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SECTORAL STUDIES PREPARED FOR THE SYMPOSIUM:

ENGINEERING INDUSTRIES

Presented by the Executive Director of the United Nations
Industrial Development Organization

E/2821

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Introduction

1. Owing to the scarcity of reliable data on the state and nature of the engineering industry in the developing countries, the statistics in this sectoral survey are somewhat incomplete. Considering the potential importance of the industry to the economy of the developing regions, the lack of detailed research on the characteristics of the various products of the engineering industry is outstanding.

2. In the survey of industries in general in both developed and developing countries, it can be seen that the contributions of the engineering industries to employment and value added to production, relative to other industries, are higher in developed countries than in developing countries, and that the state of the metalworking industry in a given country is roughly indicative of the state of that country's industrial development.

3. The definition of developing countries as used in this paper is the same as that commonly used in United Nations publications, except that the developing countries in Southern Europe are not included.

4. As used in this study, the term "engineering industry" generally includes those products classified under the following groups:

Major group		Products included under group
I.S.I.C. a/	S.I.T.C. b/ (Revised)	
35	69	Metal products
36	71	Non-electrical machinery
37	72	Electrical machinery and equipment
38	73	Transport equipment

a/ International Standard Industrial Classification.

b/ Standard International Trade Classification.

I. PRODUCTION, CAPACITY AND TRADE 1960-1965

A. The role of the developing countries in the world engineering industry

5. The importance of the developing countries in the world production of engineering goods is small (annex, table 1). In 1961 the developing countries

(excluding southern Europe) accounted for about 3 per cent of world[1/] value added in the engineering sector, and in 1965 this was probably about 4 per cent.

6. A comparison of the production of engineering goods in the developing countries in 1961 and 1965 is set out in the annex in table 2. In 1961, fifteen countries[2/] accounted for over 80 per cent of the value added in the engineering sector of the developing countries (excluding southern Europe). Of these Argentina, Brazil, India and Mexico alone accounted for two thirds. The share of the developing countries in the world production of engineering goods represents the lowest proportion of any industrial group (table 3 annexed).

B. The role of the engineering sector in the economy

7. In 1965 the engineering industry represented about 35 per cent of world manufacturing production and something like 15 per cent of world income. On the other hand, the ratio of value added in the manufacture of engineering products to the income of developing countries represents a very low proportion compared with that of the industrialized countries (annex, table 4). This is due to (a) the less-industrialized nature of the developing countries; and (b) the lack of importance of the engineering industry in the manufacturing sector of the developing countries. This is illustrated in table 5, annexed. Therefore, as is well known, not only does the importance of industry as a whole grow with economic development, but the importance of the engineering sector within industry also increases.

8. Between 1950 and 1960, the annual growth rate in the world production of engineering products was about 9 per cent, compared to a rate of growth in gross domestic product of about 5 per cent; whereas estimated annual growth in the engineering sector in the developing countries was 11 per cent compared to growth in gross domestic product of 4 per cent. The annual growth rate in the engineering sector in developing countries (excluding southern Europe) between 1961 and 1965

1/ Excluding USSR and eastern Europe.

2/ Algeria, Morocco, UAR, Argentina, Brazil, Chile, Colombia, Mexico, Uruguay, Venezuela, India, China (Taiwan), Republic of Korea, Pakistan, and the Philippines.

is estimated at 15 per cent compared to an annual growth rate in gross domestic product of between 5 and 7 per cent. It is apparent from these figures alone that the growth of the engineering sector as a whole is very responsive to growth in the gross domestic product, the response rate being higher in the earlier stages of industrialization.

9. A Study of Industrial Growth[3/] reveals that the value added in the engineering sector increases at almost twice the rate of gross domestic product per head - only the basic metals and paper products groups show higher income elasticities while the ratio for the manufacturing sector as a whole was 1.37. The same study also revealed that the engineering sector was responsive to the size of the market (measured by population size); here the ratio for the engineering sector was 1.31 compared to 1.12 for manufacturing as a whole. The engineering sector was also responsive to the degree of industrialization (showing a ratio of 1.57), but per capita income was by far the most important factor in the growth of the engineering sector. As might be expected, the sectors (including engineering) that are highly responsive to income growth generally start from a small base.

10. It should be emphasized, however, that there was a relatively high variability from the general growth pattern among the developing countries and that the analysis was heavily biased by the high-income countries. In studies of the developing African countries the deviation in basic metals and metal products from the normal or expected path was significantly positive whereas this sector in Latin America seemed to be abnormally weak. The Asian countries studied showed no significant deviation.

11. The factors accounting for the "deviations" may be:

(a) The effects of government policy, particularly affecting the centrally planned economies and, to a lesser extent, India and Pakistan;

(b) Participation in free trade, affecting the small European countries, since this gives them a larger market. A regional union of several developing countries would have the same effect;

3/ United Nations publication, Sales No.: 63.II.B.2.

(c) Endownment in natural resources. The availability of foreign exchange through primary exports which provide the means of importing manufactured goods may have temporarily reduced the need for some countries (for example, Venezuela) to develop an engineering industry. Furthermore, the existence of a developed steel industry may promote the development of the engineering sector which depends heavily on the basic metals sector for raw material inputs.

12. The importance of the developing countries as a whole in the production of steel is roughly parallel to their importance in the production of engineering goods, since the developing countries produce between 3 and 4 per cent of the world output of steel.

13. The percentage of world consumption of steel is also similar (between 8 and 10 per cent) to the developing countries' consumption of engineering products (between 8 and 10 per cent).

14. It should be noted that the ratio of value added in engineering production to total gross domestic product understates the place of the engineering sector in the economy since engineering's backward and forward linkages with the rest of the economy are greater than almost all other manufacturing sectors. The engineering sector requires and trains more skilled manpower than most other sectors.

15. The three most important factors influencing the development of the engineering industry, given a certain income per capita, are:

(a) the size of the effective market;

(b) the availability of raw materials (especially steel products);

(c) the availability of skilled manpower.

16. Broadly speaking, of the four main sub-sectors of the engineering industry, metal products is the first to develop, followed or accompanied by the repair and assembly of the smaller types of transport and electrical equipment. The next stage is usually the manufacture of certain types of transport and electrical equipment and appliances, the manufacture or assembly of the simpler and lighter types of non-electrical machinery, and the manufacture of the heavier or more complex types of metal products. The third stage of engineering development is the manufacture of the more specialized types of machinery and the more capital-intensive sectors of transport equipment.

17. Table 6, annexed, illustrates this by showing the relative importance of the sub-sectors of the engineering industry for selected countries in various stages of development.

18. Table 7, annexed, shows how relative self-sufficiency is first achieved by metal products, followed by electrical machinery and transport equipment, and finally by non-electrical machinery.

19. Table 8, annexed, shows the approximate order of sequence of various engineering products according to various stages of development. Some indices of the stages of development are as follows:

Stage of development (less-industrialized countries)

	Stage 1	Stage 2	Stage 3
Value Added in the engineering sector as a percentage of the Value Added in the manufacturing sector	8% or less	8-15%	15-20%
Percentage of imports in the domestic consumption of engineering goods	75-100%	50-75%	25-50%

It is not possible to measure the stage of engineering development with reference to income levels (gross domestic product per capita) or engineering production ($US per capita), since the size of the market has an important influence on the diversification of the engineering industry.

20. In stage 1, metal products, manufactured mainly from metal sheets, and repair and maintenance facilities are predominant. For some metal products, such as metal containers, domestic utensils, window frames and metal furniture, the high transport costs of the finished product (as compared to the costs of the transport of raw materials) gives the domestic industry an important advantage. Simple metal products and repair facilities are also activities not requiring complex skills.

21. In the later part of the first stage, or at the beginning of the second stage of development, the assembly of electrical and some transport equipment (e.g. bicycles) is usually undertaken, as well as the manufacture of those metal products requiring larger markets or more complex skills than are available in

stage 1. However, the relative simplicity and labour-intensity of the methods of production are still the most notable features of the engineering products in the second stage.

22. The expansion of the market, the greater availability of steel, and the increased availability of skilled manpower characterizing the third stage of development enable the economic production of industrial machinery, power-generating equipment, metal-working machinery and special industrial machinery. However, the most notable distinction between the less industrialized countries in this stage (e.g., Argentina, Brazil, India and Mexico) and the more industrialized countries is that the exports of engineering goods from the less industrialized countries are negligible and that the share of industrial machinery in total engineering production is smaller.

