described as follows. Only one enterprise is in class I, of the typical cases as regards the receipt of K.H., while fifteen others (including the three special cases) are in classes II and III. The remainder, with some exceptions, do not qualify because they are too small and lack the minimum requirements, either technical or economic, for receiving K.H. To simplify

/matters, in

matters, in order to give a general idea of the situation in Brazil, enterprises in classes II and III can be considered together, disregarding once again the single case of ROMI S.A., which is in class I. With this in mind, a list can be made of the various types of internal K.H. which each enterprise is exclusively responsible for defining and structuring, and this will be a measure of the will to develop within the normal up-to-date operating conditions prevailing in industry today.

The types of K.H. are as follows:

1. Selection, definition and general conception of the product.
3. Testing. In this respect, account must be taken of the important contribution that can be made by the Brazilian Machine-Tools Institute.
8. Planning of production, work orders and progress checks. Flow of production.
9. Purchasing.
10. Production, selection of production equipment, lay-out.
11. Intermediate production controls and controls of commercial parts.
13. Industrial accounting, production costs.
14. Commercial and technical sales organization.
15. Advertising, exhibitions, etc.
16. Technical assistance to purchasers.
17. Business management.

Thus, there are eleven types of K.H. to which enterprises must devote comprehensive, specific and systematic attention, given that the average rating for these types of K.H. was 53.6, barely higher than the over-all average (see Chapter II). In this respect, development will be more viable if the progress made by the advanced countries is taken as the target, since the technologies developed in such countries become public property comparatively more easily. For there to be rapid progress, the manufacturer must never lose sight of this goal, and he must be prepared to assimilate K.H.

/that has

that has already been disseminated in various forms. Careful selection of staff and a proper definition of their functions will assist greatly in this respect.

The K.H. relating to production (K.H.10) may possibly be less within the control of the enterprise, than the others depending on the complexity of the product. In certain cases, it may be necessary to import K.H. on a temporary basis. There are, however, many ways by which such outside assistance may be reduced to the minimum in practice, since Brazil's experience of manufacturing processes has already reached acceptable levels.

University courses, vocational schools, advanced and refresher courses - these form the cultural infrastructure that is essential for the development of the above-mentioned types of K.H. A country like Brazil with a large and continually expanding machine-tool industry cannot avoid assuming complete responsibility for developing these kinds of K.H. at a wide range of educational levels and in sufficient quantity; particularly since, as noted earlier, these types of K.H. are not peculiar to the sector (see table 1, Part One) but are common to other branches of industry, each of which uses them in accordance with its own individual needs.

As always, it is essential for a number of factors to coincide if these types of K.H. are to be disseminated as rapidly as required. When the manufacturer's approach is the same, the quality and scope of training and the capacity of the user to take advantage of K.H., depend solely and exclusively on the size of the enterprise.

These types of K.H. which have developed on international patterns, really constitute, the minimum contribution that Brazil must make to promote the development of its industries, given the stage it has reached.

These minimum requirements cannot be reduced by those who produce machine tools; otherwise it would simply mean that the essential basis for justifying and facilitating the receipt of other types of K.H. would be lacking, i.e., that the problem of transferring technology would take another turn:

/the establishment,

the establishment, pure and simple, of subsidiaries as the only means of development. This last, in view of the approach taken in this study, is not relevant here, and the isolated cases observed in recent years do not change this.

(b) Transferable internal K.H.

Now that what can be termed the minimum stock of internal K.H. has been defined - always closely related to enterprise size - it is appropriate to consider the transfer of foreign K.H.

Subtracting the eleven types discussed above, the types of K.H. that can be transferred are the following:

2. Study and design of the product.
4. Internal technical standards.
5. Specification of the services of subcontractors and of the parts and components supplied by third parties.
6. Design of jigs, frames and supplementary production equipment, including tools.
7. Method, instruction and time-cards.
12. Assembly, painting, test-running and checking of the finished product.

First of all, it should be noted that the main focus in transferring K.H. is on K.H.2 - study and design of the product - the others merely following logically upon it. This means that, except in isolated cases, study and design K.H. were to be excluded, the other five types would not in themselves provide an incentive for transferring K.H. This is made clear in table 5 of Part One.

Nevertheless, whether or not the other five technical types of K.H. are included is a matter of some consequence when the enterprises concerned still have an incomplete industrial structure, as is the present case.

