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VIENNA

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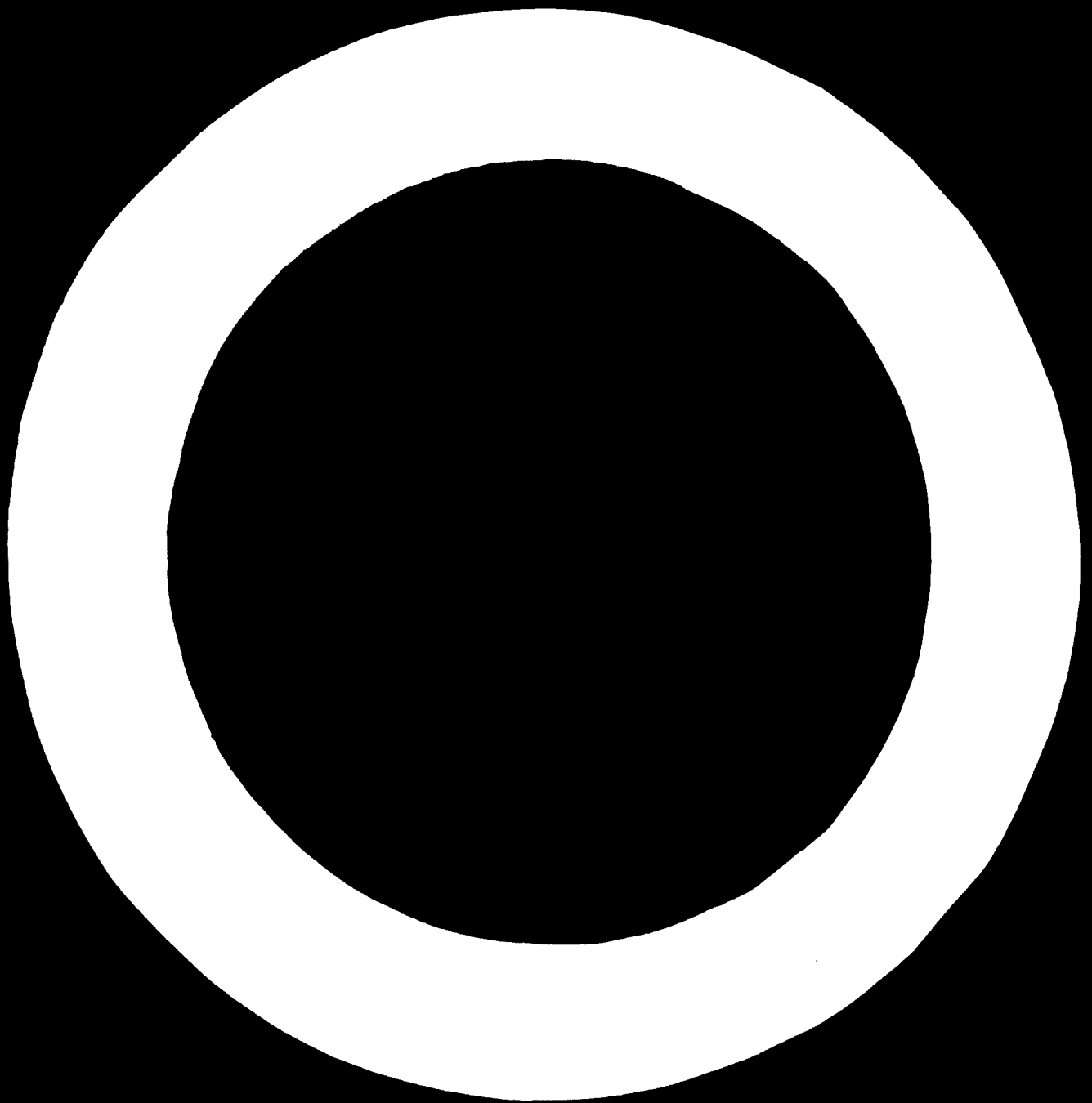
Development of Metalworking Industries in Developing Countries