C. Capacity in the engineering industry

23. Even on the basis of the scanty data available, it is clear that in many parts of the engineering industry in the developing countries there is substantial under-utilization of capacity.

24. A survey in Pakistan in 1963 showed that an estimated 80 per cent of the plants producing capital goods were operating at only one-third capacity, nearly all citing insufficiency of raw materials as a main cause. In Brazil, Ecuador, India and numerous other countries, the capacity of the engineering industry is extensively under-utilized.

25. Low utilization of capacity may be due to a variety of technical factors, (such as indivisibilities of scale), or a positive industrial policy (promoting competition), but frequent reasons given are a shortage of raw materials (due to a shortage of, or delay in obtaining, foreign exchange or import licences for the raw materials), and a shortage of skilled, supervisory labour.

26. Programmers of assistance might usefully consider the allocation of a larger proportion of aid to finance imports of raw materials and components for existing engineering industries in order to increase levels of capacity utilization.

D. Imports and exports of engineering products

27. Volume and type. In 1964, approximately one quarter of world exports of machinery and equipment (S.I.T.C. groups 71, 72 and 73) were imported into

developing countries. The total of world exports of machinery and equipment in 1964 was approximately $US40,000 million f.o.b.; exports from the developing countries accounted for less than 1 per cent of the world total.

28. Imports of metal products (S.I.T.C. Group 69) into developing countries totalled approximately $US1,000 million or something like 10 per cent of machinery and equipment imports, although this percentage was much higher in Africa (13 per cent). This reflects the lower domestic production of engineering products in Africa since metal products are among the first engineering goods to be produced.

29. Imports of engineering goods into the developing countries in 1964 are summarized in table 9 in the annex.

30. The low percentage of imports of metal products and transport equipment into Asia and Latin America is a reflection of the relatively advanced state of the engineering industries in those continents, since in the later stages of development, self-sufficiency is obtained in these two sub-sectors.

31. Therefore table 9 shows that, of the $US11,000 million of engineering imports into the developing countries, approximately 74 per cent consists of non-electric machinery and transport equipment.

32. The major suppliers. Table 10, annexed, analyses world exports of machinery and equipment (approximately 90 per cent of total engineering exports in 1964). This shows that almost half came from Western and Southern Europe and about 31 per cent from the United States and Canada. The table reveals that the United States and Canada were important suppliers to Latin America, that Europe was relatively more important to Africa and the Middle East, and that Australia, Japan and the centrally planned economies were relatively more important to South and South East Asia.

33. The importance of engineering imports. The proportion of engineering products imported into the developing countries to total imports of all commodities in 1964 was as follows:

1964 - $US billions	Imports of all commodities	All engineering imports a/	Engineering imports as per cent of all commodities
Latin America	9.0	3.8	42
Asia b/	13.1	3.8	29
Africa c/	7.0	2.5	36
Middle East d/	1.8	0.6	33
Total developing countries (excluding S. Europe)	30.9	10.7	35

a/ Including imports of metal products (S.I.T.C. Group 69).

b/ Excludes Japan but includes China (mainland), Republic of Korea and Republic of Viet-Nam.

c/ Excludes South Africa.

d/ Excludes Israel (unlike table 10 annexed).

34. The average annual rate of growth of world trade in engineering products between 1953 and 1964 was about 12 per cent, compared with a growth of 8 per cent in total world trade over the same period.

35. As an example, in spite of the laudable achievement of the Indian machine-tool industry in developing indigenous production, the value of machine-tool imports in absolute terms has increased considerably from $US17.58 million in 1956 to $US70 million in 1965.

36. Latin America constitutes a market for machine tools that is estimated for 1970 at some $US250 million per year, compared with the production of about $US50 million. The lack of a great quantity of machine types offers sufficiently attractive possibilities to justify a detailed analysis for the future.

37. The total of the exports of engineering goods from the developing countries was almost certainly less than $US400 million; or less than 1 per cent of the total world trade in engineering goods in 1964. Asia accounts for approximately 50 per cent of the engineering exports from the developing countries, and Singapore and Hong Kong about 40 per cent. The engineering exports from Latin American countries are generally weak relative to those of other developing countries and considering their stage of development.

38. When the products of a country are exposed to the world market, there are many indirect gains for industrial development. For one thing, for the product to be competitive requires it to be of better quality, efficiently manufactured and of superior design.

E. The consumption of engineering products

39. In this study, the apparent domestic consumption of engineering products was calculated for 1964 from estimates of production, imports and exports derived in turn from national statistics and the papers prepared for the various regional symposia on industrialization. These estimates are contained in table 11, annexed. An analysis of these estimates reveals the following broad picture of consumption:

(a) The consumption of engineering products per capita in the developing countries in 1964 was $US18 compared to $US740 in the United States.

(b) The total consumption of engineering goods was about $25,000 million or between 8 and 10 per cent of world consumption.

(c) The value of gross output of engineering goods was at least 50 per cent greater than the value of imports, but nevertheless approximately 40 per cent ($10,000 million) of apparent domestic consumption was satisfied from imports.

(d) Imports are estimated to have accounted for over 70 per cent of Africa's consumption, whereas they accounted for only 38 per cent and 31 per cent of consumption in Asia and Latin America respectively. Between 1960 and 1965, the consumption of engineering goods (by value) in the developing countries is estimated to have increased by at least 10 per cent per annum.

40. As an economy develops, changes in the consumption of engineering products seem to take place within the main sub-sectors rather than between them. Table 12 in the annex shows the percentage composition of the consumption of engineering goods (by value) for a number of developing countries and the United States.

41. In the case of machine tools, the low rate of production and import of machine tools into developing countries has produced a very low rate of consumption of machine tools as compared to that in developed countries. This gap has widened during the last five years since world machine tool production has increased at an average rate of 12 per cent per annum while the developing countries have reduced their imports, which form the main share of their consumption, and have even decreased their production in some years. Imports into Asia and Latin America were lower from 1960 to 1964 than in the 1955-1959 period.

42. The process of industrialization cannot be accelerated without an increase in the stock of efficient machine tools at the disposal of developing countries. Roughly, for every two persons engaged in metalworking industries, one machine tool is required.

F. Employment in the engineering industry

43. In the developing countries, employment in the engineering industry forms a higher proportion of the world total than does value added. In 1961, for example, employment in the engineering industry in developing Latin America, Asia and Africa represented 14.6 per cent of world[4/] employment in the engineering industry, whereas value added represented about 2.8 per cent of the world total.

44. In 1961 approximately one-third of the industrial labour force was engaged in the engineering sector in the industrialized countries, whereas the proportion in the developing countries was 14 per cent.

45. Data on the numbers employed in the engineering sector in developing countries are scanty, and the number employed in the developing countries (excluding southern Europe) could be, using the information available, probably about 5 million, of which about 60 per cent are employed in Asia (at least 40 per cent in India).

46. Growth in employment in the engineering sector in the developing and developed countries is shown in table 13 annexed.

II. MAJOR FACTORS AFFECTING THE DEVELOPMENT OF THE ENGINEERING INDUSTRY IN THE PERIOD 1960-1965

A. Investment in the engineering industry

47. Uses of investment. The total investment in the engineering sector in developing countries is impossible to calculate because of the lack of data available. Capital measurement is generally the weakest part of industrial statistics in the developing countries. The capital input per unit of output is probably far higher in the developing than developed countries, being a result of:

(a) Machinery requirements, which are at least as great due to either higher costs or less intensive utilization;

(b) Ancillary fixed investment which is probably due to poor infra-structural facilities (e.g., energy supplies and transport facilities);

4/ Excluding the centrally planned economies.

(c) Higher requirements of working capital due to less reliable supplies and deliveries of raw materials and finished products, lower standards of inventory and production control, and a slower rate of turnover.

48. Sources of finance. The sources of finance for investment in the engineering sector have varied considerably according to the industrial policies of particular countries. Investment by the public sector has, as a general rule, been channelled into basic industrial sectors, which call for substantial investment, and which generally, with the somewhat limited markets, entail greater risks. Examples of such sectors are the iron and steel, petroleum, fertilizer and other chemical sectors. Enterprises owned by the State or developed by the public sector generally account for less than 10 per cent of engineering output in Latin American countries, although in some countries (e.g., Mexico) the State plays a more important role either by direct management or through minority shareholdings.

49. Next to the protectionist policy, the direct participation of the State in the engineering industry has been the most important influence on its growth in those developing countries with a more highly developed engineering industry (Argentina, Brazil, India and Mexico).

