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on the Iron and Steel Industry

Moscow, USSR, 19 September - 9 October 1968

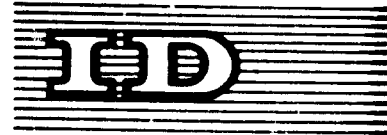
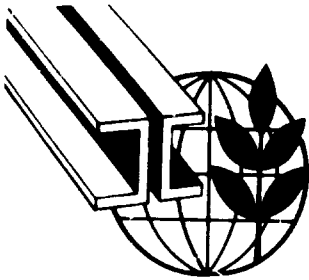
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WORLD PRODUCTION, TRADE AND PRICES OF IRON AND STEEL

Presented by the Economic Commission for Europe

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WORLD PRODUCTION, TRADE AND PRICES OF IRON AND STEEL<sup>1/</sup>

prepared by

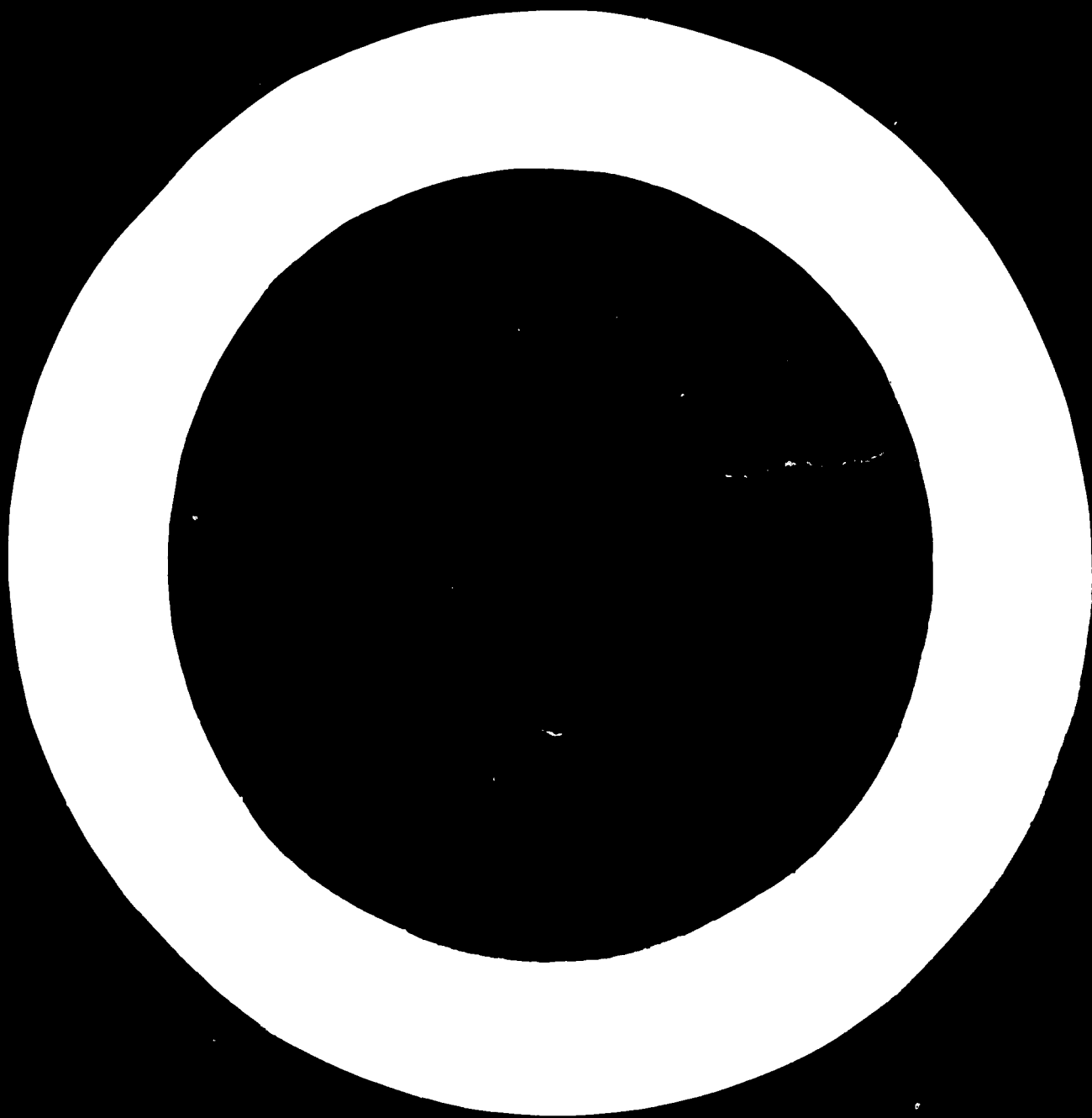
**the Secretariat of the United Nations Economic Commission for Europe**

SUMMARY

The discrepancy between growth of steel demand and of steel-making capacity, which has since a number of years characterized the steel market in many countries and, particularly, in the international market, has left its impact not only on the steel economy of the industrialized, but also on that of the developing countries. For this reason the paper starts with a brief analysis of recent developments in the world steel market and shows the principal problems. Since the bulk of steel production originates in industrialized countries and is also consumed there, development of the steel industries in the developing countries is influenced to a noticeable degree by the situation in industrialized countries. The share of developing countries in world steel consumption has increased only very slowly, from 5.1 per cent in 1950, to 6.4 per cent in 1960, and to 7.2 per cent in 1965; the rate of growth (compound) between 1950 and 1965 was 8.2 per cent per annum. The share of developing countries in world steel production grew from 1.5 per cent in 1950 to 3.8 per cent in 1965; the absolute tonnage increased at an annual rate of 12.7 per cent (a rate which merely reflects the very low initial level).

\* This is a summary of the paper issued under the same title as ID/WG.14/20

<sup>1/</sup> The paper is based on a recent study, entitled "World Trade in Steel and Steel Demand in Developing Countries" prepared by the Secretariat of the United Nations Economic Commission for Europe.



This situation of steel demand in developing countries is ascribed to the lack of foreign exchange to pay for steel imports, to the absence of investment funds for creating an own steel production, to the non-existence of steel-transforming industries or of construction projects which would use large amounts of steel. In general, the retarded economic development of these countries has led also to stagnation or insufficiently rapid growth of steel-producing and steel-consuming industries.

An analysis of price and international trade data shows, indeed, that even the strong fall in steel prices observed in the international markets (price decreases for some products were, after 1957, between 30 and 50 per cent), has not brought a very strong increase in the steel imports of developing countries, for the reasons given above. While imports of steel into developing countries increased between 1960 and 1965 only at an annual rate of 4 per cent, imports into the industrialized countries grew at 10 per cent a year during the same period. This is ascribed to growing exchange of specialities among industrialized countries (i.e. growing international division of labour), but mainly to exchange trade arising from the fact that prices in international trade were lower than those the main producers charged on their domestic markets.

In a second section, the principal characteristics of the iron and steel industry are discussed, starting with an analysis of data on iron and steel use. While a clear relationship can be shown to exist between the level of economic development and the level of steel use in developed economies, it is more difficult to establish the same relationship for the less advanced countries. Likewise, while it is possible to show a typical sector and product pattern of steel consumption for industrialized countries, for developing countries these patterns seem to vary with the type of economy (agricultural; mining; petroleum). The section sketches also the broad lines of development in the product pattern of output, as they can be derived from the experience in certain developing countries.

The impact of technological developments on the production of iron and steel is treated next. It appears that the trend towards using and developing equipment of large capacity (economies of scale), which has led in industrialized countries to the creation of large integrated plants, serving large markets, has

in certain cases been a barrier to establishing iron and steelworks in developing countries; the latter require - at least in the early stages of development - metallurgical equipment (particularly rolling mills) which can economically produce a variety of forms and qualities, in relatively small tonnages. It is pointed out that further research is needed to overcome this difficulty; it is also stressed that, on the other hand, regional groupings and the creation of common markets permit to make use of modern large-capacity equipment and provide advantages through production of large quantities of steel. Attention is also drawn to economies in investment expenditure achieved by building relatively larger plants instead of several small units.

The main secondary effects (both positive and negative) of establishing an iron and steel industry in developing countries are also briefly discussed. Mention is made of the generation of employment and, hence, of income, of the savings in foreign exchange, of the creation of ancillary services and industries as well as the expansion of steel-using sector through the regular availability of iron and steel products; attention is, however, also drawn to the possible negative effects on the balance of payments (temporary burden through import of plant and equipment; more regular burden through import of coking coal), and to the problem of securing adequate means of finance. Finally, mention is made of various protective measures used in particular by the new steel-producing countries to stimulate domestic development.

The third section of the paper makes suggestions for expanded regional cooperation and for integration of the smaller steel markets of developing countries. The fourth section shows likely trends of world crude steel production in 1970, according to which the developing countries, taken as a whole, are expected to increase their output from at present, 17 million tons to over 35 million tons, which corresponds to an annual growth rate of 16 per cent. For the period 1970-1975 a rate of increase of the order of 13-14 per cent a year may be expected, i.e. nearly a doubling of capacity during the five years; this would involve a considerable economic effort, particularly if account is taken of the required corresponding investment in consuming sectors.

The paper concludes that it is hardly possible to make general recommendations for government policies to be pursued in setting up iron and steel works or

expanding existing installations. The reason is that, particularly during the early stages of economic and industrial development, any steel-making operation is determined, as far as its size and production programme is concerned, by its market, i.e. by the kind, rate of growth and volume of demand. It is evident, therefore, that detailed pre-investment surveys are required to assess the volume and product pattern of existing demand and the required corresponding investment in ancillary and steel-using sectors. Experience shows that new steel industries have always been most successful when established as part of a comprehensive industrial development programme.