/For enterprises

For enterprises in class I, it may be sufficient to acquire all the designs and specifications for a machine (K.H.2) and develop the other types of K.H. itself, so that they will fit in with the existing structure to ensure internal standardization. But going further down the scale, in terms of category, experience and industrial size, it is not so certain that the possession of such an extremely concentrated and abstract type of K.H. as that on design is in itself a sufficient basis for manufacturing a product identical to the original product. Generally, some additional K.H. is required, the amount depending on the difference between the average degree of complexity of the line of products already being produced and that of the products to be manufactured under license; this is an important factor. The following table sets out the average situation in this respect of the enterprises in a position to receive K.H.

Table 4

DEGREE OF IMPORTANCE OF TECHNICAL TYPES OF KNOW-HOW
(Chip-producing machines)

Type of K.H.	Conventional machines A	Semi-automatic and similar machines B	Complex and automatic machines etc. C
4	Little	Some	A great deal
5	Little	Little	A great deal
6	Little	Some	A great deal
7	Little	A great deal	A great deal
12	Not essential	Depends on circumstances	For some time
Project hours	5,000 - 10,000	10,000 - 25,000	25,000

/This table

This table shows what types of technical K.H. Brazil's machine-tool sector as a whole is interested in acquiring now and certainly for some time to come. It can easily be seen that even when products are relatively simple it is necessary to complement design K.H. with other types of K.H., the amount increasing in proportion to the complexity of the machines. The table refers specifically to chip-producing machines, which require special care in their manufacture. In the case of forming machines, however, the design K.H. by itself will generally be enough if it is complete and reasonably explicit, in which case the other five types of K.H. will be less important. It is always justifiable to give priority to chip-producing machines since they account for roughly 75 per cent of the metal-transforming industries' stock and of the world supply of types and models of machine-tools. Moreover, the Brazilian producers of forming machines are technologically better equipped than those manufacturing chip-producing machines, as can be seen in Annex I.

Table 4 poses a question, namely, how much interest there is in the three categories into which design K.H. is divided, (A, B and C, in ascending order of complexity). To answer this question, it is necessary to take account of long-term market trends up to 1980, as outlined in the IPEA study. The main recommendations in this respect are set out in table 5.

/Table 5

Table 5

BRAZIL: PROBABLE DISTRIBUTION OF NATIONAL AND IMPORTED DESIGN
KNOW-HOW, 1970-1980

(Number of types and models)

N = national; I = imported

Machines	Complexity of product					
	A		B		C	
	N	I	N	I	N	I
1. Vertical lathe	1		1			
2. Multi-tool lathe	1			1		
3. Frontal type lathe			1	1		
4. Standard copying lathe			1			1
5. Tool milling machine			1	1		
6. Vertical milling machine	1		1			
7. Universal milling machine			1			
8. Production milling machine		2		2		2
9. Radial drilling machines	1		2			
10. Upright drilling machines with guides	2		4			
11. Bench planer or milling machines			NI a/			NI a/
12. Threading machines				1		
13. Universal boring machines					1 b/	
14. Production boring machines			2	2		
15. Pfauter type gear cutting machines						1
16. Fellows type gear cutting machines				1		
17. Internal grinding machine						1
18. Plant units						
		x c/				
19. Special machines	x		x	x		x
20. Forming machines	x		x	x	x	x
	6	2	14	9	1	5

Source: IPEA.

a/ Joint co-operation national-imported.

b/ Entirely under responsibility of the Brazilian Machine-Tools Institute.

c/ Indefinite quantity.

/In view

In view of the operational and structural situation of the sector, broadening its technological range will mean improvement both in quality and in the complexity of design and manufacture, and will open up a more demanding market than that supplied hitherto, something that appeared difficult to achieve within the period set using the means currently available. For this reason it was found necessary to limit the field national design K.H. much more than in the past. Consequently, the most substantive part of the technological progress which is a must for the sector will have to be supplied by local K.H. and imported K.H., as in the past, but in rather different proportions. Table 5 helps shed some light on this complex situation.

Obviously the list of products is incomplete. Throughout the period, the number of possible and necessary variants will be greater, particularly from 1975 onwards, than the figures given in table 5. No breakdown is made, for example, of forming machines, and their over-all position is only hinted at. But the table does give some idea of how much designing will have to be done locally and how much will have to come from abroad in the most significant and controversial cases. Column B is the most interesting, naturally enough, for it gives a fairly clear over-all picture of the effort Brazil will have to make to improve on past performance in the machine-tool sector; column A gives a fairly accurate idea of what this amounted to in terms of complexity. Once the sector has made enough technological and economic progress to be able to solve the problems in column B, with ease it will be faced with new prospects and fresh difficulties of the kind indicated in column C, and so on indefinitely as the level of complexity rises.