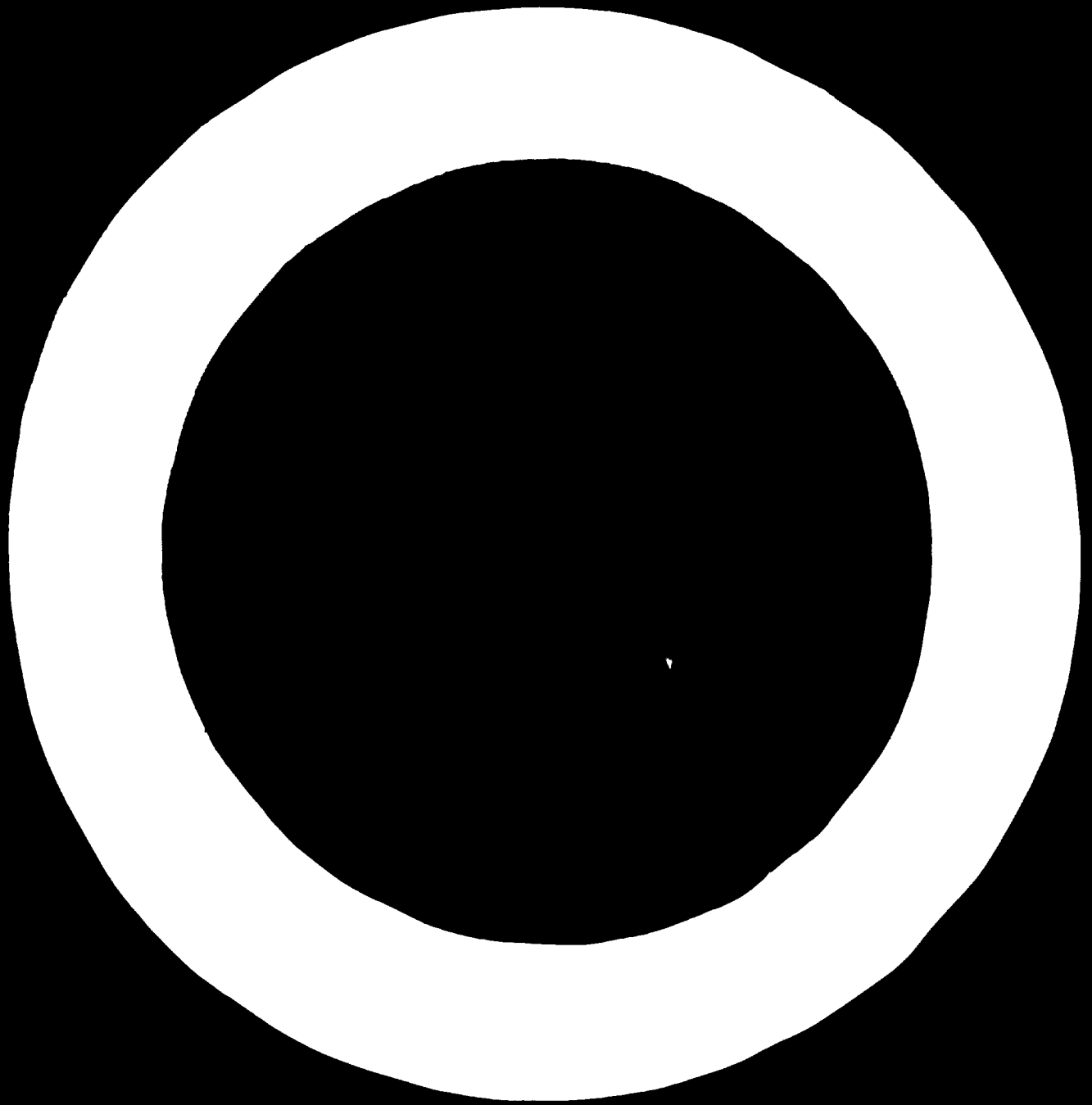
*Reports presented at the United Nations
Interregional Symposium, Moscow
7 September—6 October 1966*

Sales No.: E.60.II.B.2
ID/6



UNITED NATIONS
New York, 1969





D01186

A STUDY OF THE INDIAN MACHINE-TOOL INDUSTRY

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INTRODUCTION

The Indian machine-tool industry, which in status and sophistication is second only to Japan among the ECAFE countries, has a big gap to bridge towards self-reliance despite its progress during the past decade.

In 1965, the import of machine tools accounted for \$US 83.64 million in spite of the foreign exchange situation; domestic production was \$55.59 million.