50. Foreign private investment has also varied in importance, depending on the industrial and fiscal policy of the Government. The majority of private foreign investment in the engineering sector, especially in Latin America, has been in the manufacture and assembly of motor vehicles.

B. The trend and level of engineering prices

51. The general trend in prices. It is well known that world export prices of manufactured goods have been generally rising relative to primary product prices over the past ten or fifteen years. Table 14 (annex) shows the trend in world prices of engineering goods (machinery) compared to other commodities between 1953 and 1964. This table shows that rises in the price of machinery have been more consistent and faster than the rises in prices of any other group of commodities.

52. The level of engineering prices in the developing countries. The scarcity of data, the heterogeneous nature of engineering products, and the problems posed by exchange rates make it difficult to compare engineering product prices between various countries. Research in this field would be useful.

53. Steel prices. More than 15 per cent of the cost of output of engineering products is represented by raw materials (excluding fuel), and in particular by iron and steel products. In 1965 world steel capacity exceeded production by about 18 per cent, although until 1955, there was a surplus of demand for steel over capacity. In 1955 surplus capacity appeared, and continued to grow until 1963; since then it has remained more or less constant. This surplus capacity has been partly reflected in falling prices. For example, E.C.S.C. export prices, shown below, indicate a general fall in prices between 1960 and 1965 of about 20 per cent.

$US per ton F.O.B.

	Wire rod	Hot rolled strip	Plate 3/8" and over	Sections
1960	102-104	110-112	110-112	101-102
1962	89	93	91	94
1965	89- 90	96	99	84- 86

The excess capacity in 1965 is estimated at 75 million ingot tons and is expected to remain at this level up to 1980. Substantial under-utilization of capacity will therefore remain until 1980 and with the persistence of surplus capacity, world steel prices are likely to continue to fall over the next decade. Both domestically produced and imported raw materials are probably on average over 50 per cent higher in the developing countries. Since raw materials (mainly steel) represent more than 15 per cent of the production cost of most engineering products, the higher prices of steel will mean, other costs being equal, that the prices of engineering goods will be at least 8 per cent higher in most of the developing countries.

54. Wage costs. On the basis of the scanty information available, the tentative conclusion is reached that the low value added per employee in the developing countries relative to the United States and Japan is more than outweighed by the lower labour costs. Since wage costs represent more than 25 per cent of the cost of most engineering products, the relatively lower cost of labour per unit of output gives a price advantage to the developing countries which is probably sufficient to offset the higher cost of raw materials for many products.

55. Other costs. Capital costs per unit of output are probably higher in the developing countries for most engineering products, owing to the lower utilization

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of capacity, the higher proportion of "ancillary" capital (working capital, and investment in buildings), and the higher initial cost of machinery and equipment. Costs of electricity and other power sources are also probably higher but these are unimportant cost components in most engineering products.

56. Engineering product prices. It can therefore be broadly stated that the prices of those products which are labour-intensive, and which do not require special jigs or machinery for particular operations, will generally be lower in the developing countries. Since the cost of transporting finished engineering products may be as much as six times the cost of transporting raw materials, the prices of domestically produced engineering products in developing countries will generally be lower than import prices for those products with a low value-weight ratio. Since these are usually the products which are relatively labour-intensive their prices in developing countries are generally lower in domestic production than imports. Acquisition of automated machinery by developing countries is usually done either through a co-operative joint venture with an international corporation or by a government loan or guarantee. In the first case, the developing economy may induce the corporation to build and operate an automated plant by providing trade, tax or other concessions. The point is that instead of purchasing the equipment directly, it is purchased by concession - partnership or other form of payment in lieu of immediate cash. In the second approach, a Government may be induced to provide the purchaser with a loan or the seller with a guarantee, usually through banking channels.

C. The institutional framework and measures for the promotion of the engineering industry

57. Import substitution. There can be little doubt that import substitution has provided the greatest stimulus to the development of the engineering sector in the developing countries and that import duties have been used extensively as a means of promoting import substitution.

58. An import substitution policy must be controlled very carefully, since indiscriminate tariff protection can give rise to a number of disadvantages. Some of these are:

(a) A lack of competition leading to high prices and profits in the protected sectors;

(b) A duplication of domestic production facilities leading to excess capacity;

(c) There may be only an apparent saving in foreign exchange, that is, the total import saving may be quite small relative to the direct effect; this may be particularly applicable to the engineering sector if ferrous raw materials are not domestically available. Assembly operations may also bring only very small savings in imports.

59. Tariff levels should therefore be structured to reflect the country's state of development and should be continuously reviewed. A fact which is often ignored is that protection stems from the difference between duties on raw materials and duties on finished goods, and not merely the absolute level. If tariffs are raised to unnecessarily high levels, domestic price levels will be far higher than international prices and exports and regional integration will be discouraged. This is particularly important for engineering products which, especially in the early stage of development, are heavily dependent on imports and for which the domestic market is initially very limited. Import policy has also been used for export promotion purposes, as, for example, in Pakistan.

60. The incidence of tariffs on engineering goods was studied for a number of countries, namely, Brazil, India, Pakistan and the United Arab Republic. One of the most striking aspects of the tariff structures in these countries is their complexity, although there have been moves to simplify them in recent years, sometimes, as in Latin America, as a result of the movement towards regional integration. The complexity does, however, make it difficult to compare import restrictions.

61. Exemptions from import duties are also substantial in some countries. For example, in the early 1960's the ratio of the incidence of actual duties to theoretical duties on all products was 40 per cent in Chile and 50 per cent in Brazil.

62. Of the four countries analysed for this study, Brazil generally levies higher import duties on engineering goods than the others. The approximate levels of duties in the four countries in 1966 are given in table 15 annexed.

It appears from this table that the prime function of tariffs in the four countries is to protect local industry rather than to raise revenue, since tariffs are generally higher on metal products, the most developed sub-sector.

63. Other policies for the promotion of the engineering industry. A number of other incentives have been used to encourage engineering development in the developing countries, but none has been as far-reaching as import substitution.

64. The pattern of international assistance to the developing countries for the engineering industry is probably rational, although it is arguable that in the cases of some countries, more aid might usefully be given for manpower training and the imports of raw materials in view of the low utilization of capacity in many parts of the engineering industry.

65. The existing practice shows that the maintenance and operation of automobiles, refrigerators, radios and other equipment by companies of those countries which supply these items may be acceptable at the first stage only. It is evident that with the growth of development national repair facilities must be created as national service in a country makes it possible to render services to the industry and to the population more economically and more quickly than service from the supplier country.

III. THE TECHNICAL AND ECONOMIC CHARACTERISTICS OF THE ENGINEERING INDUSTRY

66. The technical characteristics of the engineering industry show great diversity, and it is therefore difficult to generalize about them. Broadly speaking, however, these statements can be made: (a) metal products involve chiefly sheet metal-cutting and the riveting and welding of plates, tubes and profiles; most products in this sector have a low-value weight ratio; (b) products in the mechanical machinery group (except agricultural implements) are machined to close tolerances, after forging, pressing or stamping, and generally have a medium to high value-weight ratio; (c) heavy electrical machinery (e.g. transformers and generators) requires the same processes as metal products plus other machining processes working to close tolerances. Light electrical products (components and domestic appliances) require capital-intensive stamping and machining processes. Electrical products, apart from batteries and primary cells, have a medium to high value-weight ratio; (d) motor vehicle manufacture requires pressing, forging and machining processes; bicycle manufacture requires metal-cutting and welding; and shipbuilding requires forging and metal-cutting processes.

67. Broadly speaking, the major technical developments affecting the engineering industry fall into three groups:

(a) The substitution of aluminium and synthetic materials for the major input, namely steel;

(b) The development of transfer and multi-stage machinery and numerical programming;

(c) The development of miniature and adaptive technology - involving the development of machines, plants or processes which can produce economically at smaller scales than hitherto possible, or use different factor combinations or use more versatile multi-purpose machines.

68. In general, in the engineering industry, raw material losses are small and, since the cost of transporting the finished product is from two to six times the cost of transporting the raw material, there is a tendency for engineering products to be market-oriented, although of course the precise location depends on numerous other factors such as the value-weight ratio and the raw material content of the product, the economies of scale applicable to the product, and the domestic

availability of raw materials, labour and capital. The capital intensity of the engineering industry is generally lower than that of the other "dynamic" sectors of industry (e.g. steel, chemicals and non-ferrous metals), although there is considerable variation among engineering products.

69. When total capital investment (including working capital) is considered, the advantage of lower capital-intensity for the engineering sector is slightly reduced. On the basis of data relating to India, Japan, Pakistan and the Republic of Korea, the working capital requirements of the engineering sector are generally slightly greater than those of most other manufacturing sectors.