On the basis of a detailed study of the sector and of a reasonably accurate idea of the structure of long-term demand, it has been possible to determine how much K.H. the Brazilian machine-tool sector possesses to help it solve its problems and how much it still needs to bring this task to a successful conclusion. It follows therefore that consideration of the transfer of K.H. cannot be confined simply to an analysis of a single base year but must

/be looked

be looked at over a period of time at any given point of which it should be possible to estimate how much local inventiveness has developed and to compare it with the growing demands of the users. Thus, while in a general sense the transfer of K.H. is an interesting and even exciting topic, general arguments and case histories give very little idea of the dynamic effect it can produce, especially when it is met and matched by an acceptable level of internal K.H.

Accordingly, this extensive introduction to the topic will not have been so much wasted effort if it has been possible to prove, at least in one particular case, that whenever a key sector has to catch up rapidly, in terms of technology, with the growth in demand from its users (see Figure I), it has no alternative, once it has realized that it must catch up, but to give its own K.H. a shot in the arm with foreign K.H. It is not then a question of taking the easy way out, i.e., setting up a sector and developing it exclusively on the basis of imported K.H. That is an extreme case which is completely unacceptable given the current volume of demand, since, if the sector is to develop, it needs constant and direct contact with users, to whom it should offer its own immediate solutions; and these are too specialized and adapted to local conditions for the sector to be able to depend completely and systematically on imported K.H., and such dependence would, in any event, impair its operational flexibility. There is no question, either, of refusing to import foreign design and other types of K.H. and of simply importing ready-made machines. Table 5 is already the result of a long process of selection between national and imported machines and can be summarized as follows:

<u>Consumption 1969-1980</u>	<u>National</u>	<u>Imported</u>
Units	81,6	19,4
Tons	56,5	43,5
Value	47,3	52,7

/Once it

Once it has been shown that the sector is well established and is not concerned about becoming obsolete in the future owing to violent structural changes involving other productive processes, there is absolutely no reason why it should not make efforts on its own account - internally - to import K.H. on a substantial scale. Hence the most reasonable solution is make a realistic assessment of its intrinsic capacity and rate of growth; and if its rate of growth is not consonant with its needs, the only thing to do will be to give it a boost by importing selected and specific amounts of foreign K.H.

At this point, it may be appropriate to recall that in order to reach a rating of 50, the sector did not import technical K.H. on any great scale. At present, it has only two subsidiaries of foreign firms and some seven companies producing under license which have not played a specially great role within the sector as a whole. In 1968, out of a total of 160 types and models of machines, foreign design K.H. was involved in roughly 10 per cent of cases. Hence, it is reasonable to conclude that the progress made by the sector in the past, described above, is due mainly to its own efforts. However, the amount of technology to be developed locally to raise the rating from 50 and 75 calls for more foreign K.H., to that the proportion of local K.H. will be smaller than hitherto. Given the technical and other difficulties involved in raising the rating the present proportion of local K.H. could be maintained only if all production in the sector was in the hands of class I enterprises. Hence, since it would be asking for trouble to disregard the real operational problems and possibilities of national manufacturers, the recommendations regarding the importation of foreign designs are essentially focused on those machines for which, because of the reputation of a brand name, the difficulty of obtaining maximum efficiency from the product as soon as it appears on the market, the type of user for which it is intended, the small size of initial production runs compared with the number of design hours, and the impossibility of having sufficient design hours available within a very short period of time, it would seem advisable to call upon both national and foreign design K.H. and share the tasks between them.

/There will

There will probably be many more calls on national technical K.H. in design and related fields in the near future involving a total of 300,000 hours of design work, to say nothing of all the other work on designs for models of the machines listed under items 11, 18, 19 and 20 of table 5, and all the modifications and variations that are always requested. The sector also has constantly to update its more traditional lines of production, try out more automatic models, and make better use of external, especially imported, K.H., and so on. To all this design work must be added all the hours of technical work that it necessarily involves, the whole forming a set of requirements which stretch the technical, organizational and economic capacity of manufacturers to the limit. Consequently, the purchase of some design K.H. and its complementary K.H., including possible temporary assistance from foreign technicians, would ease the situation and at the same time help to step up the rate at which the fund of technical K.H. is being accumulated, which is one of the objectives.

As regards the time element, by about 1980 the sector should have made good its relative lag and be making progress in absolute terms in order gradually to close the gap between it and the universe established as a frame of reference. It would then be desirable for the rate of growth of K.H. to be maintained in the future at maximum capacity, taking advantage of all the development possibilities that may be offered. The actual rate will also depend in part on the efficiency and hence the influence of the Brazilian Machine-Tools Institute, which has the important responsibility of complementing and improving the technical potential of each manufacturer.

