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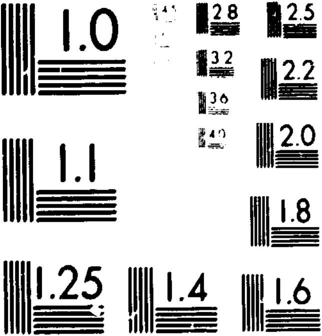

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First Consultation on the
Capital Goods Industry

Brussels, Belgium, 21-25 September 1981

FIRST GLOBAL STUDY ON THE CAPITAL GOODS INDUSTRY:

STRATEGIES FOR DEVELOPMENT *

Prepared by the Secretariat of UNIDO

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CONTENTS

INTRODUCTION

Analyses presented in this study were based on various inputs of general and specific nature as well as on two preparatory meetings organized by UNIDO's Secretariat.

The UNIDO Seminar on Strategies and Instruments to Promote the Development of Capital Goods Industries in Developing Countries which was held in Algiers, Algeria, in December 1979, discussed and evaluated some elements of strategies and methodological tools to serve the development of capital goods in developing countries. Several improvements were made in the UNIDO Secretariat documents during 1980 in order to present them for discussion to the Global Preparatory Meeting for the First Consultation on the Capital Goods Industry. The Preparatory Meeting was held in Warsaw, Poland, in November 1980. At this meeting recent trends, medium-term prospects, strategies, instruments and international co-operation aspects related to the capital goods industries were discussed and recommendations made for the final preparation of the Study to be submitted to the First Consultation Meeting on the Capital Goods Industry.

In line with the recommendations of the Global Preparatory Meeting, UNIDO's Secretariat devoted further efforts to complete the Global Study, particulary with respect to the elaboration on various elements of strategies for entries and development of the capital goods industries and on objectives, conditions and forms of international co-operation, including long-term arrangements between developed and developing countries and amongst developing countries. Findings and conclusions of this research were incorporated into the Global Study, which is now presented to the First Consultation Meeting on the Capital Goods Industry, held in Brussels, Belgium, 21-25 September 1981.

Some major findings of the research could be summarized as follows:

- The contribution of developing countries to world production of capital goods was estimated at about 6 per cent, while their contribution to world consumption was 9 per cent. It was anticipated that in the year 2000 the amount of consumption covered by local production would increase and approximately 15 per cent of the world production of capital goods would be produced in developing countries. However, those estimates and their implications require further consideration.

- The great majority of developing countries did not have a capital goods industry, and only about 30 countries had such an industry either partly established or in an embryonic stage. A preliminary classification of developing countries had been established with the aim of developing suitable strategies, taking into account their basic economic characteristics and their potential for development of the capital goods industry.

- Deep-seated inequality in production manifests itself also within international trade. Developing countries supply only 2.5 per cent of the world's exports whereas their share in imports reaches 30 per cent. The market economy developed countries provide more than 87 per cent of world exports whereby six of these countries (Canada, the Federal Republic of Germany, France, Japan, the United Kingdom, and the United States of America) account for three-fourths of this amount. The centrally planned economies provide 10 per cent of world exports.

- Imbalances within the developing countries would be seen first of all in production: Argentina, Brazil, India, the Republic of Korea and Turkey contribute between 40 to 45 per cent of the developing countries' production (excluding China). Eighty per cent of machine-tool production within the developing countries is concentrated in three countries: Brazil, China and India.

- A second group of countries is made up of those which are at the embryonic stage in the capital goods industries.

- The third group consists of 60 countries actually 110 if the 50 countries and territories of less than one million inhabitants are considered which have no capital goods industries and which rely mainly on agriculture.

- These imbalances are also shown by the nature of the products manufactured and the means of production. In numerous developing countries assembly lines have been introduced in the manufacture of more complicated products such as tractors, trucks and other vehicles. However, these operations are limited to assembling only, rendering low value added and the industrial experience thus acquired.

The First World Consultation on the Capital Goods Industries is faced with a two-fold need: how to change the present pattern of production and trade situation in the capital goods industries between developed and developing countries on the one hand, and among the developing countries themselves on the other.

To facilitate the reading of the study, conclusions are provided at the end of each part, as well as an overall summary and recommendations for the whole study.