70. Industrial patents and licensing agreements are rarely a substantial obstacle to the development of the engineering industry, although the developing countries are rarely equipped to offer effective protection to the inventions of their own nationals. Indeed, the most serious burden of the patenting system to the developing countries probably arises where the patented technology is not transferred.

71. The linkages of the engineering industry with other sectors of the economy are considerable, the forward linkages being particularly extensive. The principal forward linkage of the engineering industry as a whole is with the demand for investment goods, and inter-sectoral consistency is therefore an important factor in the projection of demand for the engineering industry. The backward linkages of the engineering industry are also considerable, the principal one being with the basic metals sector (especially the iron and steel industry).

72. Basic metals are important inputs in the metal products sector and basic metals and metal products are important inputs in the non-electrical and electrical machinery sectors. For every $100 of final engineering output, between $US10 and $US20 of gross output is required from the basic metals sector. The principal demand is for flat ferrous products, bars, shapes, narrow plates, forged products and castings. The demand for wire, tubes and non-ferrous metals is relatively minor. The major demand for non-ferrous metals (at least in the first stages of development of the engineering industry) is from electric wires and cables, while the major demand for tubes is from bicycles and structural units of steel tubing (e.g. window and door frames). The first of these raw materials to be supplied locally will usually be castings and forged products, unless the domestic market is large enough to enable the economic production of other iron and steel products.

The establishment of a "foundry industry" will, however, be economic for most developing countries.

73. Water and power requirements of the engineering industry are not, relative to other industrial sectors, particularly great.

74. Whether or not, a developing country makes a conscious attempt to develop particular engineering products depends on the importance which the Government attaches to the various criteria, since the engineering industry with its considerable linkages may require large imports of materials thereby having an adverse effect on the balance of payments.

75. The engineering industry generally has a low capital intensity compared to the average for the manufacturing sector but its requirements of skilled labour are generally above average. Manpower required and available for the engineering industries to be set up in a developing country should be considered even as early as the planning stage, so that training could be taken up where necessary.

76. Indeed one of the chief obstacles to the orderly development of the engineering sector in the developing countries is the scarcity of suitably qualified labour. In terms of skilled manpower, the engineering industry as a whole is one of the most demanding sectors of industry. Although the metal products sub-sector requires less skilled labour than industry as a whole, the machinery and equipment sub-sectors require considerably more. The needs of the engineering industry for professional and technical workers are particularly great, although the needs of the sub-sectors vary considerably as do those of particular products.

77. The scanty information available seems to indicate that there is a general rise in the level of skills required as the engineering industry develops and moves away from repair activities and the manufacture of simple metal products towards serial or mass production of components, appliances and machinery. The demand for professional, technical and semi-skilled workers tends in particular to show a rapid rate of growth.

78. The formation of a large nucleus of professional and skilled labour is therefore a precondition for the efficient development of the engineering sector in the developing countries and the technical training of a skilled management élite should be given the highest priority by the developing countries. Furthermore the emphasis should be given not so much to the training of highly skilled

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technicians conversant with the latest technology but rather to the short, intensive courses for workers already in employment, and for the managers of both large and small existing engineering establishments.

79. The training of a skilled engineering labour force will (a) encourage more shift work to be undertaken, so economizing on scarce capital resources; (b) reverse the trend towards more capital-intensive machinery, so using more unskilled labour, the opportunity cost of which is likely to be minimal; (c) improve the quality of output and promote standardization, so helping to promote exports and regional integration; (d) increase the utilization of capacity by reducing the time lost through machinery breakdowns and by improved inventory management; and, (e) reduce the dependence on expensive foreign technical know-how in the form of, for example, "turnkey projects", patents and licensing.

80. A shortage of skilled labour tends to encourage the use of more capital-intensive methods, as do other factors, namely:

(a) The increase in the differential between the social and market costs of unskilled labour through minimum wage legislation, social security financing and collective bargaining;

(b) The reduction in the cost of machinery relative to raw materials and semi-finished components through the import duty and licensing structure; and

(c) The high cost of local, vis-à-vis imported, machinery because of over-valued currencies.

81. Because of the relative social cost of labour and capital in developing countries, there is an urgent need to adopt relatively labour-intensive techniques, where possible. Unfortunately information on the capital-labour substitution possibilities in the engineering industry is scant and inconclusive. Most of the research work so far carried out on the economics of various labour-capital combinations has been connected with the promotional work on small industries, and this has tended to confuse the issues. Much more research needs to be carried out in the field of intermediate technology to discover the flexibility of various processes and to investigate the labour-capital substitution potential of, for example, aluminium in place of iron castings, plastic extrusions in place of metals, and welding techniques in place of large castings. It needs to be emphasized that intermediate technology is not the substitution of small-scale in

place of large-scale plants or the adoption of second-hand machinery, but the adaptation of a technique suited to the relative availability of labour and capital in the developing countries. There are, however, a number of policy actions which will increase the labour/capital ratio in the engineering industry. These are:

(a) Better utilization of existing capacity;

(b) Altering the relative prices of capital and unskilled labour through the use of taxes and subsidies to more closely reflect their social costs;

(c) Using labour-intensive methods of production, where these are shown to be as efficient as more capital-intensive methods;

(d) Promoting the production, as far as is consistent with other criteria, of labour-intensive engineering products;

(e) Utilizing second-hand machinery;

(f) Searching out and adapting designs of machinery used in the developed world when a different capital/labour pattern exists;

(g) Promoting small establishments;5/

(h) Adapting machinery, equipment and production methods to the needs of the developing countries.

82. Information on economies of scale in the engineering industry is almost non-existent. The relationship of cost to levels of production is known for a few products but it is clear that a considerable amount of research in this field to discover the nature as well as extent of economies of scale is necessary.

83. Technical economies of scale may be derived from (a) a greater division of labour, (b) the integration of processes, and (c) physical indivisibility. In the engineering industry, the economies derived from (c) are fairly small, but in the early stages of development, the economies from a greater division of labour and the integration of processes are probably considerable. In the later stages of development of the engineering industry, the technical economies of scale are probably insignificant.

5/ However, because of the doubt concerning the claimed advantages of small-scale industry (i.e. increased employment absorption, income distribution, increased competition and training of skilled labour), aid to small industry should be directed to removing their disabilities rather than giving them a net advantage, through concessional interest rates, for example.

84. The most important economies in the engineering industry are probably derived not so much from growth in the sizes of particular plants but from the development of the engineering industry as a whole. This is particularly the case in the middle and later stages of development, when the pecuniary and external economies become predominant (that is, economies derived from the development of a trained labour force, cheaper credit, common supply services, specialized management, specialized market research facilities, etc.).

85. Some of these economies can, however, be derived in the early stages of development by standardization agreements, sub-contracting, common repair workshops, co-operative research and selling organizations, and the establishment of industrial estates.

86. A scheme for the development of research and design services geared to the development of the engineering industry may be broken down into the following stages.

Stage 1: Technical training institute whose research laboratories and specialized staff assist and advise the industry with respect to particular problems.

Stage 2: A single mechanical engineering research centre separate from the training institute. This centre may design machinery for the engineering industry, conduct research on processes and specific mechanisms at the request of enterprises, render technical assistance in bringing into use complex imported equipment and technological processes, and supply the industry with technical and economic information concerning the latest advances; the staff of the research centre take part in the work of technical training establishments.

Stage 3: A single centre in the metal-working field and separate centers in the different branches of mechanical engineering, to develop equipment for the processing and extractive industries. At this stage there is greater specialization by types of machinery; the laboratories are concerned both with technology and with the development and study of the necessary equipment, in addition to rendering assistance to industry.

Stage 4. Research centres for particular branches of mechanical engineering, and design and research services at the plant. The centers work on long-range questions of industrial processes, regulating systems, machinery units and components, assist in solving the more complex problems facing plants, and

provide the industry with technical and economical documentation and information. Practical work on the development of machinery design services of the enterprises.

87. According to the level of development it has attained, the country concerned selects the most suitable form or organization for its scientific and design services.

88. Engineering industries in developing countries would require large investments, and for countries too small to start and maintain such an essential industry, regional co-operation between such countries could solve the problem. Financial and technical assistance and other forms of aid from developed countries would also help.

89. Regional co-operation between groups of developing countries is probably the most extensive method of developing the engineering industry at the lowest possible cost. The possibilities for regional co-operation will depend on the size and density of the regional market, the cost of imported products, the transport network and the weight-value ratio of the product, as well as the political and institutional framework of the region.