Almost all the teething troubles have been solved but the problems of attaining maturity are still many. Some account of the industry, particularly the aspects which have contributed to its rapid success in the initial period and some of the main problems which at present hinder its further development, will perhaps prove useful to other developing countries in the ECAFE region.

PAST PERFORMANCE

General survey

It is not proposed to deal here with the whole history of the Indian machine-tool industry. Nevertheless, a brief description of its performance for the last decade may illumine certain salient features contributing to the

then primarily of low-priced machine tools meant for repair workshops, training institutes, etc.

Essentially, the requirements of the engineering industry were met through imports. Out of the total machine-tool demand of about \$42 million during 1951-1955, imports accounted for almost \$36 million as against domestic production of hardly \$630,000. However, the position of the industry changed for the better during the Second and Third Five-Year Plans as can be seen in table I.

The industry, as is clear from the statistics, has shown its capacity for an accelerated growth. From a production of hardly \$2.27 million in 1956, the output shot up to \$55.59 million during 1965, multiplying by almost twenty-five in ten years; the percentage of domestic production to the total requirement rose from 11.44 per cent in 1956 to 38.54 per cent during 1965. The capital investment in the industry, which stood at hardly \$2 million in 1956, increased to \$77 million in 1965.

Investment in industries

Investment in the industrial sector, which during the First Five-Year Plan was \$650 million, rose to \$2,900

Table I

INDIGENOUS PRODUCTION AND IMPORTS OF MACHINE TOOLS-- 1956 TO 1965

Year	Total requirements	Imported (in millions of US dollars)	Domestic production	Per cent imported to total requirement	Per cent domestic to total requirement
Second Plan					
1956	19.85	17.85	2.27	88.56	11.44
1957	35.68	30.75	4.93	86.18	13.82
1958	37.44	30.28	7.16	80.88	19.12
1959	43.03	34.29	8.74	79.69	20.31
1960	56.27	43.96	12.31	78.12	21.88
Third Plan					
1961	66.25	50.86	15.39	76.77	23.23
1962	76.53	54.69	21.84	71.46	28.54
1963	98.44	66.16	32.28	67.21	32.79
1964	147.53	97.77	49.77	66.26	33.74
1965	144.23	88.64	55.59	61.46	38.54

rapid progress of the industry. Having built the infrastructure solidly, the industry is now well poised to take a big leap towards specialization, diversification and sophistication.

During the First Five-Year Plan (1951-1955), the Indian machine-tool industry verily was in its infancy, with hardly three major units producing machines of accepted standards of accuracy. The manufacture was

million and \$5,000 million during the Second and Third Five-Year Plans respectively. A detailed study of the capital base of the organized industry and commerce in India indicates that if the targets are realized by the end of the Fourth Plan (1970-71), the public sector (Government-owned) and the private sector will contribute investments in the order of \$12,000 million and \$12,300 million respectively in industry and commerce. The total invest-

ment (equity and long-term loans) in sixty-six major industrial undertakings, by the Government alone, stood at about \$4,300 million at the end of 1964-65. Out of these investments, the total of the sixty-six public sector undertakings stood at \$3,963 million distributed broadly as:

Table 2

	Value in millions of U.S. dollars	Percentage
Land.....	55.65	1.4
Building.....	508.62	12.8
Plant and machinery.....	2,015.79	50.9
Other miscellaneous assets.....	443.52	11.2
Capital work in progress.....	939.54	23.7
Total	3,963.12	100.0

It can be seen that the Government's investment in plant and machinery of the magnitude of \$2,015.79 million, the major part of which was committed during the past ten years (1955 to 1964) in these major industrial undertakings in the public sector alone, has undoubtedly given tremendous impetus to the machine-tool industry in India.

Another significant contribution to the Indian machine-tool industry has been that of the Hindustan Machine Tools Ltd. (HMT), Bangalore, a Government undertaking engaged in manufacturing several varieties of modern medium-heavy precision machine tools. Table 3 shows that 42.38 per cent of the total 1965 domestic production of machine tools was by HMT.

Foreign collaboration and domestic designs

The industry, in a span of hardly ten years, has been able to diversify its production and to produce a wide range of machine tools of modern designs. Besides the general purpose machine tools such as lathe varieties, there recently have been introduced turrets and capstans, shapers, radial and pillar drills, milling machines of various types and sizes, grinding machines (universal, cylindrical and surface), tool and cutter grinders, and new designs in single spindle automatics, vertical turret lathes, gear shapers and heavy-duty planing machines, and all-electric milling machines.

