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# Development of Metalworking Industries in Developing Countries

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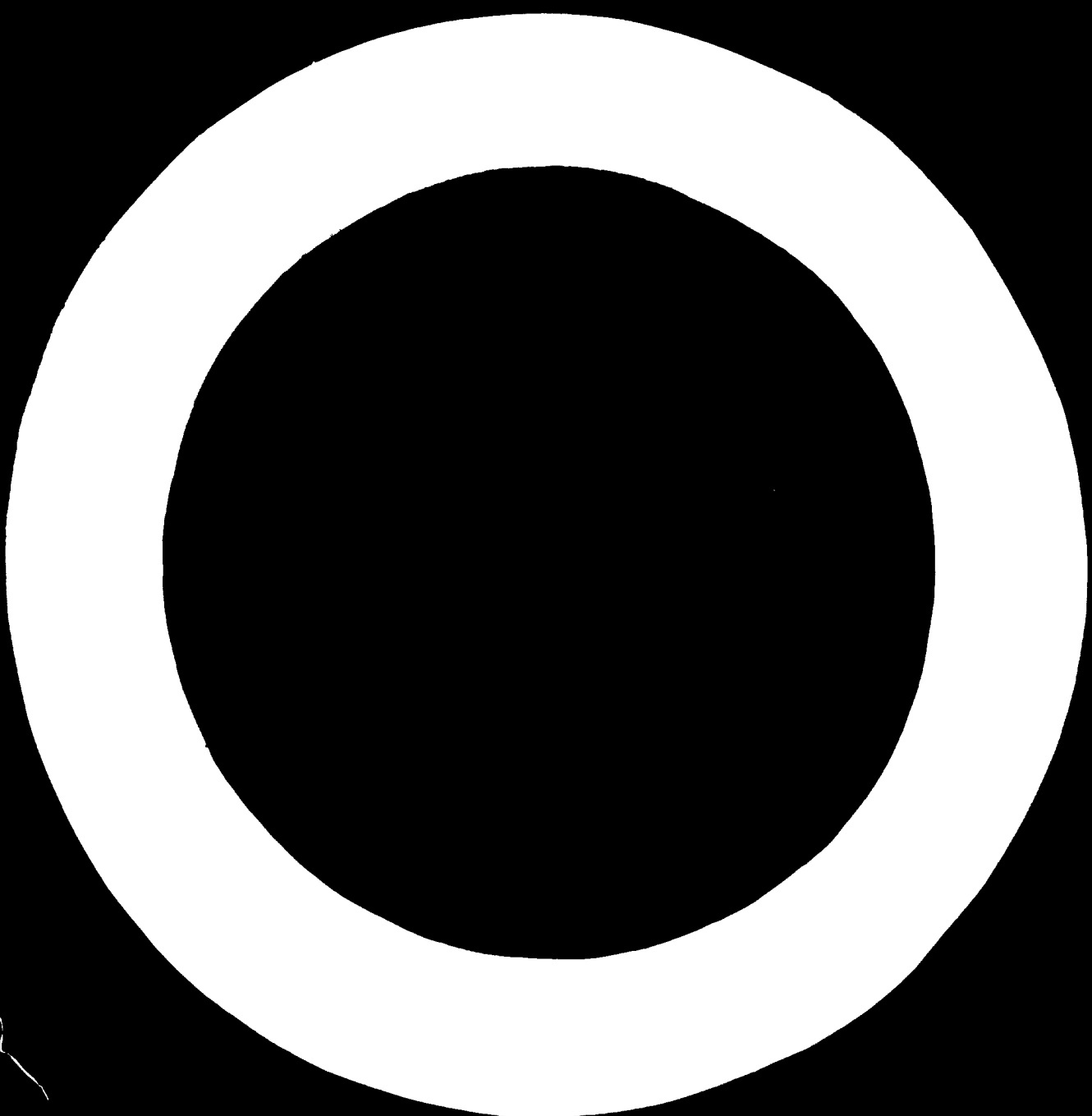