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### 1. RECENT DEVELOPMENTS AND PRINCIPAL PROBLEMS

1. World production of crude steel increased between 1960 and 1965 by an annual rate of 6.3 per cent and reached a volume of almost 442 million tons<sup>1/</sup>. Most of the crude steel output is produced in the industrialized countries. In 1965, only 3.8 per cent of world production originated in the developing countries of Africa, Latin America and the Far and Middle East, as shown by the data given in table 1 (below). It further shows that the total proportion of those countries has been increasing, from as little as 1.5 per cent in 1950 and 2.8 per cent in 1960, to 3.8 per cent in 1965.
  2. The figures on crude steel production and on consumption (see tables 1 and 2) reflect the gap in economic development, particularly industrial development, between the developing and the industrialized countries. Since steel products are used in all sectors of the economy (mainly in construction, machinery manufacture, motor vehicles, consumers' durables etc.), the low proportion held by the developing countries in total world consumption of steel (in crude steel equivalents) of not more than 7.2 per cent in 1965, shows that some of the main steel-using sectors in those countries were either non-existent or undeveloped.
  3. Since the bulk of steel production originates in industrialized countries and is also consumed there, world developments in this sector are characterized by the trends in those countries. Development of the steel output of developing countries, or availability of steel through their imports, is influenced to a noticeable degree by the situation of the steel market in industrialized countries.
  4. In a number of important steel-consuming and producing countries, particularly in Western Europe, Japan and the United States, the steel market has been marked by a certain disequilibrium between demand and supply. This has prevailed since about 1958. The situation has been one of over-capacity of production, resulting in strong competition - first, in the international market and later, in the domestic markets of some of the main producing countries. The consequent fall in prices, both for export and for domestic sales, has reached such dimensions that, in some countries, it has
- <sup>1/</sup> This figure excludes an estimated 10 million tons for China (Mainland) for which no official production data are published.

Table 1  
Production of crude steel, by regions, 1950 and 1960-1965  
(in thousands of tons and percentages)

	Latin America	Africa (excluding South Africa)	Far East excluding China (mainland)	Japan	Middle East	Total Developing Countries	Total Industrialized Countries	Total World excluding China (mainland)
<u>1950</u> 1000 t. per cent	1,317 0.7	34	1,475 0.8	10	2,836 1.5	186,064 98.5	190,900 100.0	
<u>1960</u> 1000 t. per cent	4,750 1.4	101	4,236 1.3	195 0.1	9,282 2.8	318,768 97.2	328,050 100.0	
<u>1961</u> 1000 t. per cent	5,304 1.6	108	5,175 1.5	210 0.1	10,797 3.2	330,703 96.8	341,500 100.0	
<u>1962</u> 1000 t. per cent	5,825 1.7	118	6,583 1.9	280 0.1	12,806 3.7	337,194 96.3	350,000 100.0	
<u>1963</u> 1000 t. per cent	6,928 1.8	114	7,357 2.0	390 0.1	14,789 3.9	360,211 96.1	375,000 100.0	
<u>1964</u> 1000 t. per cent	8,032 1.9	120	7,481 1.8	460 0.1	16,093 3.8	407,407 96.2	423,500 100.0	
<u>1965</u> 1000 t. per cent	8,205 1.9	120	8,127 1.8	525 0.1	16,977 3.8	427,023 96.2	444,000 100.0	
Rate of growth 1950-1965 (compound)	13.0	8.75	12.15	11.7	12.7	5.6	5.75	

Source: The European Steel Market, BCE, Geneva, several issues

Table 2  
Apparent consumption of steel, by regions, 1953 and 1960-1965<sup>a/</sup>  
(in thousands of tons, crude steel equivalents and percentages)

	Latin America	Africa <sup>b/</sup>	Far East <sup>c/</sup>	Middle East	Total developing countries	Total industrial countries	Total World <sup>b/c/</sup>
<u>1950</u> 1000 t. per cent	3,781 2.0	1,171 0.6	3,541 1.9	1,222 0.6	9,715 5.1	179,392 94.9	189,100 100.0
<u>1960</u> 1000 t. per cent	8,414 2.6	2,135 0.7	8,187 2.5	2,034 0.6	20,770 6.4	305,430 93.6	326,200 100.0
<u>1961</u> 1000 t. per cent	9,599 2.8	2,137 0.6	9,544 2.8	1,803 0.6	23,083 6.8	317,517 93.2	340,600 100.0
<u>1962</u> 1000 t. per cent	9,081 2.6	2,196 0.6	11,389 3.3	2,268 0.6	24,934 7.1	324,566 92.9	349,500 100.0
<u>1963</u> 1000 t. per cent	9,806 2.6	2,092 0.6	12,423 3.3	2,485 0.7	26,806 7.2	348,094 92.8	374,900 100.0
<u>1964</u> 1000 t. per cent	11,522 2.7	2,387 0.6	13,275 3.1	2,725 0.6	29,909 7.0	395,291 93.0	425,200 100.0
<u>1965</u> 1000 t. per cent	12,144 2.7	2,512 0.6	13,852 3.1	3,200 0.8	31,708 7.2	410,092 92.8	441,800 100.0
Rate of growth 1950-1965 (compound)	8.1	5.2	9.5	6.6	8.2	5.7	5.8

Source: The European Steel Market, BCE, Geneva

a/ Rounding of calculations explains the difference between apparent consumption in this table and world output shown in Table 1. The above table excludes castings and forgings, also trade data for quantities which cannot be allocated to a specific country. b/ excluding South Africa c/ excluding China (mainland) and Japan



caused difficulties for the steel industry; necessary re-investment and modernization, or even expansion of capacity to keep step with the growth of domestic consuming sectors, have been endangered. A brief description of the factors and developments during the various periods which led to the present situation, is given below.

5. In the years following World War II, the demand for steel increased at a rapid pace. This was due to a considerable backlog in demand for manufactured goods containing steel - a demand that could not be satisfied during the war - and also to the considerable reconstruction requirements of the countries in Europe and Asia which had suffered the most from war devastation. Steel was rather scarce and fetched a high price; since demand in many countries was increasing at a rate which an expansion of capacity could not possibly match, steel prices were also increasing, especially in the international market.<sup>2/</sup> The pressure of demand and the attraction of an upward price level brought a noticeable expansion of capacity, which stress on new equipment for finished steel rolling. Thus, investment in the iron and steel industry of countries of the European Coal and Steel Community (ECSC) grew from US\$ 454 million in 1954 to US\$ 708 million in 1957, or by 56.2 per cent, in the United Kingdom, the corresponding increase was 83.5 per cent.

6. This situation of a "sellers' market" underwent a change after 1957, at least in Western Europe and Japan. The rate of increase of steel demand in those countries showed a certain slackening, and this trend has continued. The following rates of growth of apparent consumption of steel (in crude steel equivalents) illustrate this further:

Table 3  
Rates of growth of apparent steel consumption  
(percentages, compound rates)

<u>Country or region</u>	<u>1950 to 1957</u>	<u>1958 to 1965</u>
ECSC countries	10.43	4.5
United Kingdom	4.6	2.5
Japan	17.75	11.05

<sup>2/</sup> Between 1950 and 1957, the average export price of merchant bars (Thomas quality, f.o.b. Antwerp) from ECSC member countries to third markets had increased from US\$ 65.20 to US\$ 128.00 per ton, or by 96 per cent. This trend is also found for other steel products, e.g. heavy plates, heavy sections and wire rods; price increases in domestic markets were less important. Note, that the figures quoted do not allow for the depreciation in the value of money.

7. In the United States, a similar development had started as early as in 1956; between 1950 and 1955, consumption had grown by 3.6 per cent per annum, and from 1956 to 1958 it fell by 4.2 per cent per annum.

8. The change-over from a seller's to a buyer's market is further illustrated by the following growth rates of demand (as expressed by apparent consumption in crude-steel equivalents) and of crude-steel output in the ECSC countries, Japan, the United Kingdom and the United States.

Table 4  
Annual growth rates in demand and production of steel

<u>Countries and period</u>	<u>Apparent consumption</u>	<u>Production</u>
<u>ECSC</u>		
1950-57	10.4	9.5
1958-65	4.5	4.65
<u>Japan</u>		
1950-57	17.75	14.9
1958-65	11.05	15.85
<u>United Kingdom</u>		
1950-57	4.6	4.2
1958-65	2.5	2.8
<u>United States</u>		
1950-55	3.6	3.9
1956-57	-2.6	-1.9
1958-65	3.5	2.0

9. It will be seen that during the period 1950-57, when there was a seller market, the growth rate of demand in the ECSC area, in the United Kingdom and Japan, was higher than during the ensuing period, 1958-65, generally accepted as one of a buyer's market. The situation in the United States differed from that in Western Europe and Japan: the period 1950-55 - which closed with steel consumption at a peak level which was to be the highest until 1963 - was characterized by a rate growth which was fairly moderate (3.6%) if compared with those of other regions. The situation deteriorated after 1955, with an absolute decrease of steel consumption, which was at its lowest in 1958. Since 1958, the United States market has enjoyed a phase of expansion of demand (3.5 % per annum) which, however, has been to an increasing extent met by imports.

10. As far as the rate of growth of crude steel output is concerned, the development was largely similar: In the ECSC countries and the United Kingdom increases observed after 1957 were much below the rates obtaining during the period 1950-57. In the United States, where output of crude steel had been falling for a number of years after 1955, production again rose after 1958, although also at a lower rate than during the period of a seller's market (1950-55). In Japan the situation was different: Between 1957 and 1965 the rate of growth of crude steel output was at 15.85. It thus exceeded even the very high rate observed for 1950-57 and was far higher than the rate of growth of home consumption.<sup>3/</sup>

11. The slackening of demand in some Western European countries, which brought about the turn in steel market situation, can be ascribed to a number of factors: in a number of countries, the growth in certain important steel-consuming sectors was at a slower pace, with a corresponding fall in investments. This had repercussions on the rate of expansion of steel demand, and these were further accentuated by the tendency of consumers to reduce, in times of recession, their rate of investments in stocks of component parts and in work in progress.

12. Another important influence of a long-term character arises in countries where, as economic development reaches higher levels, shifts occur in the industrial structure; these affect not only the product pattern of demand for finished steel, but also its level. Such changes in structure involve the familiar trend towards greater expenditure on services which do not, of necessity, belong to the category of steel-intensive sectors of the economy.

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<sup>3/</sup> Differences between the rate of growth of apparent consumption and that of production reflect the changing trends in net exports or net imports. In the case of net-exporting countries, a lower (higher) growth of home consumption than of production would indicate an increased (decreased) tendency towards exports; in the case of net-importing countries, a lower (higher) growth of home consumption than of production would indicate a decreased (increased) tendency towards imports.