In the course of the next year or two, newly designed gear hobbars, high production copying lathes, automatic lathes, multispindle automatics, and drum turrets are planned for domestic production. In fact, a stage has now been reached when most of the general purpose machine tools are being manufactured in the country.

The most significant feature in recent years has been the commencement of manufacture of special purpose machine tools, transfer lines and similar machines by HMT. Thus, a trend to the manufacture of more sophisticated types of machine tools of higher productivity and suitable for mass-production industries such as automobiles, scooters, tractors, bicycles, electric motors and pumps, has set in.

This has been possible mainly because of the industry

policy to enter into agreements for designs and technical co-operation with well-known foreign firms. The Government, which in fact initiated such an arrangement through HMT, set the rapid pace for development which, but for this policy, would have suffered seriously.

One of the main reasons for the outstanding success of HMT has been its ability to diversify its range of products quickly. This has been possible on account of the firm's co-operation with almost all the highly industrialized countries in the world for securing designs, manufacturing rights and technical know-how and has been one of the significant factors contributing to the rapid growth of the Indian machine-tool industry. From 1955 until May 1966, as many as 105 agreements were made with ninety firms from almost all industrialized countries for the licensed manufacture of various machine tools

Table 3

DOMESTIC PRODUCTION OF MACHINE TOOLS AND PERCENTAGE OF HMT'S PRODUCTION TO TOTAL DOMESTIC PRODUCTION 1956-1965

(In millions of U.S. dollars)

Year	Total domestic production	HMT'S production	Per cent HMT production to total domestic production
1956	2.27	0.65	28.46
1957	4.93	2.51	51.00
1958	7.16	3.72	51.98
1959	8.74	4.13	47.20
1960	12.31	6.53	53.06
1961	15.39	8.94	58.08
1962	21.84	11.64	53.27
1963	32.28	18.25	56.54
1964	49.77	19.67	39.52
1965	55.59	23.56	42.38

In this process of world-wide collaboration for securing designs and technical know-how, the Indian machine-tool industry has certainly benefited greatly in developing its own design talents. Although today it cannot be said of the industry that it has reached an advanced stage in evolving original designs of machine tools of highly sophisticated types and of heavy- and extra heavy-duty machines it has, without doubt, proved that a nucleus of design talent has been created in the country. The industry is to some extent now capable of evolving its own designs of general purpose machine tools. In fact, more advanced types of designs have also been attempted and produced successfully: for example, pre-selection headstock centre and turret lathes and all-electric milling machines.

Government assistance to the industry

One other factor which has accelerated the growth of the Indian machine-tool industry is the assistance it has enjoyed at the hands of the Government. In the economic planning of the country since independence, the machine-tool industry has been given a high priority, particularly in the Second and Third Plan periods, as the main plank

on which the modern industrialization is built. India committed itself to rapid industrialization and development of key and heavy engineering industries and its machine-tool industry therefore had to be encouraged by the Government.

Although there are no special concessions given to the Indian machine-tool industry in direct and indirect taxes or monetarily, the industry does enjoy a higher priority and consideration in the Government's planning, industrial licensing, allocation of scarce foreign exchange and issuance of import licences.

Protected market

Chronic and acute shortages of foreign exchange appear to be the main reason for the Government's restrictive policy on imports of machine tools. There is a positive support and incentive given to the domestic machine-tool industry through the Government policy of banning imports of certain types of machine tools which are being produced in sufficient numbers in the country. Thus, whether it is the paucity of foreign exchange or the intentional policy of the Government to ban the import of certain types of machine tools, both these factors account for the creation of almost a protected market. Although in many ways it is not a healthy feature for the industry to enjoy the preferential and non-competitive position continuously, the situation has helped the industry to establish itself firmly. The industry has not been resting idly on this protective cushion, but has been making efforts to diversify its products to satisfy the growing needs of the nation's engineering industry for different types of machine tools. There are also many machine-tool producing units in the country with an overlapping programme of production, thus generating, to some extent, a spirit of competition for improving quality, designs, performance standards and deliveries, and keeping check on the spiralling prices of machine tools, which has become the alarming feature of the Indian industry and trade today.