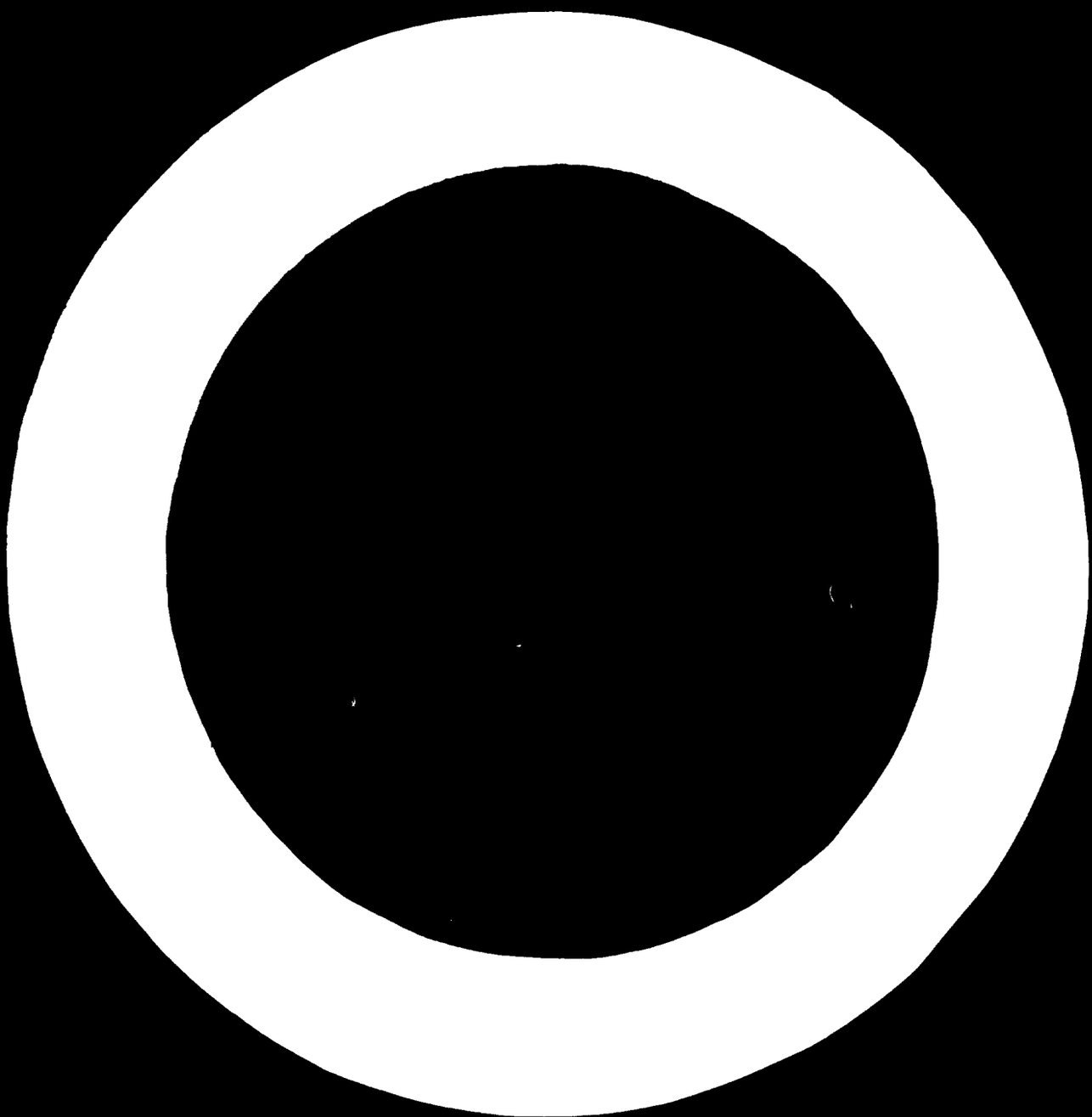

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# MANUFACTURE OF INDUSTRIAL MACHINERY AND EQUIPMENT IN DEVELOPING COUNTRIES[1]

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## INTRODUCTION

A study of the manufacture of machinery and equipment necessary to increase the production capacity and productivity in the production of goods and services was undertaken by the United Nations Centre for Industrial Development (CID) to develop appropriate methods for transferring technology and formulating development policies in this field. It became clear at an early stage of the investigation that the promotion of the manufacture of industrial machinery must be viewed as a part of the development of the metal-transforming industry as a whole. The latter, together with chemicals, is the most dynamic among all manufacturing industrial branches, not only in volume of production but also in scientific and technological development. This report summarizes such facts and findings which seem to merit consideration, even though the investigation was at a preliminary stage at the time of writing.

The first phase of the investigation reviews the principal facts concerning the development of industrial machinery and equipment manufacture in less industrialized countries of Africa, Asia and Latin America in order to permit the examination of the scope of national, regional and international promotional actions in this field. The findings and conclusions must be considered preliminary and provisional because of the general scarcity of relevant statistics, the limited time and resources devoted to the study so far and because it was necessary to complete it without direct investigation in any of the developing countries. However, the basic facts and possibilities concerning the field can be outlined with a reasonable amount of certainty.

The importance of industrialization in the economic and social development of countries is now unanimously recognized. The views strongly held earlier that such countries might develop through specialization in primary production are no longer sustained. The debate now concerns the proper choice of industries to be developed. Some views, for instance, emphasize the importance of relative scarcities of capital and labour. This, if accepted as a general rule of choice, would give strong priority to (some) consumer goods industries, and limit the development of engineering industries in general and the manufacturing of industrial machinery in particular. The debate, of course, does not concern the desirability of producing machinery and equipment, but only its feasibility and economic justification or, in other words, the economically sound timing and priorities at different stages of economic development.

Metal-transforming (or engineering) industries account for almost 30 per cent of the world industrial production (measured in terms of value added) and for about a third of the total manufacturing production. Metal transforming has been among the major industrial branches experiencing the most important increase in production since 1938[2] (see table 1). The increase has been even more important in less industrialized countries than in the industrialized. Nevertheless, the share of less industrialized countries in the total production of metal products was only 3.9 per cent in 1958, the lowest among all major industrial branches.