90. Generally speaking, those products which have a low value-weight ratio and for which the economies of scale and minimum economic capacity are small (those requiring separable and specialized tasks of a service nature, or requiring simple assembly operations such as bicycles - or involving a simple transformation of a bulky raw material - domestic utensil, metal containers, small agricultural implements) will be suitable for development on the basis of a small national market. Other engineering products, however, which yield greater economies of scale, have higher value-weight ratios, or require specialist skills, (for example, most industrial and metal-working machinery, heavy electrical equipment, electrical components for vehicles, and the manufacture of electrical household equipment and motor vehicles) will need to be based on wider national or sub-regional markets, and therefore for the economic development of these products, some form of sub-regional co-operation will usually be necessary.

91. Among the developing countries and from case studies of industries in these areas, it is found that a certain pattern of industrialization prevails. A country developing its engineering industry appears to go through three typical stages: a first stage during which installation, maintenance and repair of metal-working machines and other types of machines in other industries take place; a second stage,

wherein some manufacturing of metal goods is carried out, mainly for local consumption; and the third stage, wherein complicated machines are produced, not only for local use but also for export, and the development of basic industries such as steel production also takes place.

92. It is also found that as the developing countries are in various stages of metal-working development, their problems are varied. It is, therefore not possible to prescribe one formula for all developing countries. For instance, in those countries which are still in the first stage, the most pressing problem may be more of organization rather than a technical problem.

93. The experience of developed countries are found to be useful, but they must be adapted to local conditions. Co-operation with developed countries will enable developing countries to by-pass many trial stages.

94. A developing country has greater ability to use automated tools at a faster rate than a developed economy, due to the size, age and greater flexibility of its industrial plant. Although there are major obstacles to automation in developing countries of both social and economic origin, selective automation at the correct stage of industrialization cannot only be beneficial but may be necessary. Automation in the metal-working industries in developing countries may be the only route to survival and may be required to gain the "jump" in technology for competing in a technologically developed world market. However, great care and serious economic and social analyses must be placed over considerations of "prestige production" if automation is to be of real benefit in the developing countries.

IV. THE CHARACTERISTICS AND PROSPECTS FOR REGIONAL INTEGRATION OF THE ENGINEERING INDUSTRY IN DEVELOPING COUNTRIES

A. Introduction

95. Table 16 (annex) clearly emphasizes what is generally recognized as developing Africa's greatest obstacle to industrialization and self-sustained growth, namely the small size of the national markets, whether measured in terms of population, total national income or income per capita. More than four-fifths of the countries in developing Africa have a national income of below $US1 million a year, and two-thirds have an income per capita of less than $US100 a year.

96. On the other hand the countries in Latin America, Asia and the Middle East generally have larger markets (in terms of annual national income) although the annual income per capita is lower in most of the Asian countries than those of Latin America and the Middle East. However, the "effective" sizes of national markets in many of the countries in Latin America and the Middle East are reduced below their apparent sizes by the regressive pattern of income distribution.

97. Data on the extent of internal and external economies of scale for individual engineering products are scanty but it is safe to say that the size of the domestic market in the majority of the developing countries only supports the local production of a minority of engineering products, without resorting to extensive tariff protection or other forms of subsidy. Since, moreover, the prospects for exports of engineering products to the developed countries are generally poor, (especially in the initial stages of development), most engineering products will only be produced (if an excessive degree of import protection is to be avoided) on the basis of larger markets achieved through subregional co-operation and integration.

98. The following sections discuss the problems and prospects of the engineering industry in the regions and subregions.

B. Africa

99. In Africa many of the colonial trading and economic patterns still exist and most of the intra-regional trade is concentrated within groups of countries formerly linked to the same metropolitan country. There have been attempts by ECA to forge new groupings but none of these have as yet been notably successful.

100. In 1965 developing Africa probably accounted for less than 0.5 per cent of world value added in the engineering industry, and for about 6 per cent of the value added by developing countries. Value added in the engineering sector contributed less than 2 per cent of the gross domestic product in 1965 compared to more than 15 per cent in the industrialized countries.

101. In 1965 imports of engineering goods into Africa totalled approximately $US2.5 billion, or something like 36 per cent of all imports. Exports of engineering products were negligible.

102. Consumption of engineering products in Africa in 1965 totalled about $US3.3 billion or $US12 per head. Production represented about 30 per cent of consumption and the opportunities for import substitution are therefore considerable, especially in the field of infra-structural and transport equipment. Imports of machinery and equipment increased annually by over 15 per cent between 1950 and 1965.

103. The North African subregion accounts for over half of the region's production of engineering goods, and within the Mahgreb countries, co-ordination and the subregional allocation of new capacity is an essential precondition for the efficient development of the iron and steel industry, the assembly and manufacture of motor vehicles and the production of textile machinery.

104. The most developed sectors of the engineering industry in East Africa are the fabrication of metal products for building and household purposes and the repair of transport equipment and machinery.

105. In 1975 the metal products sector is expected to achieve 80 per cent of self-sufficiency compared to about 65 per cent in the mid-1960's.

106. It is also expected that the assembly of transport equipment will rapidly expand and that about 65 per cent of demand will be supplied by subregional industry in 1975. Self-sufficiency in the electrical and mechanical engineering industries will be 50 per cent and 25 per cent respectively in 1975. In the field of mechanical machinery, the earliest possibilities for development are in the manufacture of textile and agricultural machinery.

107. The value added in the East African engineering industry in 1975 is expected to total about $220 million; an annual growth rate between 1965 and 1975 of approximately 11.5 per cent compared to a forecast average growth rate in national income of 5 per cent.

108. The consumption of engineering products in the subregion is expected to increase at a rate of between 6.5 and 7.5 per cent per annum during the next ten years.

109. The expansion of engineering production in East Africa derives most of its impetus from import substitution, and with the development of component standardization and suitable transport facilities, over 40 per cent of the sub-region's imports of machinery and transport equipment should be from subregional sources in 1975.

110. Apart from the metal products industry (excluding some items which require large manufacturing units) and the units manufacturing simple agricultural machinery and implements (ploughs, barrows, etc.), the development of the engineering industry should be co-ordinated on a group or subregional basis.

111. Statistics on the engineering sector in West Africa, are scanty. Partly, however, because there is no significant iron and steel industry in the subregion, the engineering sector is less developed than in East Africa or North Africa.

112. However, the ECA has recommended that two iron and steel plants be established in the subregion, and these, together with the completion of the Volta River project in Ghana, and the Kaiinji Project in Nigeria, should encourage a rapid expansion of the engineering sector over the next decade. The assembly of transport equipment is growing rapidly in Nigeria, the Ivory Coast and Senegal, and various other metal-transforming industries have been developed in Sierra Leone (nails), Nigeria (simple electrical machinery), Ivory Coast (aluminium utensils), Mali (window frames), and Senegal (agricultural implements).

113. However, the assembly industries are generally working at only about 50 per cent of capacity. Subregional or further bilateral agreements are desperately needed in the engineering sector of West Africa (especially for assembly operations), due to the limited size of national markets.

114. Forecasts for the engineering industry are difficult to make since much depends on the speed of development and location of an iron and steel industry in the subregion. The consumption of engineering products is likely to grow by approximately 7 per cent per annum and annual production by at least 10 per cent. The expansion of engineering products will be concentrated in the next five years in the manufacture of domestic utensils, wire products, bolts, nuts, etc., small agricultural machinery, small combustion engines, and the repair and assembly of electrical appliances and transport equipment.

115. One of the characteristic features of intra-African trade is its marked concentration according to economic and monetary groupings. The legacy of old colonial groupings, and the associate membership of a number of countries to the EEC present considerable obstacles to the development of regional groupings according to geographic and transportation characteristics.

116. The engineering industry in the Central African Republic, Chad, Congo (Brazzaville), and Gabon is almost non-existent (although small assembly activities are in operation) and the engineering industry in the Congo (Democratic Republic) is only in the early stages of its development.

117. Imports of engineering products into the subregion in 1964 were $US135 million representing about $US5 a head. Imports of mechanical and electrical machinery grew by 9 per cent per annum between 1960 and 1965, and consumption probably by the same amount.

118. The integration of the subregion is considerably hindered by the poor transport facilities, and the low population density.

119. The typical African State provides a market for engineering products which is no larger than that of a small West European city with a population of about 200,000. Economically viable production units in most branches of the machinery industry and parts of the metal products and transport equipment sectors require substantially larger markets than those of most individual African States.