DEMAND FORECAST

General survey

In spite of the fiscal year 1965-66 being a very depressing period for the Indian machine-tool industry, it is considered only a temporary recession. Demand for machine tools should improve considerably during the Fourth Five-Year Plan. If this forecast does come true, the machine-tool industry will once again face the problem of gearing itself to the rising demands which the industry has never been able to meet in the past. Even in the lean year of 1965-66, imports of machine tools were 61.46 per cent of the total requirements. Close examination of the imports and production statistics for the past ten years (see table 1) clearly indicates the inability of the industry to catch up with the demand and although the percentage of imports to the total requirements has slowly and gradually been decreasing, imports have been consistently going up from year to year.

Report of the Working Group on Machine Tools

Forecasts of demand for machine tools during the Fourth Five-Year Plan (1966-1970) have been attempted by two agencies and although their findings vary and are even disputed by other experts, all are unanimous on one point: demand for machine tools during the Fourth Five-Year Plan is bound to outstrip national production. The report of the Working Group on Machine Tools (Group VI), appointed by the Government, estimates the demand for the graded machine tools by number of units at 173,000 for chip-removing types valued roughly at \$942.9 million and other metalworking machinery at \$235.2 million for the Fourth Plan. Details of the estimated demand for machine tools of chip-removing types from year to year are shown in table 4.

Table 4

ESTIMATE OF MACHINE TOOLS FOR 1966-70
(Average annual increase 13%)

Year	Number of units	Average price (\$)	Value (in millions of U.S. dollars)
1966	26,700	4,366	115.5
1967	30,200	4,803	147.0
1968	34,100	5,284	180.6
1969	38,500	5,811	222.6
1970	43,500	6,392	277.2
Total	173,000		942.9

The Working Group further estimated that the machine-tool industry's capacity and production would reach a level of only 85 per cent and 75 per cent, respectively, of the total demand which, based on performance in the past, is certainly an ambitious target. Table 5 shows the targets of capacity and production in 1970 for machine tools and other metalworking machinery, set by the Working Group.

Table 5

TARGETS 1970

Items	Capacity		Production	
	number of units	value (in millions of U.S. dollars)	number of units	value (in millions of U.S. dollars)
Machine tools for domestic consumption.....	37,000	237.3	32,600	207.9
Machine tools for export.....			1,500	8.4
Metalworking machinery.....		37.8		33.6
Total		275.1		249.9

Forecast by the National Council of Applied Economic Research

A most comprehensive and systematic study of the demand for machine tools was made by the National Council of Applied Economic Research (NCAER), New Delhi. The NCAER has evaluated the demand for

machine tools based on the "end-use" method in which a complete inventory of the machine tools installed in the country during 1963 was estimated by types, categories and sizes of the machines. It is estimated that there will be an additional total demand for machine tools valued at \$1,281 million (graded, \$1,215.06 million and ungraded, \$65.94 million) and in number of units, 526,000 machine tools (348,499 graded and 177,501 ungraded) for 1964-70.

The findings of the above two exercises vary in some degree (Working Group's estimate for Fourth Plan Period: \$1,178.10 million and rate of demand by 1970, \$346.50 million a year; NCAER'S estimate: total demand for 1964 to 1970, \$1,281 million and rate of demand by 1970, \$258.30 million a year). But the fact remains that in view of the industry's inability to meet the demands for machine tools, large-scale imports will have to continue.

MEASURES TO BRIDGE THE GAP

General survey

India still has to depend upon heavy imports to meet the gap in the domestic supply of machine tools. Though the ratio of internal production of machine tools to imports has gone up from 13 per cent in 1956 to over 62 per cent in 1965, the value of imports in absolute terms has increased from \$17.58 million to \$88.64 million over the same period. The heavy imports year after year made constant inroads into the foreign exchange reserves of the country.

The revised Fourth Plan Memorandum laid down a capacity of \$231 million and a production target of \$210 million to be achieved by 1970-71, the last year of the Fourth Plan, for the organized sector of the machine-tool industry as against the Third Plan's capacity and production targets of \$78.96 million and \$63 million, respectively. Even if it is assumed that the Fourth Plan targets would be met at the production level of \$231 million a year by 1970-71, requirements for machine tools in the same year are estimated at \$294 to \$315 million, resulting in a shortfall of \$84 to \$105 million worth of machine tools a year which will have to be met through imports, according to both the Working Group and the NCAER.