*Table 1*

INDEX NUMBERS OF INDUSTRIAL PRODUCTION IN 1962 (1938 = 100)

| | *Industry total* | *Mining* | *Manufacturing* | *Metal products* |
|---|---|---|---|---|
| | *ISIC 1-3,5* | *1* | *2-3* | *35-38* |
| Industrialized countries | 300 | 178 | 302 | 460 |
| Less industrialized countries | 372 | 520 | 325 | 600 |
| Share of less industrialized countries in total production in 1958 (percentage) | 10.4 | 25.2 | 8.9 | 3.9 |

## STRUCTURE AND PATTERN OF ENGINEERING INDUSTRIES IN DEVELOPING COUNTRIES

The developing countries can be classified into three distinct groups, as far as the present degree of develop-

[1] Industrial machinery and equipment comprises goods produced by different sectors of the engineering (metal transforming) industry, classified by the International Standard Industrial Classification (ISIC) as *Manufacture of Machinery, except Electrical Machinery* (ISIC 36), *Manufacture of Electrical Machinery* (ISIC 37), *Manufacture of Metal Products, except Machinery and Transport Equipment* (simple metal products or simple metal manufactures) (ISIC 35), *Manufacture of Transport Equipment* (ISIC 38), and *Manufacture of Professional, Scientific, Measuring and Controlling Instruments* (ISIC 391), which are utilized as means of production in identical processes for transformation or handling of materials, for ancillary activities, etc. The corresponding classes of the Standard International Trade Classification (SITC) are: *Machinery, other than Electric* (SITC 71), *Electrical Machinery, Apparatus and Appliances* (SITC 72), *Manufacture of Metal, N.E.S.* (SITC 69), *Transport Equipment* (SITC 73), *Professional, Scientific and Controlling Instruments, Photographic and Optical Goods, Watches and Clocks* (SITC 86).

[2] United Nations, *Monthly Bulletin of Statistics*, August 1963, Special table A: Index numbers of industrial production, excluding USSR and Eastern Europe.

ment of their engineering industries is concerned. Statistical indicators in absolute figures seem to be more characteristic in this respect than *per capita* ratios. The available statistical data of the countries in question fit reasonably well in the following pattern which can be considered as characteristic in spite of overlapping or deviation in the case of some countries and/or some indicators.[3]

The different categories indicated in table 2, industrialized countries and the three groups of developing countries, *viz*, countries with already developed and diversified engineering production (group I), countries with engineering production at an initial stage (group II), and countries with no engineering production or with engineering production restricted to repairs and simple metal manufactures (group III), can be considered as successive stages of industrial development, at least as far as the engineering industries are concerned, characterized by distinct internal structures of total engineering production as measured by the shares of the main engineering branches. The similarity of this internal structure is particularly definite in the case of industrially developed countries, although they differ in the size of their engineering industry or their economy as a whole, the share or amount of imports or exports of engineering goods, etc. The typical structure of the engineering industry in industrialized countries is:[4]

| *Simple metal products* | *Machinery except electrical* | *Electrical machinery* | *Transportation equipment* | *Instruments, watches and clocks* | *Total* |
|---|---|---|---|---|---|
| 6 | 33 | 24 | 33 | 4 | 100 |

In less industrialized countries with already developed engineering industries (group I), the share of simple metal products is substantially higher (20–30 per cent can be considered as typical), with a tendency to decrease as engineering production increases. While in developed countries, the production of non-electrical machinery is generally more important than that of electrical machinery (typically 30–40 per cent higher); in group I, the production of electrical machinery is as much as two times more important than that of non-electrical machinery. In groups II and III, the share of simple metal manufactures is even higher (typically 35–40 per cent for group II and more than 50 per cent for group III) according to statistics that are available. The share of the total production of machinery (electrical and non-electrical) which is very low or even non-existent in group III, increases with the progress in the stage of development and is more than 50 per cent in the typical structure for industrialized countries. Industrial machinery and equipment is produced essentially by the sectors "machinery except electrical" and "electrical machinery" which produce, of course, also for other sectors of the economy, mainly for agriculture, commerce and households.

The share of industrial machinery is generally higher in the case of more developed countries.

The available information seems to indicate that the three categories of developing countries present distinct problems requiring distinct measures for the development of engineering industries in general and for the manufacture of industrial equipment in particular. Four countries, India, Argentina, Brazil and Mexico, belong to group I, characterized by an already important manufacturing industry, with the total number of those engaged being well over a million and, as a part of it, with already diversified manufacturing of industrial machinery and equipment.

Steel production, already appreciable in these countries, is expected to increase further at a quick pace and to

*Table 2*

ENGINEERING INDUSTRIES IN INDUSTRIALIZED AND LESS INDUSTRIALIZED COUNTRIES: SELECTED INDICATION OF DEVELOPMENT

| | *Engineering industries* | | | *Engineering goods* | | | |
|---|---|---|---|---|---|---|---|
| | *Number engaged (thousands)* | *Percentage in total manufacturing (value added)* | *Total yearly steel consumption (thousands of metric tons)* | *Percentage imports in domestic consumption* | *Percentage exports in domestic production* | *Value added in engineering production (millions of US dollars)* | *Value added in total manufacturing (millions of US dollars)* |
| **Industrialized countries** | more than 200 | 25–30 or more | 1,000 or more | 10–50 | 20–50 | | |
| **Less industrialized countries with:** | | | | | | | |
| **I. Developed and diversified engineering production** | more than 200 | 15–20 | 1,000 or more | 50–75 | | 400–800 | 2,000–5,000 |
| **II. Engineering production at initial stage** | 20–50 | 8–12 | 400–800 | 80–90 | | 50–100 | 400–1,000 |
| **III. No engineering production or engineering restricted to repairs and simple metal manufacture** | 20 or less | 8 or less | 400 or less | 85–100 | | up to 50 | up to 400 |

*Sources*: Annex I. OEEC, *The Engineering Industries in Europe 1960*; United Nations: *Production and Export of Mechanical and Electrical Engineering Goods* (ST/ECE/ENG 1), Geneva (1960); *The Industrial Development of Peru* (E/CN.12/493) (1959); and national statistics of India, Mexico, Argentina, Brazil, Colombia, Pakistan

[3] See table 3 for detailed statistics.