13. Other factors <sup>4/</sup> which may have played a role in decreasing the rate of increase of steel demand and consumption in most industrialized countries (except the Soviet Union and other socialist countries of Eastern Europe) include the following: improvement of the mechanical and other properties of steel products, leading to a lower specific consumption of steel, standardization of steel products and manufactured goods containing steel; trends in industrial design and in construction, towards lighter and more elegant products and structures; measures for rationalization, automation and higher productivity, entailing economy also in steel products, and substitution of steel by such materials as aluminium, plastics, asbestos-cement, glass, timber, particle board, fibre-board, copper etc.

14. It is not possible, of course, to measure the impact that each of these factors has had on the growth of steel demand (nor is the list of factors complete). However, it can be assumed that all have contributed to the slower growth of demand in Western Europe and Japan.

15. If demand increased at a reduced rate, this was not the case with investments. Steel producers in many industrialized countries had embarked, in some cases, on ambitious programmes of expansion or modernization, which appeared to be almost a necessity in view of growing competition. As an example, investment data on ECSC countries and the United Kingdom are given below.

16. It will be seen that the previous trend of growth was resumed in ECSC countries in 1960, reaching a record level in 1963 (the year when world market prices for steel products reached their lowest level). The trend in the United Kingdom was similar, but the peak of investment expenditure was reached earlier, in 1961, and the ensuing decrease was much stronger than in ECSC countries.

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<sup>4/</sup> For a detailed description, see The European Steel Market in 1962, Economic Commission for Europe, Geneva, 1963, pp. 13-15.

Table 5

Investments in the iron and steel industry  
of ECSC member countries and in the United Kingdom

<u>Year</u>	<u>Millions of US \$</u> current	<u>in 1961 prices</u>	<u>Millions of £</u> current	<u>in 1961 prices</u>
1952	545.1	668.0	65.0	94.9
1953	541.8	673.0	49.0	70.1
1954	453.5	567.6	51.6	71.0
1955	524.3	638.6	58.3	75.1
1956	569.9	667.3	75.1	89.5
1957	708.2	787.8	94.7	105.8
1958	643.6	692.8	105.5	115.2
1959	586.6	618.1	98.8	107.0
1960	775.2	797.5	146.0	151.3
1961	1,123.1	1,123.1	198.7	198.7
1962	1,230.3	1,173.9	170.1	164.3
1963	1,479.5	1,348.7	76.8	72.7
1964	1,315.3	1,130.9	54.8	50.2
1965	932.2	790.9	49.6	43.2

Source: Communauté européenne du charbon et de l'acier, Haute Autorité, Les investissements dans les industries du charbon et de l'acier, Luxembourg, 1958, 1963 and 1966; and the Iron and Steel Board Annual Statistics, published jointly by the Iron and Steel Board and the British Iron and Steel Federation, London (various years). The data in 1961 prices have been calculated on the basis of indices in the ECSC source quoted above and by the Iron and Steel Board, London, in its annual report.

17. The trend in investments that led to a considerable expansion of capacity was even stronger in Japan. In the United States, capacity was also expanded, but apparently at a more modest rate than in Western Europe and Japan.

The resulting excess capacity is difficult to measure; some sources claim that, at times, there were about 75 million tons of unused capacity for making crude steel in Western Europe, the United States and Japan alone: this would represent about one quarter of the present crude steel output in those countries. Although it seems that the figure quoted may comprise a good deal of "marginal capacity" which, in view of its comparatively low productivity and consequent high operating costs, could only be used under boom conditions, it conveys an impression of the situation.

18. Figures on the rate of use of rolling and finishing capacity are very scant, but it can be assumed that the rate was similar to that shown above for crude steel making. This is confirmed by the following comparison of data published by the High Authority of the ECSC.

Table 6

Comparison of "maximum possible production" of certain finished  
steel products with actual output data of the same products  
(in percentages)

<u>Product</u>	<u>1957</u>	<u>1962</u>	<u>1965</u>
All finished rolled products	88.5	82.9	76.0
Total flat products	88.4	82.1	73.2
Strip (incl. tube strip)	85.4	81.8	76.1
Heavy and medium plate	91.8	81.3	72.4
Sheets, hot-rolled	87.4	73.1	56.0
Sheets, cold-rolled	85.7	85.4	75.3
Heavy and light sections (incl. rounds and squares for tubes)	88.9	83.3	77.6
Wire rods	87.2	85.0	82.3

Source: Communauté européenne du charbon et de l'acier, Haute Autorité, Les investissements dans les industries du charbon et de l'acier, Luxembourg, 1958, 1963 and 1966.

19. It is evident that in the countries of the European Coal and Steel Community, as a whole, no more than 76 per cent of the rolling and finishing capacity was used in 1965. The situation was the worst of all for hot-rolled sheets (with 56 per cent capacity use) and was best for wire rods (with 82.3 per cent capacity use). It is also noted that the rate of capacity use has deteriorated considerably, in comparison with 1957 and also in comparison with 1962, thus reflecting the strong increase of investments for expansion of capacity in a period of relatively slow increase in consumption of steel.

20. The foregoing analysis has dealt exclusively with steel-producing countries in Western Europe, with the United States and Japan. It is believed that developments in those countries, accounting in 1965 for 64 per cent of world crude steel consumption,<sup>5/</sup> and for about 70 per cent

<sup>5/</sup> Excluding China (mainland)

of the total volume of world trade in steel, are the cause of and characteristic of the world steel market situation. However, mention should also be made of developments in the Soviet Union and other socialist countries of Eastern Europe, where crude steel production and consumption have made rapid progress in the past 15 years, as shown by the data given below (thousands of tons and percentages):

Table 7

Apparent consumption of steel  
(in thousands of tons, and percentages)

<u>Region or country</u>	<u>1950</u>		<u>1960</u>		<u>1965</u>	
	1000 t.	%	1000 t.	%	1000 t.	%
Total developing countries	9,715	5.1	20,770	6.4	31,708	7.2
Total industrialized countr.	179,392	94.9	305,430	93.6	410,134	92.8
of which:						
Soviet Union	27,800	14.7	63,513	19.5	86,604	19.6
Other Eastern European countries	8,352	4.4	24,097	7.4	30,834	7.0
Other countries	143,240	75.8	217,820	66.7	292,696	66.2
Total world (excl. China mainland)	189,100	100.0	326,200	100.0	441,800	100.0

Production of crude steel

<u>Region or country</u>	<u>1950</u>		<u>1960</u>		<u>1965</u>	
	1000 t.	%	1000 t.	%	1000 t.	%
Total developing countries	2,836	1.5	9,282	2.8	16,977	3.8
Total industrialized countries	188,064	98.5	318,780	97.2	427,044	96.2
of which:						
Soviet Union	27,329	14.3	65,292	19.9	91,000	20.5
Other Eastern European countries	8,212	4.3	21,177	6.5	28,644	6.5
Other countries	152,523	79.9	232,311	70.8	307,400	69.2
Total world (excl. China mainland)	190,900	100.0	328,050	100.0	444,000	100.0

21. Both sets of figures show that these countries accounted in 1965 for 27 per cent of both the apparent world consumption and the world production of crude steel. In 1950 this proportion was only at about 19 per cent. A comparison of data on apparent consumption in this region with data on crude steel production reveals that in 1950 the Eastern European countries were self-sufficient in their steel supply, if considered as a group, while in 1965 their production of crude steel was 2.2 million tons higher than consumption. In other words, the region had become a net-exporter of steel, after being a net-importer for many years (in 1960, net-imports of steel still stood at 1.2 million tons, crude steel-weight.)

22. These tonnages, exported from the Soviet Union and other Eastern European countries, appeared on the international market at a time when export prices had started to decline. As stated earlier, the change from a sellers' to a buyers' market and the availability of increasing spare capacities had led to strong competition in the export markets. The volume of world trade in steel was growing at a rapid pace, although export prices of most products had been falling since 1957, with a short interruption of the declining trend in 1959. The following data on world exports of semi-finished and finished steel products provide further confirmation of this point.

Table 8

Volume of world trade in semi-finished and finished steel  
(millions of tons, actual tonnage)

<u>Year</u>	
1950	15.8
1953	18.4
1955	26.1
1957	30.8
1960	39.4
1961	39.2
1962	42.3
1963	44.7
1964	52.0
1965	59.5

23. The growth of steel exports between 1950 and 1965 was by 9.2 per cent annually; crude steel production increased during the same period by only 5.8 per cent a year. Since the decline in export prices after 1957 was very considerable, some of the steel-exporting countries attempted to curtail the exports to markets where price levels were lowest, as the result of stiff competition, and to sell more steel in the domestic markets of the main steel-producing countries of Western Europe and in the United States. However, this did not bring a halt in the export of steel products; the result was merely a slight decrease in the rate of increase of exports, from more than 13 per cent in the period 1953-1957 to 8.6 per cent in the period 1957-1965.

24. The figures given below show the changing pattern in the origin of steel exports. It is noted that in 1950, more than 86 per cent of the total steel exports still originated in the ECSC countries, the United Kingdom and the United States. By 1960, their share in total exports had decreased to 73 per cent, and in 1965 it was only 60 per cent. This was due mainly to the increasing importance of Japan and of the Soviet Union and other Eastern European countries as international suppliers of steel. It should be noted as well that the group of "other countries" (listed below) has expanded its share. In 1950, this group comprised such countries as Austria, Canada, Norway and Sweden, which were exporting specialties to neighbouring countries, but in 1965 the exports of ordinary steel products from Australia, Denmark, Finland, Greece, Portugal, South Africa, Spain and Yugoslavia were included in the group. These exports appeared on the market, together with smaller quantities of low-priced exports from certain developing countries (e.g. Argentina, Brazil, Chile and India) at a time when export prices for certain products had dropped to a level at which even long-standing, large-scale producers refused to sell, since transactions at such prices were no longer profitable. Over the past few years, repeated attempts have been made to reach an agreement between exporting countries with a view to limiting the almost ruinous competition that had emerged. However, the increased number of exporters and the legal difficulties in certain countries have so far prevented such a world-wide arrangement.