In any event, the sector's chances of success will be much greater, given the scale of its commitments and the volume of consumption, which is already approaching the figure of 100 million dollars per year, if specific development measures are taken and remain in effect for at least ten years. It is likely that IPEA'S recent analysis will yield positive results in this respect.

/Lastly, something

Lastly, something must be said about the size of the enterprises. Neither local inventiveness nor the absorption of imported technical K.H. will be possible at the levels indicated in tables 4 and 5 unless there is an increase in the scale of enterprises. The present scale is more suitable for operating conditions with a rating of 50 than for anything higher, and it is completely inadequate for greater development. Hence, any increase in the capacity for technical K.H. will largely depend on increases in the scale of the leading companies until they reach a size that will enable all types of local K.H. to co-exist at a high level; this in turn - and this is an essential point - will lead to the assimilation in depth of imported K.H. with a view to transforming it into specific K.H. applicable mutatis mutandis to locally designed products. This brings up another point which must be borne in mind when importing technical K.H.; in view of the over-all stage of development in Brazil and the somewhat individual structure of the user industries, it does not suit the national manufacturer of machine tools to depend exclusively on imported technical K.H. A sensible economic and strategically oriented approach would then seem to be to acquire some technical K.H. to complement existing K.H. - which itself should continue to develop spontaneously. Thus, importing design K.H., possibly with other types of technical K.H., should complement local K.H., not exclude it; it should constitute a form of strategic manoeuvre to gain time and knowledge and should be carefully studied to ensure that there are beneficial ancillary local effects.

(c) The transfer of external K.H.

The arguments and conclusions in Part One regarding external K.H. are just as important as those relating to the seventeen types of internal K.H. The problems connected with it are of some weight and although they are not directly related to what is normally understood by the transfer of K.H., they cannot be ignored. A look at external K.H. helps to clarify the picture and place it in its proper perspective.

/It was

It was seen earlier that seven of the sixteen types of external K.H. have a great influence on the final product and are expected to have a very dynamic effect in the coming years. While it is true that this trend will benefit most those enterprises that produce the most advanced products, it is also true that as time goes by it is becoming more and more common for enterprises at all levels to take greater advantage than in the past of the benefits of the more dynamic kind of external K.H. For example, more external K.H. in quantity and value goes into the manufacture of the lathes and conventional universal milling machines now being produced than into comparable machines thirty years ago. This is even more so with semi-automatic machines and reaches its maximum in highly productive special automatic and/or universal machines. It is clear, therefore, that as soon as a sector like the Brazilian machine-tools sector has to move on from the traditional to a more sophisticated stage (see column B, table 5), the share of complex external K.H. will tend to increase. It is impossible to disregard such K.H. since this would simply mean giving up all idea of achieving a reasonable level of technology because, except in a very few cases, there are no substitutes, unless it were to put the clock back which is ruled out by definition. The question is how to deal with the problems caused by the lack of K.H. in the internal market, and this is rather a complicated matter.

The manufacturers of a European country, for example, have access to all the external K.H. of their own country and in practice have equal ease of access to that of other areas. Hence, K.H. is used extensively and always at the highest possible level. All the necessary background, data and contacts are available for applying the specific design K.H. of other countries, and it is always possible to have discussions at the technical level regarding such functional or other modifications as may be required. If these elements are completely lacking or can be obtained only in a piecemeal and makeshift way, the manufacturer cannot but lose some of his power of invention, however well developed it may be in theory. This would be a case of what might be termed "introverted" design K.H., of which there are already several in Brazil.

/Most of

Most of the refined types of external K.H. that can be classified as dynamic are not available in Brazil. As noted above, there is little manufacture of components and importing is disorganized and inefficient. On the one hand, the seller of intermediate capital goods tends to seek the easiest and most favourable outlets and does not take the initiative of offering products that may be of interest to the sector. On the other, the machine-tools manufacturer, with some exceptions, does not know the whole range of supply available on the international market and therefore can give the importer little guidance. Because he is so far away from the producers, it is difficult for the manufacturer to evaluate the market simply on the basis of the technical literature available. It is thus the importers who are responsible for channelling the K.H. relating to specialized components from the developed areas to distant and less developed areas; given present circumstances, they should maintain a team of engineers, if possible trained in the countries owning specific types of K.H., to increase trade in highly sophisticated intermediate goods by disseminating information through high-level technical advice furnished directly to the designers. Unfortunately, this is not what happens. The manufacturer has to pick out the equipment that he can use from the plethora of suppliers, and generally he has to pay a high price for it. He may establish a relationship which is fairly satisfactory, in which case he becomes a steady customer, although he does not tie himself down, or it may be just a one-time transaction.