The study is the result of close co-operation between the UNIDO Secretariat and several institutions and organizations as well as specialists from various countries working as UNIDO consultants in their personal capacities. Special acknowledgement should be attributed to the Institute for Economic Research and Development Planning, University of Social Sciences, Grenoble, France, which made the major contribution to the study. In one way or another the following institutions and individuals contributed to the study:

- INITEC associated with TECHNIBERIA, Madrid, Spain.
- Research Institute of Engineering Technology and Economy, Prague, Czechoslovakia.
- ICME Business Consultants, Zürich, Switzerland.
- Metra/Seis, Madrid, Spain.
- PROMASZ, Warsaw, Poland.
- Institute of Economics, Academy of Sciences, Sofia, Bulgaria
- Mr. F. Vidossich, the analysis of technological complexity
- Mr. Shree Acharya, international co-operation
- Mr. A. Benbouali, long-term contractual arrangements
- Other consultants, listed in the annex to the study (see List of documents, page 273).

The Global Study in its present form was prepared by the Sectoral Studies Branch, Division for Industrial Studies, UNIDO.

POTENTIALITIES AND POSSIBLE PROGRESS OF THE CAPITAL GOODS INDUSTRY DEVELOPMENT IN DEVELOPING COUNTRIES INCLUDING THE SMALL AND MEDIUM SIZE DEVELOPING COUNTRIES

Part one : Current trends, potentialities and development prospects.

Introduction

Capital goods contribute to the gross fixed capital formation in various sectors of the economy, i.e. machinery and equipment which form part of investment. Heterogenity is an essential characteristics of capital goods. Typologies which are useful for action are therefore essential.

The definition of capital goods is based not on their nature but on the economic function which they fulfil, i.e. investment. In the market economy countries, national accounting defines them as durable goods constituting the fixed capital of the companies in an economy (excluding land and invisible assets), which therefore involves machines and equipment of all kinds (fixed or mobile) purchased by companies to form their productive capital.

In the centrally planned economy countries, capital goods form part of section I of social production, i.e. machinery and equipment, section II being the production of consumer goods. Since they form the basis for accumulation, they have, in practice, been granted priority.

This definition needs to be supplemented by other characteristics such as: the type of product and its technical nature; the degree of elaboration of the goods; and the nature of demand.

Type of product and technical nature

This characteristic is directly linked with not only the technical function which the product fulfils but also with its intrinsic technical nature, in particular the materials required.

The concept of capital goods is currently directly associated with elaborated products resulting from metal converting, within which three principal sub-groups are distinguished: fabricated metal products; mechanical products, in particular "machines" which create and transmit movement;

electrical machines and equipment based on metal componets, the essential function of which is accomplished by means of electrical energy.

This mixed criterion (function and technical nature) forms the basis of current nomenclatures for capital goods.

The degree of elaboration of the goods

The complexity of the capital goods industries is due in part to the existence of numerous successive or different converting phases of the base materials (products of the iron and steel industry or other metals) or to the incorporation of components and phases of assembly and erection which result in the final product. Thus the structure of the production in the "metal-working" industry (downstream from the iron and steel industry, but upstream from the mechanical and electrical industries) shows interlinked technical relationships: those products which have undergone forging or foundry work, will be:

- either reconverted by the client mechanical industries, for example by the machining or by welding, assembly, etc.;
- or are finished products used by the downstream industry in intermediate consumption (screws, gears, etc.);
- or are finished products intended for final use, for example containers, vats, mechanical girders, etc.

Converting phases can only form one stage of the overall process and may consist of manufacturing individual components or machines, or the total assembly of products or plants. Turnkey plants constitute one example of the latter activity. One of the essential characteristics of the capital goods industry is therefore that they constitute a highly diversified system of integrated activities, linked one to another by close commercial relationships and by technical and economic interdependence.

The nature of demand

Applying the end-use economic classification of capital goods we may distinguish the following main sub-sectors:

Capital goods for the production of capital goods

- machine tools and automation;
- construction and public works machinery and equipment.

Capital goods for the production of intermediate goods, e.g.

- power production and distribution equipment;
- iron and steel making equipment;
- petrochemical, fertilizer as well as other chemical industry equipment;
- mining and ore processing equipment.

Capital goods for the production of consumer goods

- agricultural machinery, equipment and implements
- for the production of other consumer goods

    e.g. food industry
        textiles and footwear industries
        paper, pulp and printing industries
        electrical consumer goods industry

Capital goods which are common to all sectors e.g. electrical motors, boilers, pumps, containers, tanks, valves, gears.