Table 9  
Origin of world trade in steel, 1950, 1960 and 1965  
(percentages of total)

<u>Exporting country or region</u>	<u>1950</u>	<u>1960</u>	<u>1965</u>
ECSC countries	54.9	58.5	50.1
United Kingdom	15.1	7.9	6.5
Socialist countries of Eastern Europe	6.8	12.5	15.9
United States	16.3	6.9	3.8
Japan	3.4	5.7	16.2
Other countries	<u>3.5</u>	<u>8.5</u>	<u>7.5</u>
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

25. The considerable fall in prices in the export market for steel, however, has not brought a very strong increase in the use of steel or, in the absence of increasing domestic production, in the steel imports of developing countries. Their net-imports of steel increased between 1960 and 1965, from 11.5 million tons (crude steel equivalent) to 14.7 million tons, or by an annual rate of 5 per cent, while their crude steel output grew by about 12.9 per cent a year. Judging from data on the destination of steel exports, it was the steel consumers in industrialized countries who benefited the most from the depressed price-level. The share of industrialized countries in world imports of finished steel products increased from 65.7 per cent in 1950 to 75.3 per cent in 1960, and reached 80 per cent in 1965. This is also brought out by the figures given below.

Table 10  
Destination of world trade in semi-finished and finished steel;  
1950, 1960 and 1965  
(in thousands of tons and percentages)

<u>Region of destination</u>	<u>1950</u>		<u>1960</u>		<u>1965</u>	
	1000 t.	%	1000 t.	%	1000 t.	%
Latin America	2,142.9	14.1	3,024.2	7.9	3,144.6	5.4
Africa (excl. South Africa)	875.8	5.8	1,658.0	4.3	1,975.2	3.4
Far East (excl. Japan and China [mainland])	1,227.5	8.1	3,225.3	8.4	4,406.8	7.5
Middle East	<u>969.6</u>	<u>6.3</u>	<u>1,549.4</u>	<u>4.1</u>	<u>2,120.6</u>	<u>3.6</u>
<b>Total developing countries</b>	<b>5,215.8</b>	<b>34.3</b>	<b>9,456.9</b>	<b>24.7</b>	<b>11,647.2</b>	<b>19.9</b>

Table 10 (cont'd)

	1950		1960		1965	
	1000 t.	%	1000 t.	%	1000 t.	%
Total developing countries	5,215.8	34.3	9,456.9	24.7	11,647.2	19.9
Total industrialized countries	<u>10,000.1</u>	<u>65.7</u>	<u>28,910.4</u>	<u>75.3</u>	<u>46,972.3</u>	<u>80.1</u>
Total world (excl. China [mainland])	<u>15,215.9</u>	<u>100.0</u>	<u>38,367.3</u>	<u>100.0</u>	<u>58,619.5</u>	<u>100.0</u>

26. The failure of developing countries to expand more rapidly their steel imports is due partly to the lack of foreign exchange to pay for steel imports. Another reason is that in some regions, as domestic output increases, tariffs and other obstacles to import of steel products are introduced. The third factor, and an important one is, in many cases, the lack of industries that transform steel products into manufactured goods. In the past, a large amount of finished steel has been imported by developing countries solely for construction purposes; of this, only a certain proportion belonged in the category of "creation of infra-structure" or of "building of industrial plant." In other words, a considerable part of the imported steel was "consumed" rather than being used for investment purposes in metaltransforming industries. This would also explain the stagnation or slow expansion of steel production in many developing countries. Aside from the substitution of steel imports used for "consumption" purposes, there is little additional demand from growing steel-using industries.

27. This brief survey of recent developments has shown that the present situation of the steel market, in which over-capacity and stiff competition play a prominent role, is not conducive to an expansion of capacity or to the creation of new large-scale steel industries. It appears to be difficult to find sources to finance steel plant projects at a time when the volume of unused capacity in some of the established steel-producing countries is more than twice the amount of apparent consumption of steel in all developing countries together. However, this is only the short-term aspect of the problem,

as it emerges from the actual situation of the iron and steel market. For longer-term considerations, it must be taken into account that there are few examples of countries enjoying sustained economic growth without domestic iron and steel production. Such examples show also that the establishment and gradual expansion of the iron and steel industry have always been an integral part of industrial development, i.e. a function of the size of the market. Location of iron and steel industries in developing countries must therefore form part of a comprehensive industrial development programme.

## II. CHARACTERISTICS OF THE IRON AND STEEL INDUSTRY

### Use of iron and steel in industrialized and developing countries

28. In the absence of more precise statistics, data on apparent consumption of steel, expressed in terms of crude steel equivalents and per head of population, can be taken as indication the importance of a country's steel market and even of the level of industrial or economic development. The range between the levels existing in individual countries is rather wide: from 682 kg per capita in Sweden to 16 kg in India (during 1965), and the figure is still lower in some of the other developing countries of Asia, Africa and Latin America. When countries are grouped according to per capita consumption, the picture given below emerges; it brings out certain differences in the levels of economic and industrial development reached and the differences in the type and structure of the economy of the countries listed.

<u>500 kg and above:</u>	Australia, Canada, Czechoslovakia, Federal Republic of Germany, Sweden, United States;
<u>400 kg to 500 kg:</u>	Belgium-Luxembourg, Eastern Germany, United Kingdom;
<u>300 kg to 400 kg:</u>	Denmark, France, Japan, Netherlands, Switzerland, USSR;
<u>200 kg to 300 kg:</u>	Austria, Finland, Hungary, Italy, New Zealand, Norway, Poland, Romania, South Africa;
<u>100 kg to 200 kg:</u>	Argentina, Bulgaria, Spain, Venezuela, Yugoslavia;
<u>50 kg to 100 kg:</u>	Chile, Greece, Ireland, Mexico, Portugal;
<u>under 50 kg:</u>	Brazil, China (mainland), Colombia, India, Turkey.

29. Only a very few industrialized countries have statistical data on actual consumption of steel products in the various consuming sectors; for developing countries, such figures are not available. The following discussion of the sector and product patterns of steel use in industrialized and developing countries is, therefore, based on estimates derived from statistical and other information.

30. Since the sector pattern of steel use is determined by the type of economy, the level of development and a multitude of other factors, figures for one country would hardly be typical of a group of countries. The estimates given below, are, therefore, based on statistical and other available information on several Western European countries, that have slightly developed motor-vehicle engineering and shipbuilding industries. They can be considered as typical of industrialized countries but the pattern will, of course, vary from country to country and over a period of time.

Table 11  
Sector pattern of steel use in industrialized countries  
(estimates: percentages of total use)

<u>Sector</u>	<u>Percentage of total steel use</u>
<u>Mining, railways, permanent construction, total,</u> of which:	25.9
Mining, crude oil and natural gas	4.9
Electricity supply, gas works, water supply	0.8
Railways (buildings and permanent track)	2.0
Construction	18.2
<u>Manufacture of metal products, total,</u> of which:	19.6
Hollow ware and containers	8.3
Wire, wire products, fastenings etc.	9.4
Household equipment, non-electrical	1.9
<u>Engineering industries, total,</u> of which:	18.5
Machinery, other than electrical	13.3
Electrical machinery, incl. appliances	5.2
<u>Manufacture and repair of transport equipment, total</u> of which:	21.8
Shipbuilding	5.1
Railway and tramway rolling stock	3.2
motor-vehicles, cycles and aircraft	13.5
<u>Other metal manufacturing, total</u>	11.6
<u>Other consumers</u>	2.6
<u>Total steel use</u>	<u>100.0</u>

Source: Aspects of Competition between Steel and other Materials,  
ECE, Geneva, 1966, table 41

31. It should be noted that metal-transforming industries as a whole (i.e. "manufacture of metal products", "engineering industries", "manufacture and repair of transport equipment", and "other metal manufacturing") are estimated as accounting for more than 70 per cent of steel use, and construction accounts for nearly 20 per cent of the total. The group referred to as "other consumers" includes agricultural uses of steel, which in industrialized countries are of minor importance.

32. The product pattern of finished steel use is also influenced by the industrial or economic structure of a country. The following estimates show the situation in industrialized countries of the same type as listed above.

Table 12  
Product pattern of finished steel use

<u>Product</u>	<u>Percentage of total use</u>
Ingots and semi-finished products	3.3
Railway-track material	2.4
Heavy and light sections	32.0
Wire rods	8.0
Plates	15.7
Sheets	17.9
Strip	7.6
Tinplate	3.2
Tubes and fittings	4.8
Other products	5.1
<u>Total</u>	<u>100.0</u>

Source: Aspects of Competition between Steel and Other Materials,  
ECE, Geneva, 1966, table 41

33. Flat products, particularly sheets, hold a prominent place among the finished steel products used (in the table above: almost 45 per cent). This is due to the importance of these products in motor-vehicle production, machinery manufacture, consumers durables, hollow ware and containers, and shipbuilding. "Heavy and light sections" form a group comprising a large variety of sizes of qualities, and are mainly used in construction (about 40 per cent, since reinforcement material and structural shapes are included here), but also in machinery manufacture and in production of transport

equipment. In the long-established industrialized countries, the use of railway-track material is of small significance, as demand for these products is mainly for replacement of obsolete track. Tubes and fittings have a relatively low proportion of the total since, in the countries on which the estimates were based, no special projects were carried out in the field of crude oil and natural gas (building of long pipelines, etc.) the major use was in construction (water and gas mains, sewage, and frequently for structural purposes) and in machinery manufacture.

34. As stated previously, there are no statistics on actual consumption of steel for any of the developing countries. Therefore, apparent consumption data for individual finished steel products that can be identified in output and trade statistics have been calculated and grouped, in table 13 below, by types of economies (agricultural; mixed agricultural and mining; mining; petroleum). The economies have been classified on the basis of their export structure, rather than the structure of domestic production. It should be borne in mind that in most developing countries, there is no steel-transforming industry large enough to influence the level and product pattern of steel use, despite the fact that "manufacturing" may already represent a sizable share of net domestic product. The main outlet for steel products is, in all types of developing economies, in the construction sector (heavy and light sections); the only other common criterion for steel use is the predominance of any steel-using export sector (e.g. petroleum, mining). This is also the reason why the classification of countries in table 13 is based on the export pattern rather than on the contribution of sectors to net-domestic product. An attempt has been made to relate levels of per capita consumption of steel to a product pattern of consumption by industries using steel.<sup>6/</sup> It would appear, however, that there is little similarity, except in very broad terms, between the patterns of steel consumption in countries with equal levels of per capita steel consumption. Table 13 below gives figures for 1962-1964 (average).