120. The need for speedy action in this field in all four sub-regions of developing Africa should, therefore, be obvious, since the longer industrial planning proceeds on national lines, the more inefficient units of production will be created. In the engineering sector, this will lead to similar problems to those experienced in many Latin American countries (namely under-utilization of capacity, lack of specialization, high capital output ratios and high costs) except that the problems will be magnified for African countries because of their special disadvantages.

121. Intensive studies are urgently needed, expecially in North, West and Equatorial Africa, of the co-ordination of the transport and industrial structure and the availability of minerals and energy supplies.

122. In East Africa, the present transport system is a deterrent to the integration of the subregion, since Ethiopia and Zambia are, for example, relatively isolated, although Zambia does have access to a substantial market in Katanga (Democratic

Republic of the Congo). Therefore the integration of the engineering and other industrial sectors needs to be accompanied, or even preceded, by the subregional integration of the transport network.

123. One principle of regional integration that should be borne in mind is that each country in an integrated economic grouping must receive more or less equal benefits. In static terms, Zambia, Malawi and the United Republic of Tanzania probably lost from their membership in the Federation and the East African Common Market. A simple common market will not necessarily benefit the poorer territories and only comprehensive plans with specific project allocations and fiscal transfer provisions can meet this condition, especially important for the engineering sector, of which the dynamic advantages (such as backward and forward linkages) are considerably greater than for most other industrial sectors.

C. Latin America

124. There are two important subregional groupings in Latin America:

(a) The Latin American Free Trade Association (LAFTA) consists of ten members. A recent tendency in LAFTA has been towards the integration or sharing out of specific industrial projects through the joint ECLA/INST/IDB Programme on Integration of Industrial Development, but most of this work has not gone beyond the proposal stage.

(b) The Central American Common Market is outstanding as the most successful integration effort among the developing countries. The General Treaty established in the field of industrial policy an Agreement on Fiscal Incentives for Industrial Development and an Agreement on a System of Central American Integration Industries. Under the latter agreement, "integration plants" are free from intra-zonal tariffs, and may qualify for tax inventives, tariff protection and other incentives. The Central American Bank for Economic Integration was also established in 1960 to channel finance into projects assisting integration.

125. The output of engineering goods in Latin America in 1965 probably accounted for less than 2 per cent of world output, although the region produced more than half the output of all developing countries excluding Southern Europe.

126. The Latin American countries, as far as the development of the engineering industry is concerned, can be split into three broad groups. The major producers are Mexico, Brazil and Argentina. In 1965 these accounted for over 85 per cent of engineering production.

127. In the second group of producers are Chile, Colombia, Ecuador, Peru, Uruguay and Venezuela, for which the ratio of engineering production to total manufacturing production averages about 10 per cent.

128. The remaining countries (i.e., Bolivia, Paraguay, the CACM countries and the remainder of the Caribbean area) are characterized by a small manufacturing sector and the engineering sector itself is only in the initial stages of development.

129. Mainly because of the pattern of its development, the engineering industry in LAFTA faces a number of problems and obstacles, the most important of which are as follows:

(a) Excessive tariff protection;

(b) A lack of specialization, resulting from the industrial policies followed and especially the structure of import duties and controls. The lack of specialization is especially evident in motor vehicle assembly and manufacture, and to date there have been few concrete proposals within LAFTA aimed to co-ordinate industrial development programmes, despite the research work carried out under the joint ECLA/INST/IDB programme;

(c) High cost of production and prices resulting from the high costs of inputs, the lack of specialization, and excessive tariff protection;

(d) Low utilization of capacity due to a lack of specialization, the limited markets, etc.;

(e) A lack of skilled manpower;

(f) A small domestic market in many countries.

130. Indicative of the opportunities afforded through regional co-operation is the case of Brazil. If we accept the Brazilian figures as an indication of the share of domestic production feasible, 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. However, such original forecasts may have to be relaxed in view of the industry's performance in 1963-1964. These years have seen a marked trend of reduction in apparent consumption of machine tools.

131. Venezuela's long-range projects for exports and integration in a regional plan for the manufacture of the more complex products of the metal-transforming industry depend on the successful implementation of the present import substitution programme and the development of the required technical infra-structure and skilled manpower over the next several years. Only after this stage of industrialization is it fruitful to consider the implementation of a programme for the manufacture of heavy machinery and equipment as envisaged for the Guyana area, and also such complementary activities as the production of motor vehicle parts.

D. Asia: South and South-East

132. Subregional groupings. Owing to geographic, economic and political conditions in the Far East, an economic integration movement embracing the whole region has not yet been considered practicable. Some attempts have been made at subregional integrations, and ECAFE has established a Regional Industries Promotion and Planning Centre to carry out investigations into industrial integration and to make recommendations.

133. Intra-regional trade accounted for 25 per cent of total trade in 1964, but its importance varies considerably from one country to another. Preferential arrangements have, for the most part, favoured countries outside the region and have not been made specifically on a regional basis.

134. Although South and South-East Asia, as defined for the purposes of this study, has over 60 per cent of the population of the developing countries (excluding Southern Europe), it produces only about 40 per cent of engineering output. India itself produced about 30 per cent of the engineering output of developing countries in 1965, although this represented only about 1 per cent of world output.

135. A study of the engineering industries in Asia, made in 1965 by a group of experts for ECAFE, shows that India had a highly-developed engineering industry; that China (Taiwan), Hong Kong, Indonesia, Republic of Korea, Pakistan, the Philippines, Malaysia, and, to a lesser degree, Thailand and Iran have made considerable progress in the development of engineering industries; and that the engineering industries in Afghanistan, Brunei, Cambodia, Ceylon, Laos, Nepal and Republic of Viet-Nam are only in the initial stages of development.

136. Substantial parts of the engineering industry in Pakistan are operating at well below capacity.

137. Unfortunately, some investments based on seemingly superficial feasibility studies may make the situation worse. For example, according to the Industrial Investment Schedule, total investment in bicycles and bicycle parts during the Third Plan will be $US4.4 million which is about two-thirds of the existing fixed investment in the industry, even though only 32 per cent of existing investment is being used. Investments totalling $US85 million are planned for machine tool factories at Karachi and Dacca, and a heavy mechanical complex in West Pakistan, but some aspects of the feasibility studies for those projects may be open to doubt.

138. A shortage of foreign exchange and raw materials is the main cause of the low utilization of capacity, as well as necessitating the holding of large stocks.

139. A closer examination of the engineering industry in Pakistan might reveal a case for the liberalization of import duties and controls on certain raw materials and components, the review of the import licensing procedure and a reduction or change in the investment programme for the engineering sector.

140. Between 1960 and 1965 the engineering industry in India expanded by at least 10 per cent a year; the machinery industry expanded by more than 15 per cent a year.

141. Investment in the engineering industry as a proportion of total industrial investment has been rising over the past ten years. Over the period of the first plan, the proportion was 13 per cent, during the second plan 11 per cent and in the third plan 22 per cent.

142. The target plans for the engineering industry for the fourth plan (between 1965 and 1970) are ambitious. For example, public sector investment in the industry is planned at $US450 million for the five year period, and, the engineering industry in India is therefore expected to grow at the rate of at least 10 per cent a year over the period 1965-1970. For the purposes of this report an annual rate of growth of 12 per cent has been assumed between 1965 and 1975, although the engineering industry in India, as in Pakistan, suffers from a shortage of raw materials.

E. Projections

143. Estimates of engineering production, imports and consumption in 1975 are summarized in table 17 of the annex. These estimates are, however, very rough and approximate.

144. Consumption of engineering goods in the developing countries is expected to grow by about 10 per cent per annum between 1965 and 1975. Asia and Latin America are expected to show the fastest rates of growth, although most of the increase will be met from home production. Import substitution is therefore likely to continue to be the main stimulus to the growth of the engineering industry.

145. The notion of regional co-operation should be extended to the establishment of common facility centres, comprising tool room, heat treatment, electro-plating, inspection and testing of materials in relatively densely industrialized areas. Regional co-operation may also include the following: (a) production of castings and forgings; (b) manufacture of general industrial equipment; (c) establishment of such companies which could service a number of industrial enterprises in the field of design and engineering. Such facilities would go a long way in strengthening the industrial base of a country and also in improving the quality of the products.