[4] The subsequent data are mainly based upon the sources indicated in table 2. Since different statistical sources differ as to the system of classification or content, (e.g., value added or deliveries), they are not fully comparable. However, with necessary corrections, they reflect reasonably well the proportions of the subsectors of the engineering industry.

essentially satisfy the increasing domestic consumption (except in the case of Argentina) in the foreseeable future, bringing into existence the most important base of domestic supply of raw materials for, among others, the engineering industry. This group is distinctly separated from the next, according to all meaningful economic indicators in absolute numbers, such as value added and/or number of persons engaged, both in total manufacturing and in metal-transforming industries, steel production and consumption, etc.

Group II (with some ten countries, e.g. Chile, Colombia, Indonesia, Pakistan, Venezuela) is characterized by a manufacturing industry engaging about 200,000–500,000 persons, by an accordingly lower engineering production and by the manufacture of machinery and equipment, restricted to some relatively simple items. Steel production is at a beginning stage (or sometimes practically non-existent) in the countries of this group, but their steel consumption of about 400,000–800,000 tons already opens a possibility, especially where foreseeable increase is also taken into consideration, of economically justified domestic steel production.

This circumstance is actually reflected in the economic plans or provisions of several countries in the group. However, it is generally not planned to satisfy the domestic consumption by domestic production to an extent exceeding 70–75 per cent in the next ten to fifteen years. Groups II and III are less clearly separated and the latter is less homogenous, comprising countries with an already appreciable amount of manufacturing together with countries in which there is barely any manufacturing at all. However, this group is characterized by an absence altogether of engineering production or by engineering production restricted to simple metal manufacturing and repair work and without (or with a negligible amount of) machinery production, by low steel consumption and by rather remote prospects of a substantial development of domestic steel production.

The three groups described above can be interpreted as a simplified scheme of a normal pattern of the development of the engineering industry in less industrialized countries, this development being an integral part of the over-all process of industrialization.

The pattern in question can be considered as characteristic only in the case of less industrialized countries, implying by that the existence of and the close connexions with industrialized areas. In this context, there is evidence that the two major and interdependent factors determining the degree and the rate of development of the engineering industry are the size of the demand for engineering goods (which is largely determined by the home market in the countries in question) and the supply of raw materials, mainly steel products.

The development of domestic production of engineering goods largely takes the form of a process of substitution by domestically manufactured goods of goods produced by the handicraft (cottage) industry or of imported goods. Among the engineering products, the domestic manufacture of simple metal products is technically possible and economically sound already, with the relatively small size of the economy. Design and production processes are relatively simple; the requirements, from the point of view of skills, education and training of the labour forces, are not too demanding.

Owing to the nature of the demand and the uniformity of products, a scale of production is easily attained where domestic manufacture can operate with lower costs and higher productivity than the handicraft industry, arriving at a generally higher and more uniform quality of products. Further economies of scale are not so overwhelming in cutting costs and in increasing productivity as to make the domestic industry non-competitive when compared with units operating on a much larger scale in industrialized countries. With some products fabricated mainly from metal sheets, such as containers, stoves, etc., the high costs of transport (as compared to the costs of transport of raw materials) give relative advantages to the domestic industry. Repair work of already installed machinery or, frequently, of transport equipment is obviously necessary at a very early stage of economic development. Both simple metal manufactures and repairs are to be viewed also as preparatory activities by introducing similar machinery and providing training in the skills necessarily involved in a subsequently more complicated machinery production.

With an increase in the size of the economy in group II expressed in a higher demand of both consumption and capital goods and characterized by a higher output of the manufacturing industry (which was found to be of about $400–$1,000 million in value added), the manufacture of more complicated machinery goods becomes economically possible. The greater share of electrical machinery, when compared with the engineering industry of industrialized countries, is due to the similar advantages mentioned for simple metal products, specifically the relative simplicity of the production process and the uniformity of products.[5] The production of industrial machinery proper is not yet important.

Further increase in the size of the economy, characterized in group I by value added, in manufacturing, of about $2,000–$5,000 million, creates an important demand in machinery and, consequently, the production of industrial machinery proper, power-generating equipment, metalworking machinery, and special industrial machinery such as paper, textile, leather, food processing and chemical machinery. However, even countries of group I are characterized by a less important share of industrial machinery in engineering production than are the developed countries.

Collateral to this normal pattern, it can be said as a very rough approximation of the complicated development process that the manufacturing of engineering products of standard design and serial (or mass) production appears at an earlier (or lower) stage than individual manufacturing of machinery and equipment according to individual design. The whole development of engineering industries is influenced by the availability of domestic raw materials, mainly of steel. While a total self-sufficiency in steel products is obviously not

[5] This, of course, does not apply to heavy and special electrical machinery.

necessary, and often not even advantageous, the lack of domestic supply adequate to the level to be attained may slow the development of the engineering industry.