It is not necessary for any country to plan for 100 per cent self-sufficiency in machine tools. This is not practical or feasible as there are so many types, sizes and designs. But following are some of the recommendations for the industry's continued growth towards self-reliance.

Export

In any highly industrialized country, the imports of machine tools, even with a high degree of self-sufficiency, are still about 20 to 30 per cent of the total requirements. But this is more than compensated by exports. In India, however, until very recently, there were no tangible exports of machine tools. Also, no serious attempts seemed to have been made both by the industry and the Government in this respect, perhaps because of their concentration on encouraging national production.

Table 6 shows the export of machine tools during the Third Five-Year Plan.

Table 6
MACHINE-TOOL EXPORTS FROM INDIA
(Including metalworking machinery)

Year	Value in US dollars
1961	162,889
1962	223,618
1963	199,677
1964	248,849
1965	291,338

As can be seen from the table, attention seems to have been paid recently to this vital aspect and an export target of \$21 million a year within the next five to seven years was set by the Board of Trade at a meeting in New Delhi on 30 April 1966. The importance of exports, apart from maintaining equilibrium in trade balances among countries, has a special significance in the case of non-traditional items such as machine tools. When the products of one country are exposed to the world market, there are many indirect gains for the industry. For one, the product, to be competitive, necessarily calls for better quality, efficient manufacture and superior design. The Indian machine-tool industry, to keep pace with the advanced countries, must expose itself to the world market to remain progressive, aggressive, cost conscious, quality conscious and price conscious.

Though exports of Indian machine tools to the highly industrialized West may sound like "carrying coals to Newcastle", closer examination has, however, disproved this myth and market surveys carried out by some prominent Indian manufacturers do hold promising prospects for the future. It is therefore necessary that every effort is made by the Indian machine-tool industry to export a portion of its products abroad continuously.

Need for diversification

In view of the severe restrictions imposed by the Government in issuing import licences, sometimes customers have had to accept not, ideally, what was needed for a particular operation or process, but what was available in the country. This position has been changing and the recession in the machine-tool market has, in a way, been a blessing in disguise for the customer in that he could advantageously dictate his requirements to some extent and select his machine tools. In order not to lose the customer, the manufacturer must now give him the machine he needs with accessories and tooling on a competitive basis. If there is no demand for a particular machine tool, the manufacturer should have a sufficient flexibility to switch to the other types which are in greater demand.

It is in such circumstances that the ability of the manufacturer to diversify the production programme pays a dividend. One who can without much delay meet the diversified needs of a customer will eventually succeed,

particularly when the market changes from the seller's hand to the buyer's. Indian machine-tool makers thus have a long way to go in this direction and very soon they will have to gear up their methods and organization and be flexible in diversifying their programmes of production to satisfy the customers.

One of the main difficulties in the machine-tool business is an inherent high degree of diversification which sometimes is likely to retard the growth. It is perhaps easier to evaluate the country's over-all requirements of machine tools from period to period in terms of volume and value. It is not even difficult to split up this demand into main categories, such as lathes, drilling machines, boring machines, milling machines, grinders and gear-cutting machines. What has been the most difficult problem for the estimators is to guess what different designs, types and sizes of machine tools will be needed by the engineering and manufacturing industries. This depends so much on the techniques, methods of production and processes, etc., of the end users of the machine tools that it is practically impossible to furnish a ready reckoner for the individual machine-tool manufacturers to adopt a particular pattern of diversification.

It is more for the machine-tool makers themselves to intelligently forecast and adapt their programmes of production and diversify them to suit the market demands. It could be suggested that to counteract the disadvantages of a high degree of diversification, the machine-tool manufacturers should specialize in a certain family of products and diversify within the family itself. That is to say, if one is making turning machines, he is best advised to include in the range other types of lathes: centre production, capstan, turret and even automatic lathes and, for the milling machine manufacturer, to include other types of milling machines such as production millers, tool room millers, duplex millers, knee and bed-type millers, die sinkers, etc.

Raw materials and supporting ancillary industry

Machine-tool manufacture involves specialized raw materials such as heavy-duty castings, alloy steels, steel castings, forgings, special bronze, plastic material, etc. Requirements of raw materials are specialized and these have to be so if products are to be of high quality and performance. If the domestic machine-tool industry is to progress on the same lines as elsewhere in the highly developed industrial world, manufacture of all these essential raw materials has to take priority and should be established in the country as quickly as possible.