There is, however, some excuse for the supplier of technical items, although it does not really exonerate him from the charge of seeking the easy way out. The sector's volume of consumption is rather small compared with the great variety of sophisticated intermediate goods, and also as regards such matters as maintenance and repair, or in other words, organized technical assistance. If the supplier's only customers were the manufacturers of machine-tools, this attitude might be justifiable, but in practice it is felt in many other fields as well.

/For various

For various reasons, the most important and dynamic types of K.H., in the form of electrical, hydraulic, pneumatic, mechanical, electronic, lubricating, measuring, optical and other types of equipment, are not accessible to national producers, and this gives cause for concern regarding the natural growth of the sector. Direct imports by the manufacturer might improve this situation, but this can be done in only a few cases and is not common practice; nor can it be, since resources are absorbed by other activities which are considered to have higher priority in enterprises that are not yet fully consolidated. The solution to this serious problem would be for manufacturers to maintain a joint organization which would be responsible for transferring technical K.H. relating to highly sophisticated intermediate goods (this would be one way of standardizing types, models and brands), or for them to enter into specific agreements with a reputable importer capable of appreciating the technical and commercial aspects of the problem. The current gap between needs and supply cannot continue very much longer without having profound effects on quality, productivity, modernization, and on the development of machine tools as a whole, since it is clear that it will be a good ten years before the domestic supply of machine tools grows at the rate (especially as regards range) demanded by the programme for the development of the sector. The prerequisite for ensuring that technology is transferred in an effective and efficient manner is a favourable tariff policy towards imports of technical items. To keep things in their proper proportions, it is necessary for tariff protection on components to be as low as possible, appreciably below the levels fixed for final goods. Logically enough, this is a sine qua non condition for ensuring that technology is transferred without untoward commercial restrictions, since all the other difficulties involved are quite substantial also.

(d) Regulations governing the acquisition of K.H. in force in Brazil

At first sight, the existing regulations governing K.H. would appear to be adequate enough to ensure a normal flow of technology from abroad. Annex II gives some details on this.

/Manufacturers wishing

Manufacturers wishing to acquire a license to manufacture certain items must first register their licensing agreement with the Central Bank, describing the nature of the agreement and giving all the relevant details. Once this requirement has been fulfilled, the licensee enterprise is authorized to remit abroad for purposes of income tax a maximum of 5 per cent in respect of royalties for a period of five years. If the usefulness and need for the license has been sufficiently well demonstrated, a five-year extension may subsequently be granted.

In principle, the procedure is simple. In practice, however, registering agreements with the Central Bank is not always as rapid as it should be and is sometimes restricted, which means that the inter-connected problems may make it difficult to operate the agreement.

The first problem is the length of the period for which license is granted. A ten-year period is the norm for contracts in the machine-tools sector. However, breaking it down into two five-year periods does not give the firm granting the license enough guarantees since there is the risk that the payment of royalties will cease at the end of five years. The consequent uncertainty may in effect seriously interfere with the inflow of the most suitable licenses from the technological point of view, i.e., those granted by the most advanced enterprises, and leave the field open for less important agreements with less well-known enterprises.

The restriction is particularly harsh since the legal ceiling on royalties is 5 per cent. While this may be a reasonable and adequate figure for middle-level technology over a ten-year period, it is not attractive for periods of only five years.

Table 5 shows that the level of the foreign technology that it is planned to introduce during the 1970s is an important consideration. The sector will have to look for well-structured technologies that include not only design K.H. but also other types of technical K.H. and perhaps services of experts as well. The existence of a double restriction - time period and level royalty - may reduce the likelihood of securing complete agreements at a high level of technology and of being able to select the most suitable supplier.

/Another controversial

Another controversial point that arises with respect to the registration of licensing agreements is the authorization of the initial lump-sum remittance, usually a small figure, which foreign enterprises require as a pre-condition for agreeing to the transfer of technical K.H. It is well known that once the agreement is signed, the supplier hands over a substantial amount of documentation, especially if it covers the machine tools listed in column B of table 5. If the design K.H. is accompanied by other types of technical K.H. (e.g., K.H. 4,5,6 and 7), this documentation can have an appreciable material value. Added to this are other expenditures for the preparation of the product. One or two years, may elapse between the receipt of the designs and the approval of the prototype, before production proper can begin and only after this can royalties be paid. As can be seen, it is a very slow process, and there is much delay in paying for the services rendered.