## The place of engineering industries in industrial development

It is almost impossible to give a universally meaningful statement concerning the priorities to be assigned to single economic branches in the process of industrial development of developing countries. Every case has to be analysed and investigated separately. Several methods of approach are known.

From the point of view of a country's economy as a whole, the main criteria of choice are based on or related to the impact of the resources to be devoted to investment, on foreign exchange earnings and expenditures and on manpower resources. The capital intensity (capital/output ratio) of the average of the engineering industry as a whole is near the average of total manufacturing: lower than that of metal-producing or chemical industries and higher than that of most light industries.

The foreign exchange effect depends largely on the proportion of domestic raw materials. If this is important, the engineering industry ranks high in foreign exchange earnings or savings. Finally, it is well known that the engineering industry is labour-intensive.[6] This feature is generally considered as an advantage in less industrialized countries; an advantage somewhat counterbalanced by the high requirements needed in regard to the skills and education of the labour force. It must be mentioned that this industry exercises a very active and dynamic outside influence, utilizing and at the same time generating a very important part of the new scientific and technological knowledge which, through different channels, has an important impact on the level of technological development not only in the industry but also in other economic branches.

The manufacture of industrial machinery and equipment should be viewed as a part, even one of the most difficult and complicated parts, of the engineering industry.

Such production is technically feasible in developing countries as a considerable and growing amount of industrial equipment is actually produced in all countries of group I and some countries of group II. The economic impact of the domestic production of industrial machinery in economic development is decisive and can hardly be overstated. It has been shown[7] that there are (rather theoretical and abstract) possibilities of substitution among import of grain, import of fertilizers, installation of a fertilizer plant and installation of a machine-building factory to produce the machinery of the fertilizer plant: all result in the same availabilities of grain. The alternatives involve foreign exchange and total expenditures of the following proportions:

| | Expenditure | | |
|---|---|---|---|
| | *Foreign* | *Domestic* | *Total* |
| Grain import | 1,000 | — | 1,000 |
| Fertilizer import | 270 | — | 270 |
| Fertilizer plant | 100 | 150 | 250 |
| Machine-building factory | 20 | 10 | 30 |

This example, certainly an over-simplification of the complex problem of substitution, shows clearly, however, not only the advantages of domestic production by the very important saving of expenditure in general and foreign exchange expenditure in particular, but the two main difficulties: the need of domestic capital and of skilled and experienced manpower in this connexion.

In the example, the grain is ready for consumption, but the fertilizer has to be ordered at least two years in advance of the crop season; in addition, it has to be distributed and utilized effectively, operations which require a considerable amount of competence. To build the fertilizer plant implies an investment of four to five years ahead of the availability of grain and, in order to establish the machine-building factory, the investment is required eight to ten years in advance, with the correspondingly higher requirements concerning the skills of the labour force to operate the plants and concerning other supplies, and obviously with some sacrifices of domestic consumption till the investment will pay off in increased production of grain.

The availability of industrial machinery and equipment is obviously a prerequisite of industrial development. It is equally obvious that it is neither possible nor desirable to produce domestically all industrial equipment in a developing country. The most appropriate share of domestically produced industrial equipment is not investigated in this study, but it must be noticed that official development plans and other studies (e.g. studies prepared by regional commissions of the United Nations) often indicate the necessity of considerably increasing the domestic manufacture of industrial machinery in order to increase the share of domestic production.

In framing economic policies for industrial development, it may be useful to consider the manufacture of industrial machinery and equipment in the framework of the engineering industry as a whole and to bear in mind the normal pattern of development, since this reflects basic economic and technological relations. However, it may be fully justified to plan a different pattern; for instance, to develop the production of non-electrical machinery in advance of the normal pattern. This would, of course, assume that full consideration has been given to the capability of the planning agency to implement the plans and of the prospects of efficient international co-operation.

## Promotion of the manufacture of industrial machinery and equipment

The available information on the promotion of the manufacture of industrial machinery and equipment (already existing or to be developed) in less industrialized countries, together with experience gained in indus-

[6] Compared with the average of the manufacturing industries in terms, for example, of the capital/labour, output/labour ratios, or the shares of labour costs in the value of output. There are, of course, considerable differences among subsections of the engineering industry.

[7] United Nations, *Economic Survey of Europe in 1959*, chapter VIII.

trialized countries indicate that appropriate scientific and technological knowledge and know-how and the increase in the scale of operations should be considered as the most important fields of action. According to the available information on capital output and capital/labour ratios, it seems that the burden of investment costs is less crucial here than, for example, in the chemicals or metal-producing industries. A smooth and organic growth, requiring only small investment resources at the beginning of the development period, is also possible.

The labour force of the industry from the skilled or even semi-skilled worker to the engineer or the scientist contributes by far the most important part to the factor of knowledge. From this point of view, the problem is identical to the problem of training.

An important part of the manufacture of industrial equipment in developing countries, principally as far as more complicated machinery is concerned, is extensive co-operation with some industrialized country, from contracts to blueprints, from know-how and training of the personnel to establishing subsidiary companies. Technological knowledge obtained by these means is very natural, useful and often the only possibility open to a developing country. However, an excessive dependence on foreign sources of technological information may, at a higher level of development, also cause adverse effects, e.g., slowing down the process of adaptation of product design and production methods to local conditions, or lessening the possibilities of competing in foreign markets.