Capital goods are differentiated one from another by the nature and number of the production sectors which require them. In this way it is possible to distinguish among capital goods intended for a single sector; those intended for several production sectors; and those common to all branches of the industry.

The agricultural machinary industry is an example of capital goods intended for a single sector since it is defined by the nature of the demand (agriculture) and not by the nature of the equipment which it produces. Also belonging to this category are specialized industrial equipment and plants such as those intended for the petrochemical, iron and steel, food industries, the building sector and the production of electricity.

Capital goods intended for several production sectors include, for example, cranes, equipment for automation, equipment for metal forming (foundry, forging), protective and painting equipment, storage or transport equipment, etc. Such equipment is also common to groups of industries as energy, chemicals, metallurgy.

Capital goods intended for numerous sectors or common to all branches can be semi-finished products and components (metal profiles, screws and bolts), simple machines (motors, compressors) or complex machines (machine tools).

Their common boundry with the previous category is difficult to establish since their technical characteristics can vary for the same type of product according to the purchasing sectors.

The international nomenclature of activities includes capital goods in class 38 "Manufacture of Fabricated Metal Products, Machinery and Equipment" which comprises mechanical, electrical and transport equipment and machinery, fabricated metal products, measuring and controlling equipment. Due to the ambiguity of the statistics, it is advisable to eliminate at least those products of engineering industries related to consumer goods (automobiles, domestic electrical appliances and mass consumer electronics).

This sector is therefore only a part of the metal converting or mechanical, electrical and transport engineering industries which produce capital goods, intermediate goods and durable consumer goods. World industrial statistics covering the whole of the mechanical and electrical industries sector (ISIC 38) make it difficult to isolate capital goods. The statistics for international trading are more subdivided and it is possible to detect more clearly the capital goods sector (part of SITC sections 69, 7 and 861).

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There are several questions which should be discussed at the First Consultation in order to bring about and develop a capital goods industry, particularly in small and medium-size developing countries. How can the hundred developing countries which have practically no capital goods industry enter into such industry? Why small and medium size developing countries should develop capital goods and what kind of products? What are the conditions for achieving national integration and sub-regional integration? What type of international co-operation for setting up of capital goods industry in small and medium-size developing countries should be enforced?

A. Analyses of the existing situation and development prospects

1. General characteristics of manufacturing industries and current trends in capital goods industries.

It is difficult to understand some of the basic characteristics of capital goods if the analyses are restricted only to this industry. Capital goods sector is interrelated with other sectors of national economy, particularly industrial and makes it possible to create integrated industrial structure. It is therefore important to pay attention to the current situation in industry as a whole.

As far as the growth of net manufacturing output is concerned, there are two different time periods: 1960-1968 and 1969-1980 1/. In the first period there was rapid industrial growth throughout the world with a steady increase of centrally planned economies share in world manufacturing value added while developing countries share remained unchanged despite a much larger proportion of the world's population and low levels of per capita income. The second period showed lower increase and a wider degree of fluctuation in manufacturing value added than the preceding period. Since 1968 developing countries recorded steady, although minor, gains, while developed centrally planned economies increased their share substantially. This pattern continued up to 1980 with the exception of the period of 1974-1975 in which developed market economies manufacturing value added annual rates were negative and the share of these countries dropped from 72.6 per cent in 1970 to 66.6 per cent in 1975 (annex, table1).

In the developed market economy countries annual rates of increase in manufacturing value added were lower than in the rest of the world and in the second period the degree of fluctuations in growth rates was very high. Further slowingdown in the rate of growth was experienced in 1979 and 1980 with a world wide acceleration of inflation and high levels of unemployment. More alarming, there was growing evidence that inflationary expectations, nourished a decade of continuous inflation, were becoming deeply rooted in many developed market economy and developing countries.

1/ Source: UNIDO World Industry in 1980, Chapter I.

On the external side, in large part as a result of the sharp increase in the prices of oil, other primary commodities and manufactured goods including capital goods and a slow structural adjustment, a shift in pattern of payments imbalances among countries and group of countries was in process.