V. RECOMMENDATIONS FOR THE DEVELOPMENT OF ENGINEERING INDUSTRIES IN DEVELOPING COUNTRIES

146. A number of actions for promoting the growth of engineering industries in developing countries can be undertaken independently or jointly by the developing countries, the industrially advanced countries and the United Nations system. The following recommendations can be made:

(a) Establishment of an Information Centre with the assignment to investigate and answer technological and economic questions which are related to the problems of engineering industries and are submitted by developing countries;

(b) The promotion and organization of research and development institutes, for the specific local needs of developing countries. These institutes should begin as small pilot organizations and be expanded. It should be investigated where such institutes may be located most effectively;

(c) Establishment and development of ancillary sectors to the engineering industries so that supplies of raw materials of correct specification are available;

(d) Increase help in advising the developing countries with planning and organizing for the development of engineering industries and in selecting the types of products to be made;

(e) Preparation and promotion of an international multi-language classification system of all metal-working machines to eliminate existing confusion in terminology and misunderstandings in various countries; a similar classification should be initiated for materials for engineering industries;

(f) Expansion of training courses and on-the-job training in both developing and developed countries for machine operators, technicians and engineers from developing countries; establishment of refresher courses for senior engineers is likewise recommended;

(g) Adaptation of machinery, equipment and production methods to the needs of the developing countries;

(h) Establishment of standards for engineering products manufactured in developing countries;

(i) Investigation of the feasibility of the creation of a world patent system for an international utilization of patents;

(j) Investigation of the feasibility of setting up courts of arbitration for technical disputes between countries;

(k) Low tariffs for the export of engineering industries products from developing countries;

(l) Tariff levels for goods imported into developing countries should be structured to reflect the country's state of development and should be continually reviewed;

(m) Providing loans and grants for the purchase of machinery and equipment and, to a lesser extent, raw materials;

(n) Regional co-operation in setting up research centres, obtaining advantages from a common market, from common training and from sharing of financing.

ANNEX

Contents of Annex

Table 1

World manufacturing and engineering production, 1958 and 1961

	Value added in manufacturing (I.S.I.C. 2-3)		Value added in the engineering sector (I.S.I.C. 35-38)	
Developing countries	1958	1961	1958	1961
Latin America	3.7	3.7	1.5	1.6
Africa	0.7	0.7	0.3	0.3
Asia	2.2	2.3	0.8	1.0
Middle East	0.2	0.2	0.1	0.1
Southern Europe	2.4	2.5	1.3	1.4
Total (including Southern Europe)	9.2	9.4	4.0	4.4
Industrialized[a/] countries	90.8	90.6	96.0	95.6
World[a/] Total - per cent	100.0	100.0	100.0	100.0
	Billions	$ U.S.	Billions	$ U.S.
- units	310	380	105	140

a/ Excluding USSR and Eastern Europe.

Table 2

National income and manufacturing and engineering production in the developing countries, 1965

	Gross Domestic Product (per cent)	Production: Manufacturing Sector (per cent) (I.S.I.C.2-3)	Production: Engineering Sector (per cent) (I.S.I.C.35-38)	
	1965	1965	1961	1965
Africa	14[a]	9[a]	7.2	6[a]
North Africa	6.0	4.8	4.7	3.7
Others	8.1	3.8	2.5	2.3
Latin America	42[a]	52[a]	57.2	56[a]
Free Trade Area of which:	35.0	46.0	54.5	53[a]
Brazil	)	)	17.6	)
Mexico	) -23.7	) -35.0	13.5	) -48
Argentina	)	)	13.1	)
Others	7.5	6.0	2.7	3[a]
Asia - East and South-East	41[a]	37[a]	35.5	37[a]
of which: India	18.5	20.5	20.5	27[a]
Middle East	3[a]	2[a]	0.3	1[a]
Total developing countries (excluding southern Europe)	100.0	100.0	100.0	100.0

a/ Rounded.

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Table 3

Percentage of total world[a/] value added, 1958

Industrial Group	I.S.I.C. Group	Less industrialized countries (including Southern Europe)
Food, beverages and tobacco	20-22	16
Textiles	23	22
Clothing, footwear and made-up textiles	24	11
Wood products and furniture	25-26	13
Paper and paper products	27	5
Chemicals and chemical petroleum and coal products	31-32	11
Non-metallic mineral products	33	12
Basic metals	34	8
Metal products (engineering sector)	35-38	4

a/ Excluding U.S.S.R. and Eastern Europe.

Table 4

Value added in the manufacture of engineering products as a percentage of gross domestic product

	Percentage		
	1958	1961	1965
Industrialized ccuntries (excluding U.S.S.R. and E. Europe)	13.2	15.3	-
Developing countries	2.5	3.2	3.5
Africa	1.2	1.7	1.4
Latin America	3.2	3.8	4.7
Asia	1.5	2.3	3.2

Table 5

World industrialization and the engineering industry, 1961/1965

	"Importance of the Engineering Sector" (Ratio of Value added in engineering to the total manufacturing sector	"Degree of Industrialization" (Ratio of value added in manufacturing sector to gross domestic product)
	1965	1965
Industrialized countries (excluding USSR and Eastern Europe)	39 (1961)	39 (1964)
Developing countries	18	20
Africa	13	12
Latin America	20	24
Asia	18	18

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Table 6

The relative importance of the engineering sub-sectors[a/]

	Per cent of total engineering production			
	Kenya (1963)	S. Rhodesia (1964)	India (1962)	U.S. (1964)
I.S.I.C. Group				
35 Metal products	44	33	15	17
36 Non-electrical machinery	5	2	20	23
37 Electrical machinery	2	12	19	21
38 Transport equipment	49	53	46	39
Total engineering sector - percentage	100	100	100	100
- production ($m)	34	94	1,369	147,993
- production per capita ($)	3.8	23.0	3.1	740.0

a/ Gross output figures are used.

Table 7

Ratio of production to consumption of engineering products

(Percentage)

	Kenya (1963)	S. Rhodesia (1964)	India (1962)	U.S. (1964)
I.S.I.C. Group				
35 Metal products	73	95	84	100
36 Non-electrical machinery	7	5	35	113[a/]
37 Electrical machinery	9	66	65	104[a/]
38 Transport equipment	34	66	81	104[a/]
Total engineering sector	33	57	62	105[a/]

a/ Net exporter.

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Table 8

The development of the engineering industry

S.I.T.C.	Stage 1	Stage 2	Stage 3
Metal Products			
691 Finished structural parts and structures	x	x	
692 Metal containers for storage and transport	x		
693 Wire products (excluding electric) and fencing grills		x	x
694 Nails, screws, nuts, bolts, rivets and similar articles of iron, steel or of copper		x	x
695 Tools for use in the hand or in machines	x	x	
696 Cutlery		x	x
697 Household equipment of base metal	x		
698 Manufactures of metal, n.e.s.	-	-	-
Non-Electrical Machinery			
711 Power-generating machinery, other than electric	x	x	x
712 Agricultural machinery and implements	x	x	
714 Office machines			x
715 Metal-working machinery		x	x
717 Textile and leather machinery		x	x
718 Machines for special industries		x	x
719 Machines and appliances (other than electrical) and machine parts, n.e.s.	-	-	-
Electrical Machinery and Equipment			
722 Electrical power machinery and switchgear			x
723 Equipment for distributing electricity		x	x
724 Telecommunications apparatus	x(A)	x	
725 Domestic electrical equipment	x(A)	x	
726 Electric apparatus for medical purposes and radiological apparatus			x
729 Other electrical machinery and apparatus	-	-	-
Transport Equipment			
731 Railway vehicles		x	x
732 Road motor vehicles		x	x
733 Road vehicles other than motor vehicles	x(A)	x	
734 Aircraft			x
735 Ships and boats	x	x	x

Note: x denotes the stage at which the group of products is likely to be manufactured or assembled (A).

Table 9

Imports of engineering goods,[a/] 1964

SITC Group	Per cent				
	69	71	72	73	Total
Imports into:					
Latin America	8	45	16	31	100
Africa	13	33	14	40	100
Asia (South and South-East)	8	45	21	26	100
Middle East	8	34	21	37	100
Total Developing Countries (excluding S. Europe)	9	41	17	33	100

a/ Based on imports from USA, West Germany, UK, Italy, Japan and France, accounting for approximately 80 per cent of total imports into the developing countries.

Table 10

World exports of machinery and equipment in 1964

Exports from:	Latin America	Africa	Asia (South and S.E.)	Middle East	All Developing Countries	All Countries
Western and Southern Europe	13	14	14	5	46	55
Canada and USA	18	3	8	2	31	26
Australia and Japan	2	3	6	0.5	11.5	5
The Centrally Planned Economies	2	2	7	0.5	11.5	14
Total - percentage	35	22	35	8	100	100
- billion dollars	3.5[a/]	2.2[a/]	3.5[a/]	0.8[a/]	10.0	40.3

a/ "Africa" excludes South Africa, Asia excludes Japan, but the "Middle East" includes Israel. It should be noted that these statistics derived from exports differ slightly from an addition of national import statistics converted at official exchange rates.