The most important means for influencing the effectiveness of operation in the field in question, with regard to costs and productivity and even partly with regard to technical achievements, is the increase of scale of production.

The economies of scale do not result mainly from an increase in the volume of production if this is achieved only by a proportionate increase in the diversity of production (i.e., by producing completely new items), though several overhead costs will decrease even in this case. However, economies of scale result much more from a relative increase in the scale of production; by a shift towards serial (or batch) from individual production; by the increase of seriality, and by a shift towards mass from serial production. This means an increase in identical or similar items produced or operations performed at the same time on the same machine or equipment, with the same tool or instrument, according to the same design, etc.

In this context, there are wide possibilities of increasing the scale of operations, even within the limits of a given volume of production and/or a given size of final demand. The most important methods put forward are standardization, co-operation among different factories (subcontracting) and concentration on the production of widely utilized parts (and/or raw materials). It is to be noticed that all these methods are generally utilized in the engineering industries of developed countries.

The scale-increasing effect of standardization is exercised by all its forms, from in-plant standardization through special industry-wide standardization to national standardization. The first intends to reduce the variety of similar parts and components within one plant; the second has the same effect within a whole industry (machine building, in this case); the third has to reduce the diversity of final products through agreement between suppliers and consumers. It is probable that due to the very large number and variety of parts and components utilized in machine building, the second kind of standardization has the most important impact on the economies of scale of the industry as a whole.

In machine building in general (except in mass production), a part of the special equipment, e.g., machine tools producing large and heavy parts, is never utilized to full capacity when operated only for one particular factory. In order to utilize more effectively such equipment which is often very expensive and complicated, different factories may co-operate through a system of subcontracting, which can be developed as a useful and general method to ensure effective utilization of plant facilities and skills within the industry. A high proportion of parts, components, raw materials or accessories in machine building are identical, similar or produced by identical production processes, while the amount required by a single factory is below the limit permitting the operation of plant facilities with advanced and highly productive technologies. The method proposed in such cases, principally for castings and forgings, is the concentration of the production into a few, well-equipped plants serving a large number of factories.

These methods involve principally technical problems and problems within the engineering industry. To ensure the uniform utilization of productive facilities, there is a need for economic forecasting, and planning and co-ordination among industrial branches. Otherwise, it may happen that periods of overloading alternate with periods of idling, especially in heavy engineering and in view of the rather restricted demand in developing countries.

Even in the case of optimal utilization of the indicated methods it seems improbable that engineering industries of developing countries could attain a satisfactory scale of operations without an active participation in the international division of labour, i.e., without exports. The size of the engineering industries of developing countries belonging to group I is comparable, at least in regard to the number of those engaged, to that of the smaller industrialized countries. But, while exports of the former are insignificant, the latter export about 50 per cent of their engineering production and import as much or more, with the resulting economies of scale due to the possibilities of narrower specialization of the domestic production. For countries belonging to group III, pooling of their resources and planning on a subregional or regional scale can be considered as a prerequisite even at the initial stage in the manufacture of industrial equipment.

The complicated problems of finance, tariffs, goodwill, etc., of the export promotion of machinery are not investigated here. However, some remarks concerning the importance and possibilities of export promotion seem necessary. Co-operation of developing countries seems to be an easier way to promote exports of machinery than exporting to industrialized areas. The higher labour-

intensity of machine building is an advantage to exporting machinery as far as the competition with industrialized countries is concerned. The potential demand in developing countries, taken together or by regions, is important enough to permit a sharp increase in the production of industrial machinery in the countries in question.

An ECLA study[8] reviewing the equipment required for the projected expansion in 1961–70 of the petroleum, electric, steel, cement and paper and pulp industries, found the share of equipment that could be made by domestic industry at about 80 per cent of the total at prices competing fairly well with imported equipment. Another ECLA study put the share of domestic production in machine-tool consumption for 1967–71 to 65 per cent (against 38 per cent in 1955–61). The industries are representative of the heavy industry as a whole. Machinery and equipment for light industry is obviously easier to produce. If we accept the Brazilian figures as an indication of the share of domestic production and assume increasing co-operation between developing countries, it seems reasonable to admit the possibility of a share for domestically produced industrial machinery and equipment for 1975 of about 60–70 per cent.[9]

The importance of machinery exports cannot be evaluated only by the foreign exchange earnings. Exporting always raises the industry's effectiveness regarding costs as well as technical achievements. Export must be viewed as a major incentive to the development of industrial machinery and equipment production. The importance of this is not measured only by its output but rather by its impact on the whole course of industrial development.

The influence of the present dependence of engineering industries, in developing countries, on foreign sources for the technological knowledge and know-how, together with the role of subsidiaries of foreign firms in this respect, needs to be investigated. It is often easier to import technological knowledge than to develop it in the country. On the other hand, there are indications that plants being set up mainly to surmount tariffs on foreign exchange barriers, and being subsidiaries or licensees of a foreign enterprise, have no general policies favouring the extension of their activities towards export.[10]

## Need for research

In order to give substantial and immediate help to developing countries in the development of engineering industries, a detailed and comprehensive investigation of the technical and economic aspects of the present situation of this branch seems necessary. To avoid the abstract generalization of the widely known experience of industrialized countries or the excessive simplification in the description of the local problems of technological development, extensive information has to be gathered in the field in at least some of the developing countries. Information connected with technical and economic problems in industrialized countries is readily obtainable by the use of the generally good statistics, books, articles, and teaching materials, or of the practical experience of most specialists.