The recent slowdown in developed market economies effected a wide range of industrial activities. Many of the slower growing industrial sectors are either key areas of industrial activity (iron and steel, petroleum refining) or are light industries with large labour forces. The fast-growing industrial branches either accelerated (e.g. scientific equipment, diverse chemicals) or declined only moderately (e.g. electrical machinery, plastic products).

The slowdown in industrial growth in the second half of 1970's led to changes in industrial policy. Through international economic relations the changes in developed market economy countries unfavourably effected industrial prospects for the developing countries. In 1960 the developing countries' share of world manufacturing value added was 8.2 per cent, in 1970 the share was 8.8 per cent and in 1975 10.3 per cent. The corresponding figure for 1980 according to prelimanary estimates was 10.9 per cent. That is a slow progress in recent years towards the Lima target of at least 25 per cent of total world industrial production by the year 2000.

Industrial progress in the developing countries has been modest a in 1978-1980 mainly due to the gains recorded in Latin America. Manufacturing in Asia enjoyed a period of rapid growth before 1978, at the end of the 1970's the pace apparently slackened. Many industries in the region are export-oriented and among other things the spread of new protectionism probably slowed their progress by the end of the decade. Africa's share in world manufacturing value added has remained practically unchanged throughout the entire period 1960-1980.

The industrial growth rate was very uneven in Latin America, varying considerably from country to country. Such countries as Brazil and Mexico influenced the growth rate and raised the average, while most countries continued to experience more difficult conditions of extreme external vulnerability.

The position of the centrally planned economies in the world industry has evolved along different lines. These countries' share of world manufacturing value added has steadily grown and today the centrally planned economies account for 24 per cent of the world value added while in 1960 the share was 14.0 per cent. The government policies and measures taken in the 1970's particularly more efficient usage of raw materials and energy, better resource allocation, more efficient restructuring process and improved utilization of investment funds have a long-term character. The pace of growth in the first half of 1980's is expected to be lower than in the past, only later the impact of various measures could be perceivable.

Capital goods sector as an essential part of the manufacturing industries experienced in general similar trends. Average annual growth rates in metal and engineering products 1975-1978 were higher for the world total as well as centrally planned economies and Asia (excluding Israel and Japan), while developed market economies and Latin America did have either lower or similar growth rates in comparison with manufacturing industries. The rate of growth in the capital goods industries in developing countries has declined relative to earlier years and the share of these countries in the world production by value added, ISIC 38 decreased between 1975-1978. As far as the changes of structures between 1960 and 1978 are concerned (table 2), in centrally planned economies capital goods producing industries continued to lead the manufacturing sector and increased their share in world engineering production substantially, market economy developed countries' share scaled down and developing countries' share raised only modestly.

The contribution of developing countries to the value added of mechanical and electrical engineering industries is critically low with high concentration around few countries, contrary to the general objective put forward at Lima.

Among the three developing regions, the situation in Asian countries improved in 1976-1978 compared to earlier years. For Latin America an opposite situation can be observed in the same years, although preliminary estimated for 1979-1980 suggest that the pace of growth may have resumed in the line with overall industrial progress in this region. As far as

African countries are concerned, production of capital goods is limited to comparatively few countries and lags behind corresponding rates of expansion recorded for all developing countries.

Creation of capital goods production in developing countries has brought direct competition with those of the industrialized countries and to a certain extent influenced the growth of the engineering industries in the market economy developed countries. It is around the capital goods that the principal challenge of the new international division of labour is located and that competition is becoming more intense.

2. Capital goods production and consumption

In 1970 (table 2) world production of the mechanical and electrical engineering industries was estimated (in added value) at $446 billion. In 1976 it was about $703 billion (1975 value).

The market economy developed countries are responsible for more than 65 per cent of the added value, the planned economy countries for more than 28 per cent. However, the contribution of the developing countries is about 6 per cent, showing the considerable gap which remained between the real situation of these countries and the general objective put forward at Lima.

During the period 1960-1976 (table 2) there was a falling back in the case of the market economy developed countries (71.4 per cent of the world production in 1960, 65.5 per cent in 1976), whereas the contribution of the planned economy countries increased considerably (23.6 per cent in 1960 and 26.6 per cent in 1976). As far as the developing countries were concerned their part increased slightly.

However these estimates remain very approximate and provisional, but at all events the contribution of the developing countries is very small.

Production appears to be highly concentrated around the major producer countries, as can be seen from the production of machine tools which is significant of the level of production in capital goods alone [1].