The foregoing brings up some associated points. Because of the structure of the legal provisions governing the transfer of K.H., in principle there seems to be no integrated set of criteria for making a searching technical evaluation of requests for the registration of an agreement. In theory, there might be some duplication as regards different machine types and models, which would mean giving up any possibility of bringing indirect pressure to bear to promote greater consistency in the coverage of Brazil's technological needs.

In brief, it would seem that, without substantially changing existing provisions, greater efficiency could be achieved in practice if there was an official body, for example a specific executive group for the machine-tools sector, similar to those established in the past, to consider the technical aspects of licenses and associated matters. The basic criteria for this are plentiful and in a certain sense remain valid over a lengthy period of time. All would seem to indicate that the legal provisions governing the transfer of K.H. would be most beneficial to Brazil if responsibility for authorizing agreements was divided between technical/strategic and monetary/fiscal bodies, whose action would be harmonized on the basis of previously established development targets and over-all strategy.

Lastly, it should be noted that, as indicated above, past experience in the purchase of licenses and technical assistance is virtually useless as a guide for the future, since there have been few licensing agreements. Hence, the foregoing relates rather more to the way they may be used in the future.

CHAPTER IV

SUMMARY AND CONCLUSIONS

(a) For other countries

Most of the international manufacturers of machine tools that are in the lead in the field of technological progress operate in countries with a gross domestic product of over 50,000 million dollars; there are, however, other smaller - though still important - manufacturers, such as those in Switzerland, Sweden, Czechoslovakia, etc., and certain isolated firms in various countries. In the first group, the largest in terms of volume and value of production are the United States, West Germany and the Soviet Union, though the first two of these countries have the advantage in terms of technological content, which brings them close to the standards of the universe defined in Part One.

Whether because of the size of a country, its advanced state of industrialization, or a combination of both, the machine-tool industry is constantly developing and changing under various influences. Greater productivity - which nowadays covers everything from mass production to the small-scale manufacture of highly complex parts - better quality, an ever-increasing range of final products of different design and conception, and the materials processed are all making for new solutions, adaptations of old solutions or a mixture of both. The reaction of a manufacturer in a given country will be more or less dependent upon the importance of each of these factors and the extent to which each one comes into play.

The over-all picture can be summarized as follows:

1. A group of advanced countries with industries which, for domestic reasons, will continue making a substantial contribution to the development of the sector as a whole, combining their own experience and the increasingly valuable acquisition of external K.H., with the results of research carried out by specialized local institutions.

/2. A second

2. A second group of countries whose industries, though highly developed, are somewhat slow in introducing innovations. However, because they already possess an industrially mature structure that places them in class I (see Part One, table 5), they are in a position to copy, equip themselves with, and assimilate advanced forms of K.H. in a fairly short time. This situation may apply either to enterprises in developed countries that are slow in developing their own K.H. 1 and 2, or to very advanced enterprises in relatively less developed countries. The sole difference would lie in the distribution of these industries, there being proportionally more in the developed countries. For a number of reasons, which do not necessarily include the technical capacity of the enterprises themselves, there may be transfers of K.H. between firms in developed countries in this group.

3. Continuing down the scale, there are enterprises or sectors which are very slow to innovate. They are faced with two alternatives: to add to their traditional and basic lines of production (this concept changes with time), or to apply developed technologies to some of their products. Obviously, this is where the best opportunities of acquiring advanced types of K.H. lie since, at this stage, the traditional K.H. should already have become fairly self-sufficient, although on the basis of the wealth of technical material available throughout the world. This group may also include enterprises in industrially developed countries and countries in a state of industrial expansion, but, in contrast to the previous example, there will be more of these enterprises in the sector in the countries undergoing industrial expansion than in the developed countries.

4. Next come those enterprises that have an incomplete or recently established structure which therefore need to acquire technical K.H. for the manufacture of strictly traditional machines. This is the situation in the countries that did not begin to develop their metal-transforming industries until thirty or forty years ago. At this level, there is no transfer of K.H. between developed countries. Transfers from developed to undeveloped areas are however possible; they are not only possible, they prepare the ground for the absorption of the K.H. that the latter must acquire if they are later to make progress in this field.

/5. At the

5. At the bottom of the scale come the bold artisans, unfettered by major responsibilities - particularly as regards quality - who invade the machine-tool field more or less successfully, from time to time but can never hold their ground. They are mentioned here only for their daring.