All this information, however, is scarce when it concerns the problems of developing countries. This aspect is even more important for engineering industries than, for example, for the fertilizer, aluminium or steel industries, where methods of production and the pattern of (possible) output are determined by the existing equipment, the alteration of which is generally a difficult and costly operation. The metal-transforming industries, the technological processes and their combination to produce a given output, as well as the design of products, are less determined by the existing equipment which can be more easily changed and developed.

In a local survey, attention has to be focused upon the problems of countries with less developed engineering industries (groups II and III) and the clarification of the following problems: volume and pattern of the existing and foreseeable demand for engineering goods, conditions of supply of raw materials and parts for the engineering industry, available production facilities and the possibilities of improving their utilization, comparison of actually utilized technological processes with technological processes in industrially developed countries, possibilities of increasing the scale of operations by standardization and subcontracting and the availability of a skilled labour force necessary to adapt and develop production technologies and product design.

Simultaneous with this investigation in the developing countries, and utilizing its results, attempts may be made to study:

(*a*) The equipment and technological processes to be utilized in foundries and forges, which serve a great number of machine-building factories, as an important means to improve productivity and quality in the production of raw materials;

(*b*) The possibilities of utilizing such technologies and processes, which permit substantial savings in skilled manpower (even at the cost of additional utilization of highly skilled or engineering manpower, e.g. numerically controlled machine tools);

(*c*) The adaptation and further development of the methods of forecasting, planning and co-ordinating of engineering industries, including the utilization of (mathematical) programming models, in order to improve the over-all utilization of productive capacities. It is furthermore proposed to devote special attention to the problems of the engineering industry in work projects already on hand such as those on repair shops, standardization, second-hand machinery, and in the field of training and management.

[8] *The Manufacture of Industrial Machinery and Equipment in Latin America. I. Basic Equipment in Brazil.* (E/CN.12/619/Rev.1), Sales No.: 63.II.G.2.

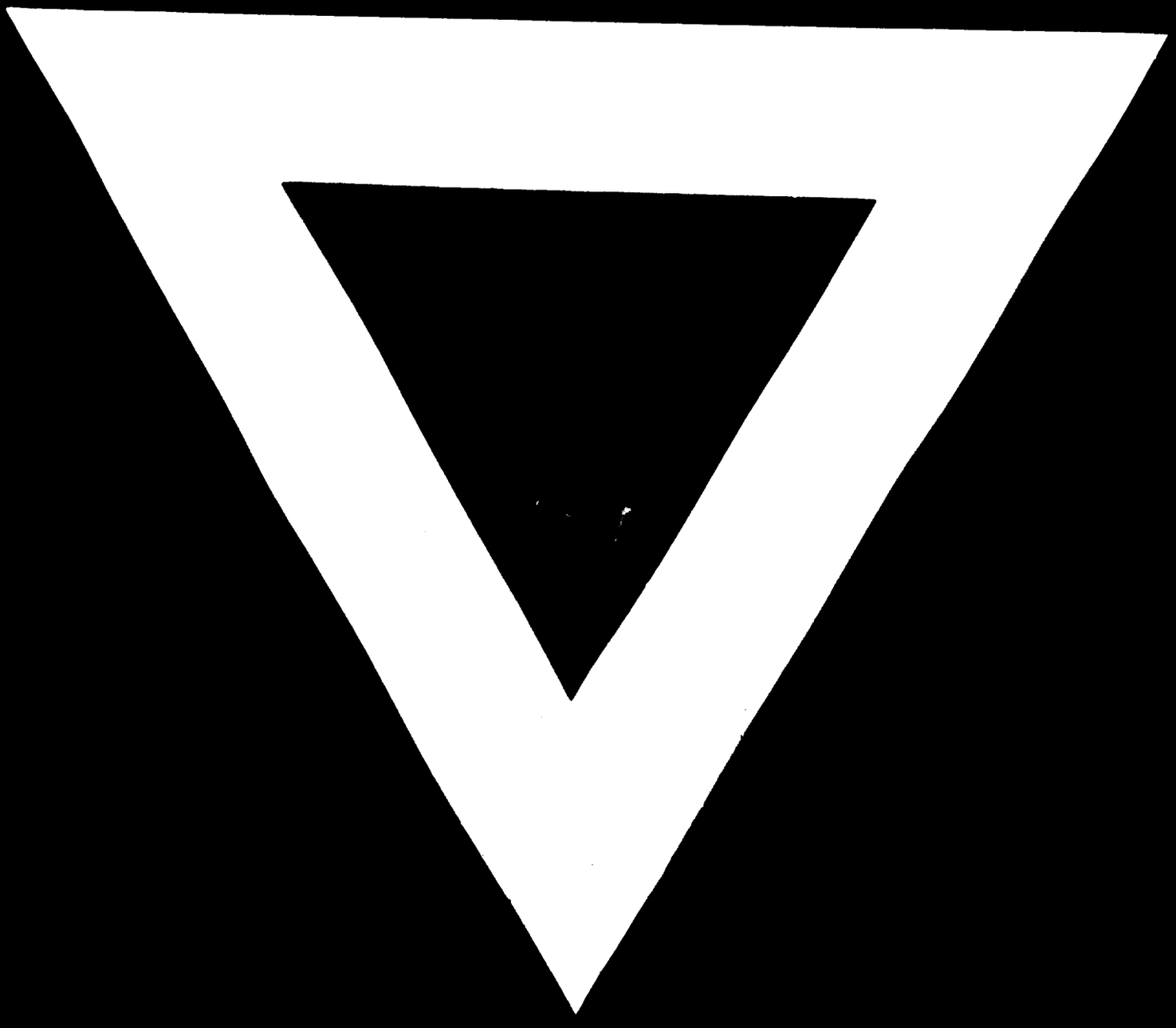
[9] This figure is not to be considered as a forecast of the probable share of domestically produced industrial machinery which has not been investigated here. A study, Projection of Demand for Industrial Equipment, prepared by the Centre for Industrial Development and published in *Bulletin on Industrialization and Productivity* No. 7 (1964) put the probable share to about 25 per cent.