- the four leading producer countries, Federal Republic of Germany, USA, USSR and Japan, account for 60 per cent of the world production,
- the 8 leading countries account for 78 per cent of the world production,
- the 12 leading countries account for 89 per cent of the world production.

As far as capital goods consumption is concerned, figures are even more approximate than the previous ones, but they do indicate:

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[1] Machine Tools Study, worked out by the Research Institute of Engineering Technology and Economy, Prague. Czechoslovakia.

- that the developing countries account for 9 per cent of the world consumption, the remainder being divided between the market economy developed countries and the planned economy developed countries;
- the rate of cover of the demand by domestic production in the developing countries is of the order of 47 per cent. This value is overestimated when only capital goods are considered;
- the market economy developed countries fully cover their domestic demand by their domestic production, whereas the planned economy developed countries nearly cover their consumption by their production.

3. Trading in capital goods

- World exports of products in Class 7 (SITC code) accounted for more than $370 billion in 1978 (table 3). These statistics on international trading confirm the high level of dissymmetry between groups of countries, as already observed for production:
  - it is the market economy developed countries which are the origin of more than 88 per cent of the exports, 7 countries alone exporting nearly tree-quarters of this total (Federal Republic of Germany, USA, Japan, France, Italy, the United Kingdom and Canada). As compared with this group of principal exporters the planned economy countries occupy a modest position and show a slight overall trading imbalance. As far as the developing countries are concerned they only export 2.6 per cent of the world total but, by contrast, they purchase 30 per cent of the imports, hence representing a considerable buyer market for the producers in the developed countries.
  - over the period 1970-1978 (table 5) it can be seen that the market economy developed countries generally maintained their position in world exports, the planned economy developed countries lost 2 points, and the developing countries gained

2 points. As far as imports were concerned it was mainly over the period 1970-1978 that an acceleration of imports by the developing countries can be seen.

- over the period 1970-1978 it should be noted that, for the market economy developed countries and the planned economy developed countries, a large part of the trading takes place within these groups. In the case of the market economy developed countries 96 - 98 per cent of imports were within the group, whilst for the planned economy developed countries this part is smaller and had a tendency to fall over the period to the profit of imports from the market economy countries.

4. The situation of the developing countries

Production

There are 144 developing countries, including 50 countries and territories with less than 1 million inhabitants: these represent only about 5 per cent of world production, or of the order of $40 million in 1978, while in manufacturing value added 10.5 per cent. The situation between the developing countries is highly contrasted, so that it is possible to effect a double classification:

- a classification of the countries according to their level of entry into the capital goods industry,
- a classification by groups of countries as a function of their economic characteristics.

Countries according to their level of entry and development in the capital goods industry

Two indicators illustrate the situation:

a) Employment (table 6)

- employment in class 38: all metal converting industries
- employment in class 382: non-electrical machines

- employment in class 38 as compared with the whole of the manufacturing industry [1].

This table is therefore a representation of the absolute and relative importance of the metal converting industry.

b) The value of production

- about 35 developing countries share in production of capital goods was about 85 per cent of the total in 1977;

These two sets of information suggest the following observations:

a) About ten countries have a capital goods industry

India, Brazil, Argentina, Turkey, the Republic of Korea, Mexico, Egypt, Hong Kong and Singapore, to which should be added, although data is not available, the People's Republic of China.

b) About sixteen countries have an embryonic capital goods industry:

these are Iran, Algeria, Venezuela, Indonesia, Colombia, Peru, Chile, Pakistan, Thailand, Philippines, Malaysia, Iraq, Jamaica, Sri Lanka, the Ivory Coast and Uruguay.

c) Other countries may have a relatively large mechanical engineering industry (manpower in class 38 as compared with manpower in the manufacturing industries greater than 10 per cent even if, in absolute value, this industry represents very little within the developing countries taken together. The available data make it possible to cite Zambia, Mauritius, Kenya, Nigeria, etc.

d) Whilst about thirty five countries have a capital goods industry, either established or in embryo, the great majority of the countries do not have a capital goods industry. These are 60 in number, or 110 if one takes into account the 50 countries and territories with less than 1 million inhabitants.

1/ The threshold considered is 10 percent.