35. The most important products in almost all of these countries are heavy and light sections and sheets, which together usually account for 40 - 70 per cent of total consumption. No distinctive differences in the pattern of consumption emerge from a comparison of the high per capita consumption countries

<sup>6/</sup> More detailed discussion contained in a study, World Trade in Steel and Steel Demand in Developing Countries. - ECE Steel Committee (chapter V - factors influencing steel demand and its product pattern in developing countries.

with those having low per capita consumption. Indeed, the relationship between the proportions of consumption held by the two product groups does not appear to reach a common level even among countries with similar levels of per capita steel consumption. In the estimates for industrialized countries, as given above, sections and sheets were also the main product groups. The difference, however, lies in the quality and type of the products used, and this is not brought out by these statistics. For industrialized countries, a considerable part of the sections consists of high-quality products used in machinery manufacture while in developing countries the bulk of the sections is accounted for by concrete reinforcement bars and structural shapes of ordinary quality. The sheets used in industrialized countries are, to a large extent, of the deep-drawing quality required for the motor-vehicle industry and the production of consumers' durables; in developing countries, most of the sheets imported are galvanized sheets, used for roofing.

36. The stage of development of the railway system is an important factor that affects the pattern of steel consumption in developing countries. If railways are being built or extended, countries with low per capita consumption tend to require a greater percentage of railway-track material than to countries with higher consumption levels. In the few countries (listed in table 13) with the lowest per capita steel consumption, the percentage of rolled steel used for railways averaged 9 per cent in 1962-1964, while in the eight countries with higher consumption, the proportion was only 2.5 per cent. The importance of tubes, pipes and fittings, and hence the relative proportion of other products, largely depends on whether or not the country is an oil producer, regardless of its over-all per capita consumption. The average share of tubes in consumption in Iran, Iraq and Venezuela was 16 per cent; for all other countries, it was just over 9 per cent.

37. The following analysis suggests that, at low levels of economic development, the distinctive features of each country seem to outweigh the similarities, at least as far as steel consumption is concerned. The volume of steel consumption in one sector of the economy is determined quite independently of the consumption in another, and the sector pattern of steel use is quite different in each of the countries, depending on the specific type and speed of development of one or another sector. This is true even if the countries are grouped accor-



ding to their principal economic activity. The steel statistics for agricultural exports, e.g. Argentina, Brazil, Pakistan, Thailand, UAR and Uruguay show no common features; neither do those for the exporters of mining products, e.g. Chile, the Democratic Republic of the Congo and, to a lesser extent, the Philippines and Malaysia. Even among the oil-producing countries, the pattern of steel consumption reveals few similarities except for steel tubes and pipes. On the other hand, the agricultural exporting countries as a group tend to show features which are distinct from the mining and petroleum exporting countries. Although the per capita figure for steel consumption was lower in the agricultural countries, than in the mining and petroleum economies, the product pattern of steel use in agricultural and mining countries was remarkably similar, with percentages for single products showing differences of no more than five percentage points between the country groups. The pattern of consumption in the petroleum producing countries was, by contrast, appreciably different, particularly in respect to their heavy consumption of tubes and heavy and light sections, with a lower share for sheets.

Table 13  
Percentage distribution of rolled steel consumption and per capita consumption - 1962-1964

Type of economy	Country	Per capita consumption of steel, kg. 1963	Proportion of products in total						
			Railway material	Heavy and light sections	Plates	Sheets	Tubes and fittings	Tin-Plate	Wire rods
A	Indonesia	3 <sup>a/</sup>	10	31	7	18	11	2	3
M	Congo (Dem. Rep.)	3 <sup>b/</sup>	7	30	8	32	13	2	-
A	Pakistan	8	7	13	5	30	8	7	2
A	UAR	10 <sup>a/</sup>	12	40	3	9	18	7	-
A	Thailand	11	-	29	5	37	11	4	-
AM	Philippines	20	-	15	8	33	6	12	5
A	India	14 <sup>a/</sup>	10	38 <sup>c/</sup>	14	19	n.a.	4	-
P	Iran	20	-	46	3	17	26	2	-
AM	Malaysia	26	3	34	12	23	12	7	1
A	Uruguay	26	-	46	5	20	5	10	5
P	Colombia	30	2	28	4	16	7	6	7
A	Brazil	43	3	30	8	31	3	1	9
P	Iraq	39	3	69	3	9	10	3	-
AM	Mexico	57	4	22	5	27	13	4	7
A	Argentina	63	1	33	12	16	11	5	13
M	Chile	74	6	30	3	28	4	5	7
P	Venezuela	91	-	29	3	10	21	11	5

Source: Table 13: The European Steel Market, ECE, Geneva, (various years) and statistics of World Trade in Steel, ECE, Geneva, (various years)

Key:

A	Agricultural economy	22	5.5	32.5	7.5	25	9.5	5	4
AM	Mixed agricultural and mining	31	2	24	8	28	10	8	4
M	Mining	39	6.5	30	5.5	30	8.5	3.5	3.5
P	Petroleum	45	1	43	3	13	16	5.5	3

a/ - 1962; b/ - 1961; c/ - includes wire rods

38. In summary, it would appear to be very difficult to find meaningful relationships between steel consumption (per capita or aggregate) and the rate of growth or the level of development for developing countries; consistent relationships of this type, as they have been proved for industrial countries,<sup>1/</sup> begin to appear at much more advanced stages of economic development. The countries commonly classified as "developing countries" portray such a diversity of economic experience that comparisons between them are of little value even when they are statistically possible. The same may be said for comparisons between two or more developing countries over a period of time. Until the manufacturing sector develops beyond a certain point, i.e. when an indefinite number of identical steel-intensive articles begin to be produced, steel consumption is almost entirely directed towards unique, i.e. non-current, projects whose development depends on local, exogeneous factors such as the pattern of raw material resources, the climate, location, political and social structure etc. In many cases, these projects create new steel demand, not only through replacement demand, but also through new industries which may grow around them.

39. What remains to be shown is the origin of steel supply in different types of countries, i.e. the proportion of domestic or foreign produced (imported) steel held in the total. As stated in the first part of the present paper, international trade in steel has been growing at a rapid pace, particularly in connexion with the exchange of products among industrialized countries. Although most of those countries are globally net-exporters of

<sup>1/</sup> Cf. also Long-term Trends and Problems of the European Steel Industry, ECE, Geneva, 1959, page 118 et seq.

steel, they also depend on imports for particular products, in the production of which another country may have a comparative advantage; similarly, they export their own specialties to their trade partners.<sup>8/</sup>

40. The very few developing countries with a sizable domestic iron and steel industry have all made considerable progress in recent years in the attempt to reduce the size of the deficit in steel consumption that must be covered by imports. This is brought out by data, given in table 14 below, on domestic production as a percentage of apparent consumption in selected industrialized countries and in the few developing countries for which statistics are available.

41. The share of individual steel products of domestic origin in the total apparent consumption of each product has also been calculated; data are given in table 15 for India and Latin America. It should be noted that in India, the erection of new steel plants in Bilhai, Durgapur and Rourkela has led, for most finished-steel products, to a decrease in the size of deficits, which are now rather insignificant in the case of rails, sections and wire rods; for hoop and narrow strip, as well as wire, home production now covers more than three quarters of domestic consumption. In Latin America, the situation is further advanced: Brazil, Chile and Mexico have rapidly-expanding and well-equipped iron and steel industries and are now covering more than 90 per cent of requirements. Other countries depend on imports to a much higher degree, since their own production is insufficient (Argentina, Colombia, Peru, Venezuela) or since production of iron and steel has not yet been started. The figures in table 15 show that, except for railway-track material, tubes and fittings and tinplate, deficits have declined to 20-25 per cent of total use of individual products. In this context, however, it should be borne in mind that these are only "apparent" deficits, based on

<sup>8/</sup> It has been calculated that at present, almost half of the world trade in steel consists of such "exchanges" of specialties, the remainder of international trade being for "covering deficits"; in 1937, "exchange trade" was not more than 24 per cent of the total, and "deficit covering" still accounted for three quarters of international trade, which shows the growing international division of labour in the field of iron and steel production. For more details, see World Trade in Steel and Steel Demand in Developing Countries, a study prepared under the auspices of ECE Steel Committee (chapter III); the method of calculation is also explained there in more detail.

figures referring to steel demand that was satisfied from either domestic or foreign sources. In these countries, certainly there is a steel demand which could not be met by imports since there was no foreign exchange available to pay for them or there were other obstacles (tariffs, contingents etc.) to imports.

42. Establishment of domestic iron and steel industries in developing countries leads to a change of the product pattern of steel imports, as domestically-produced steel is substituted for certain products. In the early stages of development, the product patterns of consumption and production usually diverge widely, and the product mix of domestic output is largely dictated by financial possibilities and the available technical know-how, rather than reflecting the trend in the structure of demand. The broad lines of development in the product pattern of output may be summarized as follows.

43. In the early stages of industrialization, the decisive step is from the production of iron castings (cast-iron pipes) and light forgings only, to the rolling of small sections and bars (concrete reinforcement bars) of wire rods and, if the size of the market should justify the building of a rolling mill, for rails. Rolling of light sections and bars was started in India as early as 1911, in Mexico in 1914, in Brazil in 1925, in South Africa in 1926, and in Chile in 1938. Rails were produced in India from 1915 onwards, in Brazil before 1935 and in South Africa in 1935. In all of these countries, wire rods (and, in Argentina, also wire) were among the first products to be made domestically.

Table 14  
Domestic production as a proportion of apparent consumption, in  
1937, 1950, 1957, 1960 and 1964  
(percentages; total apparent consumption = 100)

Country	1937	1950	1957	1960	1964
<u>Net-exporters</u>					
Belgium-Luxembourg	320	274	345	433	327
France	129	161	133	124	115
Federal Republic of Germany	120	121	117	117	111
United Kingdom	117	121	119	111	112
Japan	99	115	102	114	127

Country	1937	1950	1957	1960	1964
Soviet Union	99	102	103	103	110
Czechoslovakia	128	112	101	104	120
United States	105	102	105	100	98
Italy	97	97	101	89	87
Netherlands	-	26	39	61	67
Sweden	66	66	73	79	95
Switzerland	18	21	25	18	16
India	61	84	51	65	80
Argentina	-	33	53	43	65
Brazil	17	74	78	84	91
Chile	-	34	78	80	93
Mexico	49	53	67	85	90
Colombia	-	-	15	44	42
Egypt	-	4	37	46	54
Venezuela	-	1	1	9	44

Source: Calculated from The European Steel Market (several years) ECE, data for 1937, 1950 and 1957 from: LONG-Term Trends and Problems of the European Steel Industry, ECE, Geneva, 1959, pp. 27 and 28.