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Table 11

The apparent consumption of engineering products in the developing countries, 1964

	Asia[a]	Africa[b]	Latin America	Middle East[c]	Total
Production ($B)	5.5	0.9	8.4	0.1	14.9
Net imports[d] ($B)	3.4	2.4	3.7	0.6	10.1
Apparent consumption	8.9	3.3	12.1	0.7	25.0
Population (M)	920	277	245	24	1,466
Consumption per capita ($)	10	12	49	29	17
GDP per capita ($)	93	108	365	245	145

a/ Excludes Japan, Mainland China, North Viet-Nam and North Korea.

b/ Excludes South Africa, Angola and Mozambique.

c/ Excludes Israel.

d/ After deducting exports based on EEC figures.

Table 12

Composition of consumption of engineering goods in developing countries and the United States

	Percentage					Ratio of production to consumption per cent
	Metal products	Non-electrical machinery	Electrical machinery	Transport equipment	Total ($m)	
ISIC Group	35	36	37	38		
US (1964)	18	22	21	39	140,689	105
India (1962)	11	36	18	35	2,200	62
Pakistan (1964)	15	36	14	35	600	36
Republic of Korea (1963)	10	45	20	25	150	22
Kenya (1963)	20	25	9	47	100	33
Ethiopia (1963)	18	34	13	35	45	12

Table 13

Growth in employment in the engineering sector (% p.a.)

	1953-1958	1958-1961	1961-1965
Industrialized countries	2	4	-
Less - industrialized countries	5	7	6
- Latin America	6	3	-
- Asia (excluding Japan)	6	10	-

Table 14

World prices of commodities, 1953-1964

	1953	1958	1961	1964
Total	100	100	99	102
Food	100	93	87	97
Raw materials, excluding fuels	100	91	92	94
Fuels	100	108	98	96
Chemicals	100	96	90	86
Machinery	100	114	119	123
Other manufactures	100	98	101	102

Table 15

Import duties on engineering products in Brazil, India, Pakistan and U.A.R., 1966

Import duties as a percentage of C.I.F. value	Metal products	Machinery		Transport equipment
Brazil	80-100	50-80		20-40
		Mechanical	Electrical	
India	40-60	15-30	50-100	27 1/2
Pakistan	40-60	20-30		20-30
U.A.R.	45-60	general very low 2%		15-50
U.S.A.	23	12	20	13
E.E.C.	16	13	15	22
U.K.	21	17	23	25
Japan	20	17	18	30

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Table 16

Population and income concentration in the developing regions, 1965

Groups	Number of countries within group			
	In Latin America a/	In Africa b/	In Asia	In the Middle East
Population (millions)				
0 -2.4	10	13	1	5
2.5-4.9	7	14	1	-
5 and above	8	12	15	3
	25	39	17	8
Annual National Income (G.D.P. - $B)				
0 -0.9	14	31	4	4
1.0-4.9	6	8	9	4
5.0 and above	5	-	4	-
	25	39	17	8
Income per capita ($p.a.)				
0-99	-	21	7	-
100-199	2	9	6	2
200 and above	23	9	4	6
	25	39	17	8

a/ Latin America excludes most of the British West Indian countries and territories.

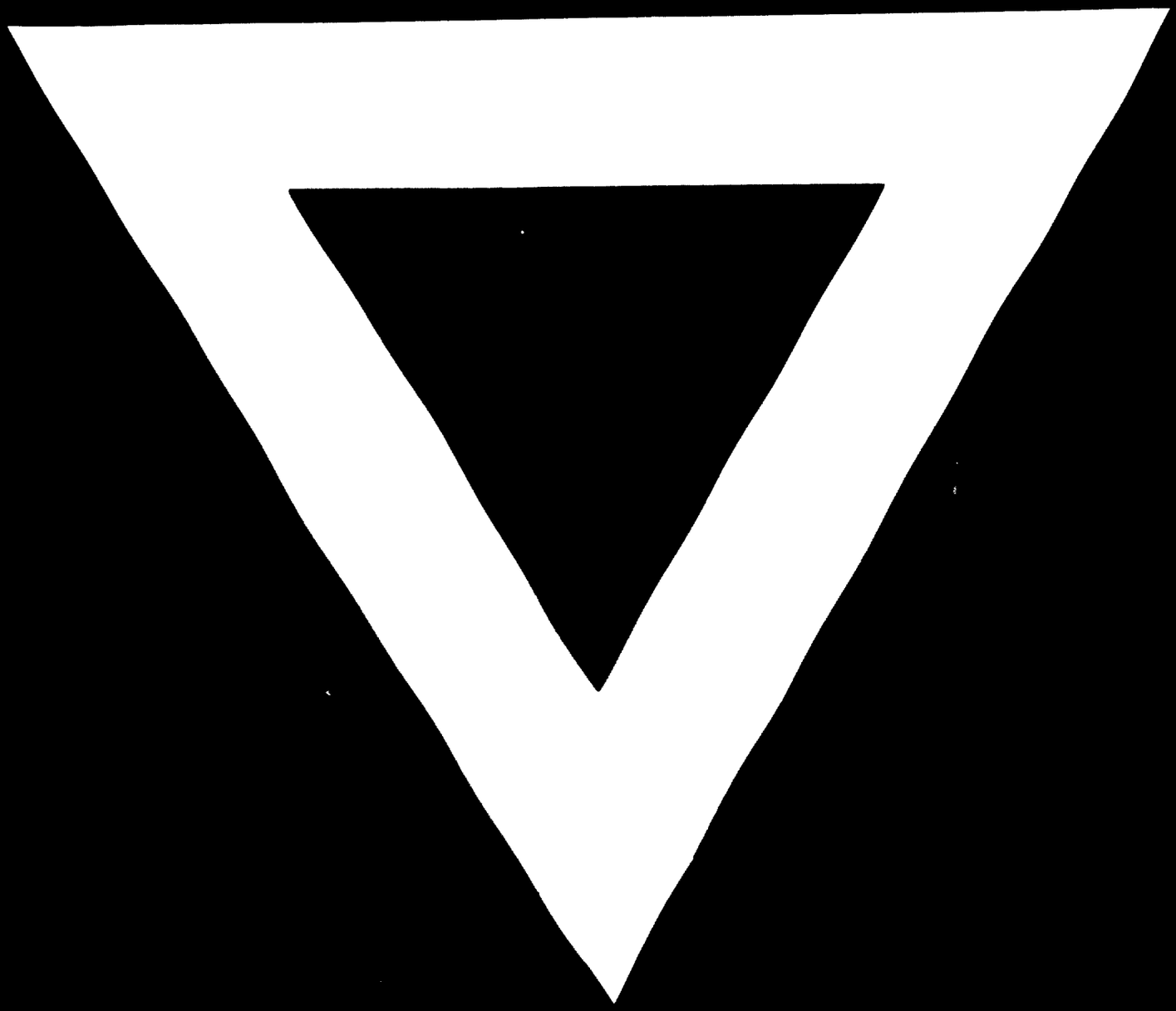
b/ Africa excludes Angola, Mozambique, South West Africa and some of the very small territories such as the Seychelles and French Somaliland.

Table 17

Estimates of engineering production, imports and consumption in 1975 - Developing Regions

	South/ South-East Asia	Latin America	Africa	Middle East	All developing countries
Gross Domestic Product					
(% Growth per annum 1965-75)	5-6	5-6	5-6	5-6	5-6
Engineering Industry					
Value added[a/]					
- $B - 1965	2.8	4.2	0.5	0.1	7.6
- 1975	11	16	1.4	0.3	29
- % growth per annum	15	14	11	-	14
Net Imports					
- $B - 1965	3.4	3.7	2.4	0.6	10.1
- 1975	3	5	4.2	1.0	13.2
- % growth per annum	-	3	6	-	2.7
Consumption					
- $B - 1965	8.9	12.1	3.3	0.7	25
- 1975	25	32	6.5	1.3	65
- % growth per annum	11	10	7	6	10
Consumption Per Capita					
- $ - 1965	10	49	12	29	17
- 1975	21	105	19	40	35
- % growth per annum	8	8	5	3	7

a/ Gross production is approximately double value added.



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