One other serious disadvantage facing the machine-tool business in India is the relatively slow development in the supporting and ancillary industries which supply hundreds of highly specialized bought-out parts and other proprietary items such as ball bearings, special electric motors, switch gears, Ward Leonard sets, electromagnetic clutches, programme control equipment and other electrical, hydraulic, pneumatic and electronic equipment needed for modern machine tools.

Modern designs

The domestic machine-tool industry has, in the past

decade, made definite contributions and met some of the specialized needs of the engineering industry. This has been, to a large extent, possible through the purchase of designs from abroad and production of the machines under licence. Although this has been and still continues to be an essential feature of the development of the machine-tool industry in India, it is absolutely necessary for the manufacturers of machine tools to evolve their own modern designs.

To achieve this it is important to train machine-tool designers systematically and give them encouragement and scope. Every machine-tool entrepreneur should devote part of his resources to this basic need so that his own designers could closely associate themselves with the work of machine-tool research centres in the country and abroad and be able to design the required machine tools. This calls for sustained efforts but, though long and tedious, it is a "must" for the progressive development of the machine-tool industry.

India today, to some degree, is self-sufficient in medium- and light-duty machine tools of the general types. The country, however, is not manufacturing highly sophisticated heavier and modern machine tools such as transfer line machines, multispindle automatics, jig borers, machine tools for automatic production, machine tools with numerical controls and heavy- and extra heavy-duty machine tools. India is not even producing some of the basic machine tools such as horizontal boring machines, gear hobbing machines, multispindle automatics and drum turrets, although recently certain licence agreements have been concluded for the manufacture of some of these machines.

The Government of India has set up, in collaboration with Czechoslovakia, the Heavy Machine Tool Plant, a unit in the complex of the Heavy Engineering Corporation Ltd., Ranchi, to produce heavy and very heavy machine tools such as horizontal boring machines, size 160 mm and above, radial drills, size 80 mm and above, heavy-duty lathes (1,000 mm swing and above) and heavy vertical boring mills. But until this unit goes into production, all similar machine tools have to be imported. By and large, it may be said that India's future imports will be for more and more heavier types and for modern designs of machine tools.

The trend appears to favour single and special purpose machines and machine tools to do specific operations. The modern trend in the highly developed countries abroad is towards machine tools designed for automation, transfer line machines and for the production of machine tools with automatic repeat cycle systems and positioning and measuring by numerical controls. The domestic machine-tool industry has to think in terms of producing these designs soon if it is to meet the increasingly specialized demand for machine tools without having to depend upon large-scale imports.

Metal-forming machines

Taking up types of machines, the high proportion of metal-cutting machines is evident. But the trend in the highly industrialized countries to higher proportions of metal-forming machines, nearly 24 per cent in the United

States as against 16.5 per cent in India, can be explained by the fact that production of durable consumer goods, the components of most of which are formed, is more pronounced in these countries.

The production of metal-forming machines in India is far from satisfactory and, compared to industrialized countries abroad, is very poor. Modern heavy-duty presses of capacities varying from 100 to 5,000 tons for the automobile, shipbuilding, aircraft, refrigeration equipment and domestic appliances industries are not yet made in the country and all have to be imported. The need for early development of this vital wing of the metalworking industry is great in India. Somehow, progress in this vital branch of the metalworking industry in India has been very slow and a few of the items, mostly presses, press brakes, forging machines and shearing machines which are produced in the country today, cannot be termed as very modern. Hence, not only is it necessary to improve the design and quality of metal-forming machines currently produced in the country, but there is equally an urgent need to diversify the production of these machines in the country to include the other essential types of metal-forming machine tools.