Whereas the enterprises in groups 1 and 2 represent everything that the more developed countries have to offer in terms of volume and variety of advanced technologies, those in group 3, although they represent the lowest level in the industrialized countries, may be the most valuable level from the point of view of the developing countries, which also have enterprises in groups 4 and 5, a level that has virtually disappeared in the highly developed countries. Consequently, it would appear that transfers of technical K.H. through designs, literature and experts would be feasible in varying degrees and useful in a number of ways. If there are in the developed countries three main levels of supply (groups 1, 2 and 3) whose composition changes as time goes on, this is because the local industries require many different types of K.H., which shows that there is not one dead level for the use of technologies, as is obvious from the average age of the stock of machine tools available to the various user sectors. It is therefore natural that, mutatis mutandis, these combinations of technology at different levels should also be found in countries with developing industries, especially Brazil for reasons already given.

The transfer of technical K.H. in different parts of the world calls for further comment. From this angle it may be said, for example, in its most complete form, group 1 is restricted to highly industrialized countries with machine-tool sectors employing more than 5 million people; they would have few industries at the level of groups 2 and 3. In medium- and small-sized industrialized countries with machine-tool sectors employing between 500,000 and 2 million people, there would be combinations of groups 1, 2 and 3 but not in the same proportions as in the highly industrialized countries. At this level, certain transfers of technical K.H. are not only possible but justified when the intention is to modify the existing proportions within a given period.

/In the

In the few developing countries that are large in terms of both size and population, the mixture of enterprises in groups 3, 4 and 5 represents only a transitional stage, since in a relatively short space of time those in group 5 will be disappearing, those in group 4 declining in importance, those in group 3 becoming stronger and, finally, group 2 enterprises will be emerging. Depending on the choice of objectives and growth rates, the long-term prospect of moving into group 1 should not, a priori, be discounted. This could happen in the case of countries whose machine-tool industries employ nearly a million people and for which a target of 2 or 3 million would not be over-optimistic. One such country is Brazil.

Finally, there are the countries that are expanding more slowly because they are smaller in size and/or population and where an employment target of 500,000 people in the machine-tool industry would be a significant achievement. Here the manufacturers in groups 4 and 5 should aim essentially at the technological level of group 3, though they might sometimes make a foray or two into group 2 as well.

This brief outline shows that a series of combinations of transfers of K.H. would be possible between the developed countries themselves, between developed and developing countries and, finally, between the larger and the smaller developing countries. As regards the level at which this transfer would take place or its actual technological content, the combinations that are both feasible and desirable would depend on the group to which the recipient belonged. In other words, it is most likely that group 3 would strive to obtain group 2 K.H., group 4 that of group 3, and that group 5 would try to reach some kind of understanding with group 4. While not altogether impossible in theory, jumping from group 4 to group 2 or from group 5 to group 3 would be most unusual, and of debatable value economically and strategically speaking.

To conclude then, experience has shown that it is not advisable to urge machine-tool manufacturers to try to jump from one category to another strictly on the basis of a transfer of K.H. in various forms. The transfer of technological K.H. in this very specialized field might

/indeed, through

indeed, through the spread of its effects to other sectors, help them to accelerate their own development; but the passivity of the manufacturers clogs the wheels of progress. For example, a manufacturer from group 4 who could push himself up into group 3 without a proper technological basis but simply with imported K.H. would not have either the general background or the attitude that would enable him to attain that stage quickly, and so on, and he might just bog down later on. In the field of machine tools and in enterprises that are above a certain size, a manufacturer must always possess a body of knowledge of his own which, intelligently combined with the acquisition of new K.H., will keep the enterprise constantly prepared for further progress. Therefore, everything points to the fact that, in the long run, a transfer of K.H. will have really good effects only if it is a partial transfer and fits into a pre-existing framework of internal K.H. For this to come about, the actual selection of K.H. must be based on carefully thought-out criteria related both to manufacturing and to the development strategy of the user sectors. The only valid exception would be that of small and medium-sized countries in the initial stages of development which do not possess a traditional artisan-type basis in the machine-tool sector which could be a starting-point for this type of manufacture. Some African and Asian countries would probably fit this description. For the rest, the transfer of external K.H. will always have to be partial and perhaps only a small element in the most varied combinations; this will give the best results in the long run, regardless of any other immediate condition or consideration of immediate expediency.