Table 15

Domestic Production as percentages of apparent consumption<sup>a/</sup> in India and Latin America, 1955 to 1964

India	1955	1960	1961	1962	1963	1964
Railway-track material	53.5	45.0	50.0	69.2	75.3	100.0
Heavy and light sections ) wire rods )	75.0	88.0 84.5	93.0 95.0	94.0 91.0	94.0 89.1	94.3 83.1
Strip	16.6	30.6	64.2	53.0	60.0	78.3
Plates ) Sheets )	67.9	71.3 47.0	70.6 50.9	84.0 67.0	76.6 71.1	69.3 67.2
Tubes and fittings	n.a.	56.2	79.0	n.a.	n.a.	n.a.
Wire	40.9	26.3	37.5	39.5	47.5	75.5
Tinplate	56.9	47.0	67.0	68.8	67.9	62.5
Wheels, tyres and axles	86.0	72.0	40.0	31.5	52.0	68.0

<sup>a/</sup> In finished steel weight

Latin America	1955	1960	1961	1962	1963	1964
Railway-track material	8.3	14.9	30.0	27.8	22.7	21.5
Heavy and light sections	52.1	78.5	61.0	83.8	84.0	85.0
Wire rods	96.0	97.7	95.9	95.0	95.0	93.3
Strip	70.1	72.5	73.0	79.0	80.0	80.0
Plates	32.8	37.8	56.3	55.0	71.0	87.0
Sheets	26.3	72.1	65.9	74.0	73.1	71.0
Tubes and fittings	6.1	43.5	50.0	46.5	39.0	52.7
Tinplate	5.8	33.2	47.6	50.0	30.3	29.1

Source: The European Steel Market, ECE, Geneva, (various issues); and Iron and Steel Annual Statistics, 1965, London, 1966

44. The next step in the development of national steel production is, in the majority of cases, the rolling of flat products. Plates and sheets are the usual starting point, followed by narrow strip and tinplate. Domestic production of sheets is often preceded by the operation of galvanizing plants based on imported sheets. While cast-iron pipes are produced at rather early stages of development of domestic iron and steel industries, steel tubes and pipes normally follow much later. Usually, production of welded tubes is initiated first, using locally-produced flat products; the production of seamless tubes is generally undertaken later, in view of the high investment costs and the technical difficulties in producing a high quality of semi-finished and finished tubes.

45. The picture outlined above is necessarily incomplete; however, present examples of nascent steel industries seem to confirm it, even though, in some countries, the production of flat products or tubes may be introduced at early stages if the size of demand, the financial possibilities and technical know-how permit this.

The impact of technological developments on production of iron and steel in developing countries

46. The iron and steel industries, particularly in the field of technical developments, are dynamic and progressive. In the past twenty years, it has gone through a period of profound change, characterized by a rapid development in metallurgical science and, in the field of economies of production,

by a strong tendency towards the use of increasingly-large and highly-productive equipment. Before consideration of a few of the problems that may arise, as a result of technological developments, in setting up iron and steel works in developing countries, a brief description will be given of the main features of the technology of iron and steel production.

47. The production of finished iron and steel products is carried out in the majority of cases, in integrated plants (comprising the full cycle of the process from iron melting through rolling of finished products), with crude steel capacities ranging from 500,000 tons to large units of 4 - 5 million tons or more a year. The process leading to production of finished iron and steel products involves the following main stages:

- (a) Iron ore, in a crude or prepared stage, together with flux materials, is melted in blast-furnaces (or, to a lesser extent, in other iron-making installation), using coke (sometimes together with other solid or liquid fuels) both as a source of energy and a reducing agent.
- (b) Most of the resulting pig-iron is used while still liquid, together with scrap, in the production of crude steel, the remainder being transformed into cast-iron products. Crude steel is made in open hearths, electric furnaces or converters. The lastmentioned group comprises acid Bessemer, basic Bessemer (Thomas) and top-blown oxygen converters, of which the LD-type (and its variants) and the Kaldo and Rotor vessels are the most important.
- (c) Most of the crude steel output, once cast into ingots, undergoes further processing in rolling mills or forging shops; part of it is used for production of steel castings. Hot-rolling of steel is carried out in successive stages, in primary mills (where ingots are transformed into semi-finished products, e.g. blooms, billets and slabs) and in finishing mills (which transform semi-finished products into a large variety of forms, e.g. rods, bars, light and heavy sections, wire, rails, sheet, strip, plate and tubes). Mention is made here of the continuous casting process, which eliminates the casting of ingots and their rolling in primary mills, by casting liquid steel directly into the form of semi-finished products.
- (d) Hot-rolled steel products are either sold as such or transformed into products of further improved quality by cold-rolling and forming, and by heat treatment; such products are: cold-rolled strip and sheet, cold-rolled sections (also obtained by bending of strip), cold-drawn sections, bars and rods, wire, welded tubes etc. Furthermore, hot- and cold-rolled products are frequently coated with other metals (zinc, lead, tin, aluminium) or materials (plastics) for surface protection against corrosion.

- (e) An improvement in the quality of steel products is also obtained through alloying the steel, in liquid stage, with other metals, such as aluminium, copper, manganese, nickel, silicon, and vanadium, or combinations of these.

48. Mention has been made of the trend in industrialized countries towards using and developing equipment of large capacity in view of the well-known advantages of economies of scale. These developments, which have led in industrialized countries to the creation of large integrated plants, serving large markets, are sometimes a barrier to establishing iron and steel works in developing countries. In some cases, their markets are too small - even if they have grown since the initial stages of industrialization - to keep employed at an economic rate the high-capacity equipment offered by the heavy engineering industries. Furthermore, it is at least theoretically true that the quantities of individual steel products needed in relatively small quantities in developing countries during the early stages of development can be produced and could be supplied at lower cost for the users by the long-established steel-producing countries, where they may represent marginal quantities produced on the large-sized equipment mentioned above.

49. The latter point is only valid in the short-run, and not in a situation where foreign exchange is unavailable even for the lowest-priced steel imports. On the other hand, lack of iron- and steel-making equipment that can be economically operated in a relatively small market and can be expanded once industrialization and steel consumption have gained momentum, represents a major problem. It would seem that in the field of pig-iron and crude steel production, smaller-sized installations exist; mention should be made of examples where low-shaft furnaces are successfully operated, either in combination with iron foundries (spun-iron pipes) or with smaller LD-converters. However, the main problem continues to be the rolling and finishing installations which, at the same time, account for most of the equipment cost. A modern primary mill (blooming) may have a capacity of 1-4 million tons a year, 1 million tons being enough to supply the present annual needs of sections and bars of all of Africa. An efficient wire-rod mill produces about 4 million tons, which corresponds to four times the total use of this product in Latin America. A similar situation obtains in the field of flat products; wide strip mills of recent construction have capacities of

4.5 million tons, which largely exceeds the present consumption of total flat products in Latin America.

50. In this respect, high hopes have been placed - also because of savings in investment expenditure - in the development of continuous casting machines and their possible use in developing countries. Apart from the problem of training a highly-skilled operating and maintenance staff, it appears that the most successful use of these installations at present is in producing a very limited range of qualities and sizes of steel products (preferably small- and medium-sized semi-finished products) in large quantities. The relatively limited market in developing countries would rather demand the possibility of producing a large variety of sizes and qualities, in relatively small batches, for which the economic operation of continuous casting machines does not yet appear to be possible. However, a number of machines is already operating in developing countries, and it would be useful to analyse the economics of their operation.

51. It is understandable that in the past, research in the field of equipment production has been mainly adapted to the needs of industrialized countries, inasmuch as they produced and consumed more than 90 per cent of world steel output. Furthermore, steel plants in these countries have provided the operational experience required for large-scale development of the equipment needed to satisfy markets which had extended beyond national boundaries through the increasing exchange of specialties. However, the needs of developing countries would appear to justify fully the attempts made thus far to produce, and operate economically, smaller-sized instruments of production adapted to the needs and size of markets in some of the developing countries; there would appear to be room for concerted international action to intensify further research in this field.

52. In markets where the vast size of the country alone would mean a volume of demand corresponding to the capacity of modern equipment, e.g. Brazil and India, such equipment is being used. However, even the largest of the developing countries cannot yet make use of the rolling mills of very large capacity (mentioned above). It is for this reason that attempts to create regional groupings and common markets often originate in the iron and steel industry. The classic examples of the European Coal and Steel Community and of the

steel industry organization of the Council for Mutual Economic Assistance have been followed by similar efforts (e.g. in West Africa and Latin America) which, however, have not achieved visible success.

53. A further problem arising from the rapid technological progress in industrialized countries, and from the fact that standard equipment is adapted to their needs and to their skill of operation, is the shortage or even lack of adequately trained personnel in developing countries. The training of skilled labour and technical personnel for the iron and steel industry takes a relatively long period of time. Despite a generally well-advanced state of automation, many operations require interventions based on judgement and experience, by workers. Even in the well-established steel-producing countries, new installations will only reach full capacity and produce a satisfactory product after several months of experience. In developing countries, the shortage of qualified workers to be directly attached to the production process is further aggravated by the need for highly-qualified maintenance and repair personnel.

54. The training of the number of workers needed to man an integrated iron and steel plant with capacity of 1 million ton of crude steel a year often poses difficulties and requires considerable time; a plant of this size employs about 10,000 workmen (as distinct from engineers, technicians and administrative personnel). Although a good deal of the training in a new plant can be undertaken by foremen and technicians, considerable schooling is required; moreover, the minimum technical skills needed may take years to develop in a given population group.