[10] *Problems and prospects in the export of manufactured goods from the less developed countries*, United Nations Conference on Trade and Development, E/CONF.46/P/2.

*Table 3*

DEVELOPING COUNTRIES: SELECTED STATISTICAL INDICATORS OF INDUSTRIAL DEVELOPMENT

| Country | Value added in million dollars | | Share of metal products in total manufacturing (per cent) | | Steel | | Number of persons engaged in total manufacturing (thousands) |
|---|---|---|---|---|---|---|---|
| | All manufacturing ISIC 2–3 | Metal products ISIC 35–38 | Value added | Number engaged | Production (thousand metric tons) | Consumption (thousand metric tons) | |
| **GROUP I** | | | | | | | |
| India | 4,701.8 | 753.3 | 14.5 | 12.9 | 4,071 | 5,154 | 1,820.5 |
| Brazil | 3,643.8 | 645.2 | 14.3 | 11.5 | 1,843 | 2,701 | 1,547.0 |
| Mexico | 2,994.9 | 557.0 | 14.3 | 13.8 | 1,728 | 1,840 | 1,478.0 |
| Argentina | 2,412.7 | 480.0 | 20.7 | 25.3 | 441 | 2,379 | 1,411.0 |
| **GROUP II** | | | | | | | |
| Turkey | 1,012.6 | 100.1 | 7.4 | 10.9 | 282 | 549 | 295.3 |
| Venezuela | 886.6 | 85.9 | 6.1 | 6.0 | — | 448 | 137.8 |
| Pakistan | 803.1 | 101.6 | 8.6 | 11.6 | 9 | 192 | 397.9 |
| Colombia | 685.2 | 70.8 | 8.0 | 12.6 | 176 | 405 | 236.8 |
| Chile | 643.4 | 71.1 | 9.7 | 13.3 | 363 | 506 | 216.5 |
| Korea (Rep. of) | 571.6 | 58.5 | 9.9 | 10.3 | 61 | — | 260.6 |
| United Arab Republic | 497.6 | 44.6 | 6.0 | 7.0 | — | 373 | 260.8 |
| Philippines | 447.6 | 53.3 | 10.7 | 11.2 | — | 504 | 228.4 |
| Indonesia | — | — | 10.9 | 11.6 | — | 439 | 334.5 |
| Iran | — | — | — | — | — | 351 | — |
| **GROUP III** | | | | | | | |
| Peru | 367.6 | 28.4 | 6.1 | 7.8 | — | 246 | 116.3 |
| Federation of Rhodesia and Nyasaland | 356.4 | 57.4 | 24.6 | 22.4 | 60 | 244 | 109.6 |
| Cuba | 351.8 | — | — | — | 277 | — | — |
| Algeria | 341.4 | 66.1 | 22.0 | 20.2 | — | 402 | 146.7 |
| Uruguay | 313.7 | 57.6 | — | 18.9 | — | 86 | 191.4 |
| Morocco | 303.1 | 50.8 | 19.0 | — | — | 152 | — |
| Thailand | 253.5 | — | — | 10.3 | — | 257 | 189.8 |
| China (Taiwan) | 253.1 | 39.7 | 6.1 | 8.2 | 198 | 287 | 173.0 |
| Burma | 181.8 | — | 2.8 | 3.6 | — | — | 120.9 |
| Ceylon | 180.6 | 32.2 | 23.6 | 36.0 | — | 89 | 49.9 |
| Ecuador | 121.2 | — | 1.5 | 1.7 | — | — | 30.4 |
| Syria | 92.6 | — | — | — | — | — | — |
| Guatemala | 71.7 | — | 3.9 | 6.9 | — | — | 27.6 |
| El Salvador | 48.3 | — | 4.1 | 3.8 | — | — | 60.3 |
| Honduras | 41.1 | — | 2.8 | 3.0 | — | — | 20.1 |
| Nicaragua | 31.1 | — | 1.3 | 2.1 | — | — | 18.9 |
| Paraguay | 24.2 | 0.3 | 3.7 | 5.3 | — | — | 34.3 |
| Ethiopia | 23.2 | — | — | — | — | — | 20.0 |
| Nigeria | — | — | 5.4 | — | — | 182 | — |
| Tunisia | — | — | — | — | — | 79 | 12.9 |
| Ghana | — | — | 9.3 | 13.8 | — | 67 | 21.7 |



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