Classification by group of countries as a function of their economic characteristics

A typology of the developing countries has been established, making it possible to distinguish five groups of countries [1]:

- India and China.
- 14 countries having a major industrial base.
- 22 countries where an industrial base is being established.
- 31 countries producing combustible and non-combustible raw materials, but without an industrial base.
- 62 essentially agricultural countries.

From the point of view of the capital goods industry, and more precisely of all the metal converting industry (Class 38 and 7), it has been possible to estimate for each group (excluding China), the production, imports, exports and consumption in the following manner: (table 7).

a) World production (excluding China) has been estimated at $1,700 billion in 1977 [2], of which 4.1 per cent is from the developing countries, or $70 billion. Imports (excluding China) are of the order of $90 billion, exports of the order of $8 billion.

b) For each group of countries (excluding China) hypotheses have been made on the basis of the known data for certain countries on the rate of cover of domestic consumption by production (P/C) and hence by imports (I/C). (exports are neglected) [3].

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[1] These 5 groups cover 131 countries; 13 countries and territories are classified under miscellaneous, representing 117,000 inhabitants.

[2] Internal UNIDO/ICIS note, October 1979. Analysis of the situation in regard to capital goods. Data in table 7 do not correspond with table 2.

[3] $\frac{P}{C} + \frac{I}{C} = 1$

c) Imports of engineering products for 1977 (SITC class 7) are then calculated for each group of countries [1].

d) It is then possible to calculate both consumption and production.

The results are to be considered as orders of magnitude which are, however, significant.

- It is the countries which are producers of raw materials which <u>import</u> the greatest part of the capital goods (35.8 per cent.) This reflects the major role of the oil producing countries as importers [2]. Then follow the countries where the industrial base is being established, then the semi-industrialized countries. The very small contribution of the essentially agricultural countries should be noted.
- <u>The consumption</u> of engineering products by the essentially agricultural countries is very low, being of the order of $12 per inhabitant, whereas the mean is $75. This shows the low level of development of these countries. The same applies to India which, unlike the essentially agricultural countries, has its own capital goods industry.
- In regard to <u>production</u>, India and those countries which have an industrial base produce of the order of 70 percent of the capital goods for the developing countries. The essentially agricultural countries, which account for 27 per cent of the population of the developing countries (excluding China and India), produce only of the order of 1 percent of the capital goods.

<u>Trading</u>

The results differ according to the sources (ECE, UNCTAD, GATT).

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[1] Bulletin of statistics on world trade in engineering products - 1977 ECE - 1979.

[2] If we consider all the petroleum producing countries, certain of which are classified other than in the category in question, the contribution of imports would be in the region of 45 to 50 percent of all imports by the developing countries.

The statistics of the Economic Commission for Europe give the following developments from 1970 to 1976.

- In regard to the destination of the exports from the developing countries,the market economy developed countries have an increasingly important place, the planned economy countries have a negligible part, and as far as trading between the developing countries is concerned this is falling.
- In regard to the imports (table 5), 91 percent of the supplies are from the market economy developed countries, the planned economy countries representing 5 percent (a very considerable fall in the position of this group as a supplier), whilst imports from the developing countries themselves are increasing slightly.

Exports, of capital goods from developing countries which represent according to the sources approximately 3 per cent of world exports, come from at the most ten countries. In the case of these countries two highly contrasted situation can be seen:

- the Republic of Korea, Hong Kong and Singapore are the three leading exporters of engineering products. However of the products exported more than 50 percent fall into Class 71 (electrical machinery), in particular electronic components. More than 50 percent of the exports go to the market economy developed countries. As far as Korea is concerned one should, however, note a rapid evolution in exports, in particular of mechanical machines to the developing countries.
- Brazil, Argentina and India export mainly mechanical machines (Class 71) and means of transport (Class 73). Brazil in particular is the leading exporter of mechanical machines, and the level of its exports exceeds that of Yugoslavia, of Norway and almost reaches that of Spain and Poland.
  These three countries export more than 50 to 60 percent to the developing countries with, in the case of Brazil and Argentina, a predominance towards the countries in their own zone, whereas in the case of India one finds trading with the countries of the East and all the developing zones with the exception of Latin America.

B. Alternatives for the future

Introduction

It is known that the Lima objective (25 per cent) has never meant 25 per cent for any given sector. It is therefore necessary to ask: What should the contribution of the manufacture of capital goods in the developing countries be to the total world production in the year 2000 ?