55. In countries where a steel industry already exists, the establishment of a new plant can be facilitated by training, well in advance, a large proportion of the personnel required and by transferring, or assigning temporarily to the new structure, experienced personnel from the existing plant. On the international level, progress has been made in the past ten years in providing assistance for technical training. Many facilities are now provided under bilateral aid programmes. Among the services available from international organizations, special mention should be made of the extensive training activities carried out by the International Labour Organisation, the technical assistance provided under the United Nations

Development Programme, and the in-plant group training programmes for engineers and technicians which are sponsored by UNIDO. The training for foremen, technicians and engineers, provided by the suppliers of equipment prior to or during the construction of an iron and steel plant, should also be mentioned.

56. The level of investment expenditure for setting up iron and steel plants is also closely connected to the type and size of steel-making, -rolling and -finishing equipment which is now being designed or offered. It is difficult to derive "typical" examples of investment costs since they are determined by a variety of factors other than the price and size of plant and equipment. Such factors include to exact geographical location of a plant (distance to iron ore or coal deposits, rivers, canals, deep-water ports, markets); the type of processes used for production of pig-iron, crude steel and rolled steel; the type of product to be produced; the quality of raw materials to be used; the price and wage levels obtaining in a given country, etc. As a rule of thumb it is commonly assumed that an investment of US \$300 per annual ton of crude steel capacity is required for an integrated plant of 1 million tons annual output. This figure seems to be confirmed by recent experience in building entirely new plants. Thus, the first stage of the Piaçaguera plant of the Companhia Siderurgica Paulista (COSIPA) in Brazil, having a crude steel capacity of 500,000 tons a year, required total investments of US \$192 million, or US \$382 per ton of annual crude steel capacity. Taking into account that the plant has only half of the capacity assumed for the "rough" figure of US \$ 300 per ton, and that part of the equipment is laid out for further expansion of the plant, the difference of US \$82 appears to be of little significance. The planners of the plant had originally foreseen total costs of US \$170 million, or US \$340 per ton of crude steel capacity. This figure comprised the following items (percentages):

Table 16

Estimated investment expenditure  
Piaçaguera plant of COSIPA (Brazil)

<u>Item</u>	<u>Percentage of total cost</u>
Plant and equipment:	53.2
Material handling	2.2
Sinterplant	1.4
Coke plant	5.2

Table 16 (cont'd)

<u>Item</u>	<u>Percentage of total cost</u>
Power station and distribution	5.6
Blast-furnace plant	4.5
Steel plant	4.0
Rolling mills	25.5
General facilities	4.8
Labour costs	17.3
Material costs	21.1
Freight costs	5.1
Other costs	3.3
	Total 100.0

57. The breakdown of investment expenditure given above shows that a considerable part may be contributed within the country and need not be imported, against payment of usually scarce foreign exchange. It would appear that most items other than "plant and equipment", - i.e. one quarter to almost one half of the expenditure - can be of domestic origin. In a country like Brazil it may even be possible to produce part of the equipment locally, particularly equipment for "material handling" or "General facilities". However, the \$95-140 million worth of equipment which would have to be imported still represents a considerable burden in connexion with the balance of payments situation (for comparison: Brazil's total imports of "engineering products", i.e. SITC, section 7, excluding transport equipment, amounted in 1964 to not more than US\$ 246 million).

Secondary effects of and difficulties encountered in establishing an iron and steel industry in developing countries

58. The positive effects of establishing and operating an iron and steel plant in a developing country have often been described. Some of the effects only become apparent in the long-run, since the impact which the iron and steel industry has on progress in general industrialization takes time to materialize; other effects become evident at an early stage, during the building of the plant as well as after the start of operations. The first effects are the creation of employment and the generation of income. As pointed out

above, a good deal of the investment for the construction of a plant may be contributed from domestic sources. Many people find employment as building workers; at Bhilai, India, for example, 60,000 were employed in the construction of the plant, ore mines and a town for 100,000 persons. Further jobs are created in the corresponding expansion or setting up of the transport system and, since a steel-works is a large consumer of energy, in the building and operation of power plants and coal mines.

59. The other main beneficial effect is the saving of foreign exchange, which occurs as soon as locally-produced iron and steel can be substituted for some of the imports. Indeed, the expectation of obtaining a greater quantity of iron and steel products for a given expenditure of foreign exchange is one of the main motives for initiating domestic production. Developments in the international steel market during the past decade, which led to a spectacular fall in export prices, have in some cases discouraged the expansion of construction of plants in importing countries, or have created difficulties for existing enterprises, particularly since costs of production tend to be rather high during the early years of operation and to compare unfavourably with the low prices of imported steel. However, even with the low level of export prices, calculations for Latin American countries have shown that, theoretically, a plant producing 300,000 tons of bars and profiles a year would, through foreign exchange savings, pay back the foreign exchange component of investments over a period of about five years; for a flat-products plant of 500,000 ton capacity, the foreign exchange component of investments would be returned in about ten years.<sup>2/</sup> It should be noted, however, that the hypothetical cost figures used in these calculations are probably too low, since they refer to a situation where capacity is fully used and theoretical productivity actually attained, and since assembly and operational costs in Latin America are generally higher than those that are assumed for the hypothetical cost calculations used for deriving the foreign exchange savings per ton. This would appear to indicate that, although there certainly are savings of foreign exchange through import substitution, their

<sup>2/</sup> Proceedings, United Nations Interregional Symposium on the Application of Modern Technical Practices in the Iron and Steel Industry to Developing Countries, Prague, Geneva, November 1963, p.110.(Sales No: 64.II.B.7)

exact level (and hence the length of the period of time required to pay back the foreign exchange component of investments made) will depend on a great many local factors which must be analysed in detail before a decision for setting up an iron and steel plant can be taken.

60. Among the beneficial effects, mention must also be made of the impact that the availability of iron and steel products (at satisfactory prices) will have on the activity in, or the establishment of, the main consuming sectors. In the earlier stages of development, these sectors are mainly construction and some of the metal-using industries, which produce hardware and cutlery, tools and agricultural implements, certain types of machinery etc. In this respect, it is fortunate that the types of products required in a country on the road to industrialization are also relatively simple to produce, without the high general levels of technical skill or the heavy investment needed for the complicated equipment to turn out steel products of a higher stage of finishing.

61. As to the possible negative effects of the establishment and operation of an iron and steel industry, the temporary burden on the balance of payments caused by imports of steel plant equipment, structural steel, building machinery, transport equipment etc. has already been mentioned. However, this appears to be unavoidable once the decision to build a national steel industry has been taken; appropriate arrangements, of course, have to be made for credit facilities and for keeping a balance with other import requirements. If, on the other hand, the import of iron- and steel-making raw materials, such as ore, coke or coal and scrap is a regular feature, this would endanger the balance of payments situation of most developing countries. So far, there is no example of a developing country that has, or intends, to set up iron and steel works without having at its disposal any of the necessary raw materials; it is only the lack of coking coal in certain countries of Latin America that forces them regularly to import coal for blending. In 1964, Argentina spent \$US 14 million (or 1.4 per cent of the value of all commodity imports) for the import of coal, coke and briquettes, of which the bulk was used in metallurgy; in Brazil, the value of such imports in the same year was nearly \$US 30 million (2.3 per cent), and in Chile, \$26 million (0.9 per cent). A similar situation obtains in Algeria, and it

will obtain in most other African countries when their iron and steel production reaches a sizable scale.

62. One of the main problems in erecting iron and steel plants in developing countries is to secure finance; since the price of equipment and the costs of its installation are comparatively high, the necessary funds cannot often be raised within the country alone. However, new iron and steel plants sometimes are not profitable for a number of years and thus offer little incentive for foreign private capital investment. In cases where the suppliers of equipment advance loans or make direct investments in developing countries, these are generally guaranteed by governments or by inter-governmental agencies.

63. For the Governments of developing countries, investment in a new iron and steel plant may represent a heavy drain on financial resources. As a result, steel projects are often financed jointly by the Government of the receiving country, international financial institutions, grants or loans from foreign Governments, equipment producers and, sometimes, by enterprises of the iron and steel industry through establishing subsidiaries abroad or serving as technical advisers.

64. Another question that arises in discussing the effects of starting national steel production is whether it does stimulate steel consumption. Theoretically, this should be the case, and there are a number of examples of countries where steel demand has increased faster than domestic production, with a consequent increase in imports of steel. However, the examples of other countries, particularly in Latin America and India <sup>10/</sup> shows that an apparent "self-sufficiency" is attained, i.e. that imports shrink in volume, and this is at a level of apparent consumption per capita which indicates clearly that saturation of demand is far from being attained. This is certainly due to the lack of foreign exchange and to tariffs and other barriers to steel imports. The main purpose of such barriers is generally to protect the balance of payments or a particular industry. They also exist to raise extra revenue; to maintain standards of quality; to channel trading through selected importers etc. These measures may take the form of fixed or ad valorem tariffs, global or selective quotas import licences, exchange control permits, import taxes, prior deposit require-

<sup>10/</sup> Cf. also table 15 above

ments, multiple exchange rates, etc. <sup>11/</sup> Tariffs and other now applied duties in developing countries range from 13 to 15 per cent ad valorem duties (in Bolivia) to 40 - 60 per cent in India; in Pakistan, finished steel imports are subject to a statutory duty of up to 40 per cent, plus a 25 per cent defence surcharge, plus a 15 per cent sales tax (total: 80 per cent)

65. Such protective measures to stimulate domestic industry should not, in theory, depress the level of consumption provided that only a change in the source of supply is involved. However, consumption may be held back for the reason that domestic steel is often more expensive than imported steel or that for certain uses of steel, other products are substituted. Consumption levels may also be affected because centralized import restrictions are normally based on broad groups of steel products, although local production may not cover every type of steel in the group, i.e. some products will not be imported because of high duties, and they cannot be obtained locally.

66. A similar stagnation of steel output and use may occur when the newly created domestic production is used merely as a substitute for the tonnage and range of steel products thus far imported, instead of as a means of meeting growing demand from other sectors. Once this substitution has been achieved, production may stagnate if no new outlets are created for it on the domestic market through appropriate planning of development of consuming sectors. If the size of the plant has been selected to exceed the demand existing at the time of its installation, the rate of capacity use will be low and production costs per unit of output will be correspondingly high. In some cases, this situation has led to very low-priced exports of steel from developing countries. Although this increases foreign exchange revenue, it represents a severe loss for the economy as a whole.

<sup>11/</sup> For more details, see World Trade in Steel and Steel Demand in Developing Countries, chapter IV.