(b) For Brazil

As the Brazilian machine-tool sector's general K.H. has a rating of around 50, which means that it is slightly more than 40 years behind compared with the universe, the options open to Brazil with regard to the transfer of K.H. are strictly limited and can all be clearly assessed. As one of the large countries, with a population that is

/rapidly approaching

rapidly approaching 100 million ^{7/} and a machine-tool industry that by 1980 may be employing 1,160,000 people, Brazil is proof of the fact that, considering the commitments it has already accepted, it will not by itself be able to sustain a high rate of growth and attain the ambitious targets it has set itself simply by relying on the transfer of external K.H., since an attitude of passive acceptance would eventually prove an obstacle to its plans. The over-all figures for Brazil are so enormous that the machine-tool sector, and probably other sectors as well, will have to make tremendous efforts and demonstrate their inherent vitality and ability, even though this will mean adopting, for a time, tried solutions which have already been defined and accepted; but if these solutions are taken merely as valid points of reference, this would be an advantage. Therefore, since the volume of technology that the country requires, now and in the future, is so great, any idea of Brazil not developing a sound and reliable basis of internal K.H. must be ruled out from the start. This approach to the problem is far from being nationalistic; it is a clearly defined philosophy - which may not be very applicable to other cases, perhaps - in which size and population are really the determining or influential factors.

This being the case, the transfer of technical K.H. takes on clearly defined characteristics: it must complement the sector's own capacity, improve the domestic technological level as much as possible and put manufacturers in a position to replace outworn technologies from 1 to 1.5 times per decade through contact with more advanced K.H. In other words, a certain level of imported technical K.H. must be turned to such good account that the transfer will occur at progressively higher and higher technological levels. If this

^{7/} 1971: 95,930,000; 1975: 107,120,000; 1980: 122,990,000.

Source: IPEA Population Division.

process is to be efficient, it is important to choose either the kind of design K.H. which starts with simple models, that can easily be developed into more sophisticated types at a later stage, or else the kind which, because it is used by only a limited number of manufacturers throughout the world, cannot be applied in enough different ways to justify original designing at the project level.

Lastly, it may be said that, in Brazil's case, the transfer of technical K.H. will be a help and even a determining factor in its development provided that it goes hand in hand with, to start with, an equal, and subsequently a greater, determination to build up all the types of internal K.H. that have been discussed here. Otherwise, the transfer process and its effects will reach saturation point, and thus lose touch with the user's real requirements; and, if this happens, the pressure on imports will reach practically unbearable proportions.

ANNEX I

TECHNOLOGICAL RANGE OF CONSUMPTION
OF MACHINE TOOLS, 1968

A. Brazil's consumption compared with the entire range of chip-producing and forming machines was found to be as follows:

	%	<u>Types and models</u>	%
Range of types and models in the universe		1,024	100.0
Range of imported models		291	28.4
Range of nationally produced models		160	15.6
Range of consumption			
<u>Total</u>	<u>100.0</u>	365	35.6
National	20.3	74	
Mixed	23.6	86	
Imported	56.1	205	

B. The breakdown for the two categories of machine is as follows:

	%	<u>Types and models</u>	%
<u>Chip-producing machines</u>			
Universe		764	100.0
Imported		219	28.7
National		89	11.6
Consumption			
<u>Total</u>	<u>100.0</u>	<u>252</u>	<u>33.0</u>
National	13.1	33	
Mixed	22.2	56	
Imported	64.7	163	

/Forming machines

ANNEX I (Conclusion)

	<u>%</u>	<u>Types and models</u>	<u>%</u>
<u>Forming machines</u>			
Universe		260	100.0
Imported		72	27.7
National		71	27.3
Consumption			
<u>Total</u>	<u>100.0</u>	<u>113</u>	<u>43.5</u>
National	36.3	41	
Mixed	26.5	30	
Imported	37.2	42	

ANNEX II

SELECTED LEGAL PROVISIONS GOVERNING THE
TRANSFER OF KNOW-HOW

Act No. 4131 of 3 September 1962

"Article 12. Sums owed in respect of royalties on the use of patents or industrial or other trade marks, and in respect of technical, scientific, administrative or other such technical assistance, may be deducted for purposes of income declarations under the provisions of Decree No. 47.373 of 7 December 1959 up to a maximum amount equivalent to 5% (five per cent) of gross receipts on the item manufactured or sold.

Paragraph 3. Expenditures relating to technical, scientific, administrative or other such assistance may only be deducted for five (5) years after the initiation of operations by an enterprise or the introduction of a special production process; this time-limit may be extended for a further five (5) years upon the authorization of the Currency and Credit Supervisory Board (N.B. At present the National Monetary Board is responsible for giving such authorization)."