On the basis of some simplifying hypotheses it is possible to give orders of magnitude [1], making it possible to direct subsequent studies.

1. Overall projections

Projections on the basis of the UNIDO model [2]

The UNIDO model is a computer model simulating world industry. It is a normative model in regard to the future and simulative in regard to the past (it "reproduces" past relationships). It concentrates on the achievement of the Lima objective as a function of various hypotheses in the industrialized countries.

Macro-economic assumptions have been established for rates of growth of the GDP in;

The developing countries over the period 1970-2000 of:
8 per cent and 6.5 per cent.

The developed countries over the period 1970-2000 of:
4 per cent and 2.6 per cent.

Tables 8 and 9 give the macro-economic magnitudes for developing countries[3]. It can be seen that:

- production of mechanical and electrical machinery and instrumentation will increase at a rate of either 9.8 per cent or 11.2 per cent.

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[1] See study Capital Goods Industry (Preliminary Study) UNIDO/ICIS/SEC 15 April 1978.

[2] World Industry Co-operation Model.

[3] Production data in tables 8,9,16 and 17 do not correspond with information contained in the table 2 due to methodical differences.

- consumption will increase at a rate of either 10.5 per cent or 9 per cent.
- local production in the year 2000 will cover 52 per cent of the consumption as against 44 per cent in 1977.

The Interfuturs scenario and the capital goods sector

Here we are setting out only the principal results. The essential points of the method are as follows:

a) Six scenarios have been studied and are set out in a diagrammatic manner in Table 10.

b) The world has been broken down into twelve regions (table 11). In particular the data concerning trading are related to trading between regions, it being understood that intra-regional trading (for example intra-EEC trading) is not taken into account.

c) In the sectoral breakdown capital goods comprise Section 7 (SITC) excluding personal vehicles.

d) Finally the results for the year 2000 for the capital goods sector are only given for two scenarios:

A : Scenario of high growth,

B2: Scenario of moderate convergent growth.

The interest of these scenarios is that they take into account China and trading between the three principal groups of actors:

- Market economy developed countries: A
- Centrally planned developed countries: Eastern Europe and China : B
- Developing countries : C

The principal results are set out below:
- Production (table 11) [1]

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[1] The base figures for the year 1970 do not correspond with the United Nations figures.

- In scenario A world industrial growth is 5 per cent, or 4 per cent for the OECD countries, 5.4 per cent for Eastern Europe, 7.4 per cent for China and 7.6 per cent for the developing countries. Growth in the capital goods sector is 4.6 per cent for the OECD countries, 6.4 per cent for Eastern Europe, 8.1 per cent for China and 9.0 per cent for the Third World.
- In scenario B2 growth is lower for all the groups of countries.
- In the year 2000 it can be seen that, according to the scenarios, the contribution of the developing countries to the world industrial added value will be of the order of 16 to 17 per cent or 24 to 25 per cent if one includes China. For the capital goods sector the contribution will be 12 per cent, or from 16 to 18 per cent if China is included.
- Trading (table 12).

It must be recalled that intra-sub-regional trading is not taken into account, and this is the reason why trading in region B is very small, since it only represents trading between China and the Eastern European countries.

a) The market economy developed countries will see their contribution to world trading in capital goods reduced, mainly due to a slowing down in trading between themselves (53.2 per cent of the world trading in 1970, 41.9 per cent and 37 per cent, according to the scenarios, in the year 2000). However this slowing down is compensated for by an increase in trading with the developing countries and the centrally planned countries.

b) The centrally planned developed countries will see their contribution to world trading increase (9.4 per cent to 11.5 per cent of exports and 11.5 per cent to 12 per cent of imports). This is due to an increase in trading with the market economy developed countries and the developing countries, whereas the contribution of trading between China and the Eastern European countries is reduced (table 14).

c) As far as the developing countries are concerned the development of a capital goods industry is accompanied by:

- a very considerable increase in intra-regional trading: 3.8 per cent and 2.7 per cent of world trading, according to the scenarios, instead of 0.4 per cent in 1970 (table 12).
- trading with the centrally planned developed countries will be proportionately more important than in 1970.