III. REGIONAL CO-OPERATION AND INTEGRATION

67. Mention has already been made of the few existing examples of regional co-operation and integration in the iron and steel industry and its market. Discussion of the impact of technological developments on iron and steel production in developing countries has shown, among other things, that the economies of large-scale production play an important role in iron- and steel-making and that there is, therefore, a strong tendency to enlarge markets, also through increased international division of labour, i.e. exchange of specialties, in order to achieve a suitable volume of batches in rolling of finished steel products. The economic advantages of common markets for steel, as well as common investment programmes, are evident; however, political obstacles have often prevented co-operation in the iron and steel industries of developing countries with the result that, in many cases, several less economic installations have been built instead of a large central unit which could have served identical markets at lower prices. In this context, it should be stressed that leaving aside all foreign exchange difficulties, the products of a rolling mill of 500,000 ton capacity would hardly be able to compete successfully with products from an installation with capacity of 5 million tons even though the latter products were transported over long distances. Therefore, it would appear that regional co-operation and integration are an economic necessity which has to be met in order to achieve the desired progress in industrial development.

IV. TRENDS AND PROSPECTS

68. It would exceed the scope of the present paper to provide a detailed assessment of future trends in both demand and supply of steel in individual countries. Detailed studies of the expected growth of macro-economic indicators (in a global approach) or of the individual steel-consuming industries (in the so-called sectoral approach) are needed to obtain a reasonably reliable forecast. For the year 1970, however, it is now possible to give, on the basis of known plans or official forecasts, an impression of the expected development of crude steel output; grouped by regions, the following picture emerges:

Table 17  
Likely trends of world crude steel production in 1970<sup>a/</sup>  
(in thousand of tons and percentages)

<u>Region</u>	<u>1965</u>		<u>1970</u>		<u>Rate of growth</u> 1965 - 1970 (compound)
	1000 t	%	1000 t	%	
Latin America	8,205	1.9	16,800	3.0	15.4
Africa (excl. South Africa) and Middle East	645	0.1	2,500	0.4	31.1
Far East (excl. China [mainland] and Japan)	8,127	1.8	16,340	2.9	15.0
Total developing countries	16,977	3.8	35,640	6.3	16.0
Total industrialized	427,023	96.2	530,600	93.7	4.45
Total world (excl. China [mainland])	444,000	100.0	566,240	100.0	5.0

69. The figures reveal that the developing countries as a group will probably increase further their share in the total world production of steel. The growth rates over the five years, 1965 - 1970 are rather high and show that considerable material and financial efforts are involved in creating new plants which can produce the tonnage shown. A comparison with the rates of increase during the period 1950 - 1965, given in the last line of table 1, reveals that the growth expected up to 1970 is faster (compound rates);

Table 18  
Comparison between the growth rates in period 1950-1965 and estimated rates for 1965 - 1970

<u>Region</u>	<u>1950 - 1965</u>	<u>1965 - 1970</u>
Latin America	13.0	15.4
Africa and Middle East (excl. South Afr.)	19.6	31.1
Far East (excl. China [mainland] and Japan)	12.15	15.0
Total developing countries	12.7	16.0
Total industrialized countries	5.6	4.45
Total world (excl. China [mainland])	5.75	5.00

<sup>a/</sup> Secretariat estimates for 1970

70. The growth rate shown for industrialized countries is falling. This is due partly to the well-known phenomenon of decreasing rates of increase at higher levels of development, and partly to the present situation of over-capacity for steel-making which results in a slowing down in the rate of investments.

71. Some statement should be added on the further developments expected between 1970 and 1975. The situation for 1970 could be sketched rather easily, in view of the time needed to bring into being investment projects in the iron and steel field, and in view of the considerable information on the plans and projects which will come into operation by 1970. A forecast for 1975, however, requires the detailed analysis described at the beginning of the present section. The first results of a study of this type, carried out under the auspices of the ECE Steel Committee <sup>12/</sup>, show that world crude steel output may grow between 1970 and 1975 by a further 3.5 to 4 per cent a year, to reach a volume of 650-685 million tons. Output in developing countries can also be expected to increase further, although at a slightly lower rate than in the preceding five-year period. A rate of increase of the order of 13 - 14 per cent a year may be expected, i.e. nearly a doubling of capacity during the five years; this will involve a considerable economic effort, particularly if account is taken of the required corresponding investments in the consuming sectors. The rate of increase in output in industrialized countries may not be higher than 3 - 4 per cent a year; however, taking into account the rather high level likely to be attained in 1970, such a "modest" rate of increase will mean the building of about 80 - 90 million tons of new capacity, which represents a considerable task.

<sup>12/</sup> The World Market for Iron Ore, ECE, Geneva.

#### V. CONCLUSIONS

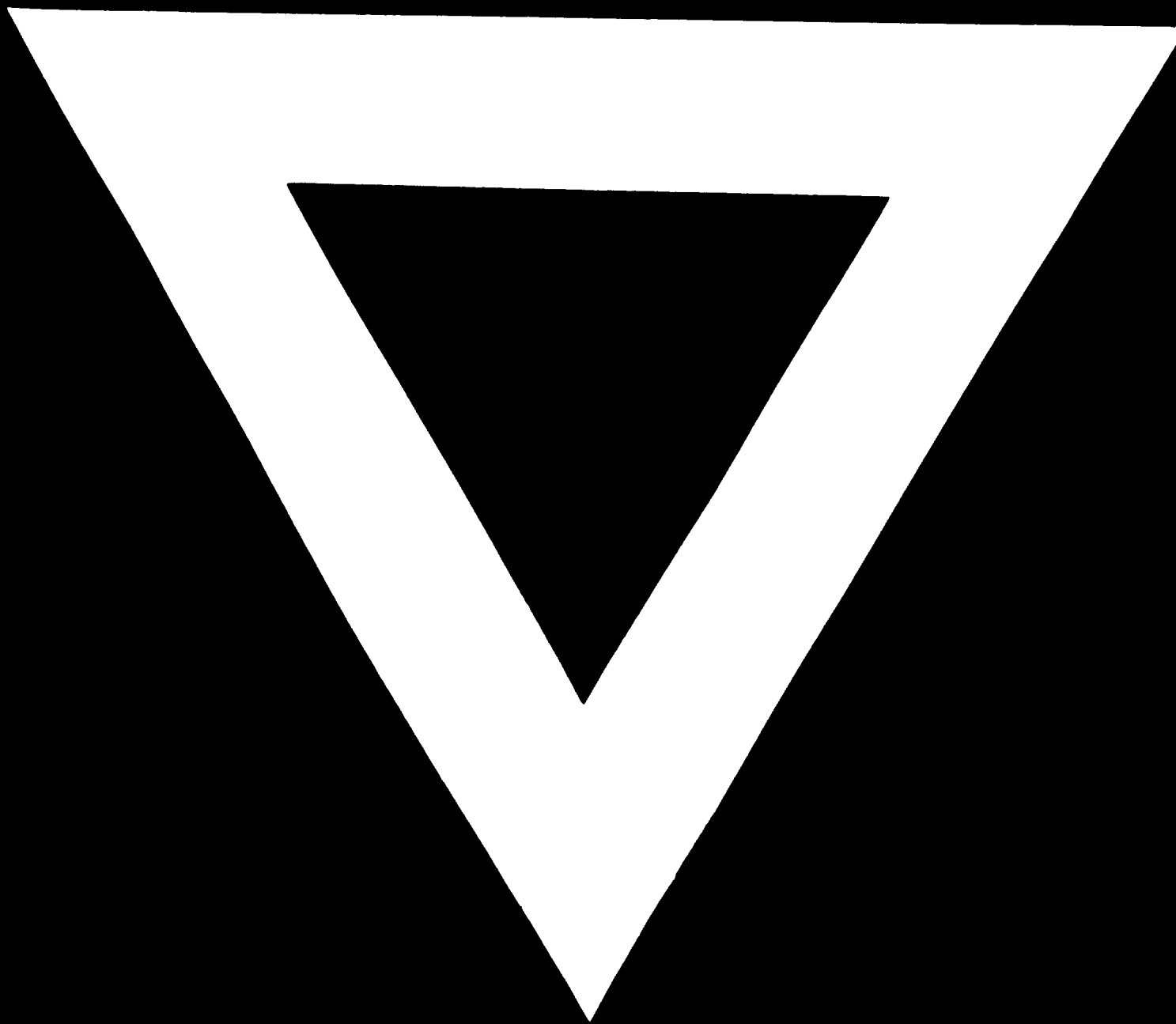
72. The present paper has provided a survey of the actual situation of the iron and steel industry and its markets in order to give an impression of the background against which the development prospects and problems of the young steel industries have to be viewed. It has been pointed out that the present

situation of the steel market is not conducive to large-scale expansion of capacity since a considerable part of the world's steel production equipment is now idle. The ensuing section gave a brief description of the characteristics of the industry and its markets, showing that, next to the construction sector, the metal-transforming industries are the main outlet for iron and steel products. This brought out clearly that for developing countries, erection of national steel production must always be preceded by the planning or parallel establishment of consuming industries and the initiation of large-scale construction projects. (e.g. the setting up of infra-structure).

73. It was also determined that technological trends, and the fact that large scale production in the iron and steel industry is an economic necessity, present a number of problems in connexion with the building of steel plants in developing countries. Even in countries where the size of the population would ultimately provide a market corresponding to large-capacity equipment, the demand during the early stages of development is likely to be too small to justify the immediate building of (expensive) high-capacity plant; in the smaller developing countries, the size of the market would require the operation of medium-sized plants for which equipment of corresponding capacity cannot always be found on the market.

74. It is hardly possible to make general recommendations for Government policies to be pursued in setting up iron and steel works or expanding existing installations. The reason is that, particularly during the early stages of economic and industrial development, any steel-making operation is determined, as far as its size and production programme are concerned, by its market, i.e. by the kind, rate of growth and volume of demand. Since the volume of demand depends on the type of economy and the level of industrialization, it is not possible to make general recommendations on measures to be taken to meet the demand for iron and steel products. It is evident, therefore, that detailed investment surveys are required to assess the volume and product pattern of existing demand and the required corresponding investment in ancillary and steel using sectors. Experience shows that new steel industries in developing countries have always been most successful when established as part of a comprehensive industrial development programme.





**74 . 10 . 15**