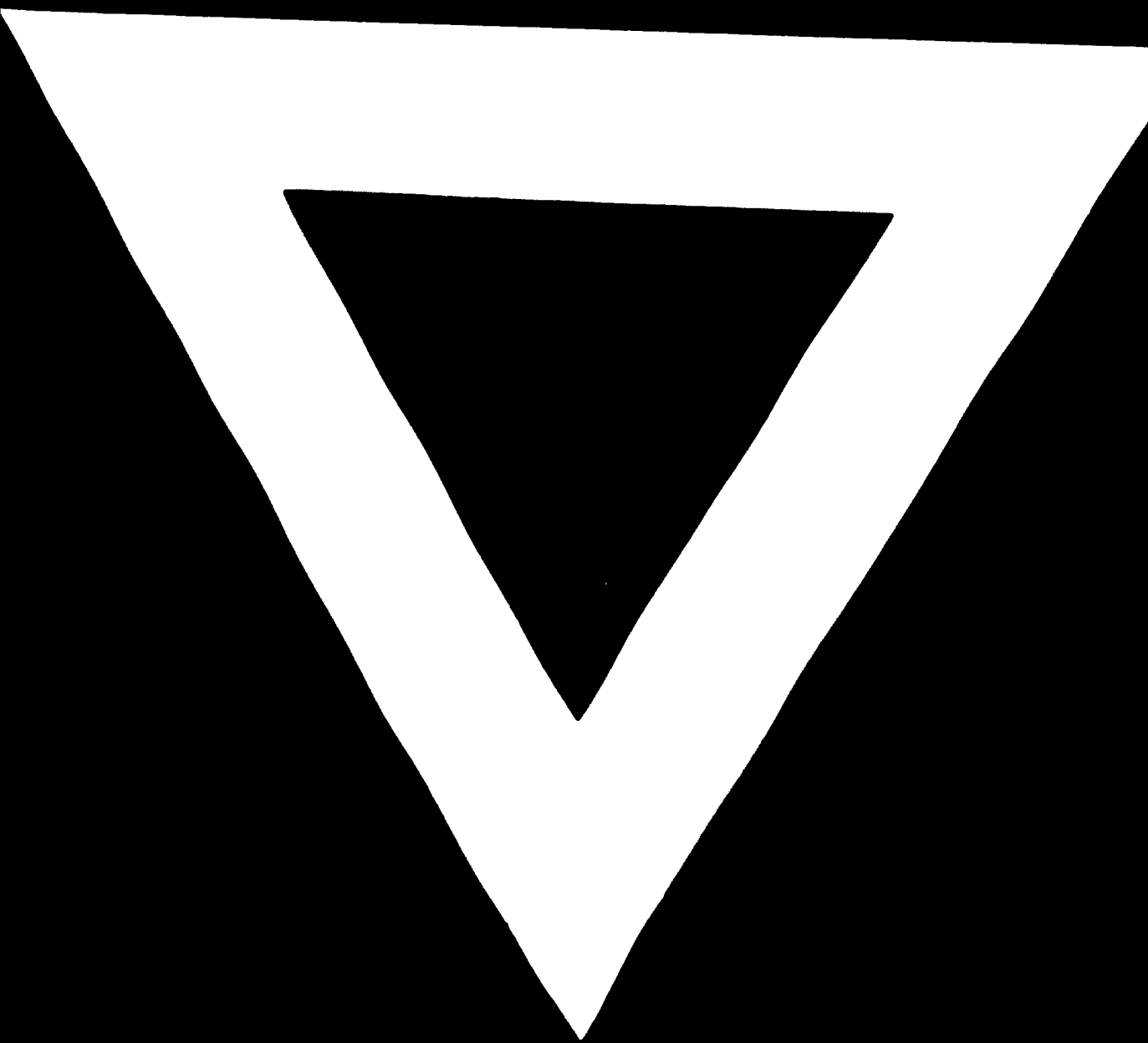
Machine-tool research

If the Indian machine-tool makers are to meet the

growing needs of the domestic manufacturing industry, they will have to concentrate on the applied research in production technology and development of machine-tool designs. This is evident from the rapid and spectacular progress that has been achieved by all the European countries, the United States and the USSR in all industrial fields and especially in machine tools. Unlike the USSR, Czechoslovakia, Poland and the German Democratic Republic, where research is concentrated in the Government-operated and financed agencies, the Continental and United States programmes rely to a large extent on the contribution of the private builders made directly or through their national associations. Similar initiative should come forth from the Indian Machine-Tool Manufacturers' Association.

The Government of India, with the assistance provided by the Czechoslovakian Government, has set up a machine-tool research institute, the Central Machine-Tool Institute, in Bangalore. Many more machine-tool research institutes are needed in the country and it should not be for the Government alone to take initiative in these matters. It should be more in the interest of the machine-tool builders themselves not only to take active part in such sponsored ventures but substantially to guide and finance the work towards progressive modernization of the industry.





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