These three characteristics are effectively contrary to the development seen between 1970 and 1977. This means that the actions of the actors could be modified as a function of the development of capital goods industry in the developing countries. It can already be seen that external trading in Brazil, India and Argentina is more in accordance with the trends which emerge from the scenarios. The same will undoubtedly be the eventual position for Republic of Korea which, although its trading is highly orientated towards the OECD countries, is beginning to export machinery and equipment to the developing countries.

Finally it must be observed that, even if the developing countries enter the capital goods industry to a very considerable extent and reinforce trading between themselves and the centrally planned oountries, they will for a long time remain net importers of capital goods, even if their level of cover with the other regions improves slightly. (It will only be 10 per cent with OECD countries). They will therefore import, in the year 2000, 75 to 80 per cent of their needs from the market economy developed countries (table 15).

In the two models which have been described (UNIDO, Interfuturs), the objective of 25 per cent (which has never meant 25 per cent for any specific sector) is not achieved for the production of capital goods.

It may be assumed that, in the year 2000, a proportion of the capital goods produced in the developing countries of the order of 12 to 15 per cent (excluding China) (subject to the possibility of realization) will be coherent with the overall objective. However the amplitude of the changes to be effected is extremely challenging and involves many actions at national, regional and international levels as well as ongoing consideration and study in this field.

2. Projections by groups of countries

This is essentially an exercise of the arithmetical type by which the coherence of the final image may be verified. The "two constructions" [1] have been produced in the following manners:

a) A base year 1977, for which the production [2] and consumption for all the developing countries and also by groups of countries has been estimated.

b) Hypothesis 2 of the UNIDO model has been considered, that is to say, for all the developing countries:

Annual rate of growth of production: 9.8 per cent.
Annual rate of growth of demand: 9.0 per cent.

This makes it possible to calculate, for the year 2000, the overall values of production and consumption in terms of 1977 Dollars.

c) Two alternatives have been considered.

Under the first alternative:

- India, and the countries with a major industrial base. will experience greater growth of demand which is near the mean (8.9 per cent), so that the rate of satisfaction of the domestic demand by domestic production will increase slightly.

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[1] China is excluded from this exercise because of the lack of data.

[2] Production data do not correspond with the information in table 2.

- By contrast it is the countries with an industrial base in the course of establishment which will experience a major increase in demand (9.8 per cent) and in production (11.5 per cent), so as to increase the level of national cover.
- However the agricultural countries will not improve their position, since the rates of increase in demand and production will be less than the mean.

Under the second alternative:

- It is then mainly the poorest countries with an agricultural base which will, in the long term, experience a major rate of increase in demand (11 per cent) and production (15.6 per cent), so that the level of covering national demand with national production will increase from 0.08 to 0.20 (i.e. to 20 per cent).
- Countries with an industrial base in the course of establishment will also experience a considerable increase in demand (9.5 per cent) (though this is lower than in the previous case) and production (11.4 per cent).
- Countries producing raw materials will experience a rate of growth of the demand equal to the mean (9 per cent) and a rate of growth of the production which is greater than the mean (11.2 per cent).
- Countries with a major industrial base and India have, on the contrary, a rate of growth of demand and production which is lower than the mean.

The"year 2000 image" for these two alternatives (tables 16 and 17)

Alternative 1

- It is those countries with an industrial base in course of establishment which improve their position most. They represent 27 per cent of the demand of the developing countries and 22 per cent of the production (as against 23 per cent and 15.5 per cent respectively in 1977) and the level of covering national demand with national production (national cover) will increase from 0.30 to 0.43.

- Countries with a major industrial base, such as India, see their situation more or less unchanged, whilst improving their level of national cover (P/C), since they have become important exporters.
- The most backward countries in regard to development (countries with an agricultural base) will see their situation unchanged or possible even make worse over the period.

Alternative 2

- The most backward countries will see their situation improve. However it should be observed that, even with high rates of growth, countries with an agricultural base will still represent only 3 per cent of the production of capital goods in the developing countries, 7.8 per cent of the consumption and will have a level of national cover which will not exceed 0.20 on average in the year 2000; countries with an agricultural base have 28 per cent of the population of developing countries.
- Countries with an industrial base in course of establishment will achieve the same score as in the previous case.
- India, and countries with a major industrial base, will see their contribution slightly reduced in the whole of the developing countries.

Some conclusions to be drawn from this "exercise"

Consideration should be given to the poorest countries (essentially agricultural countries and countries producing raw materials):

In effect,

a) On alternative 2 high rates of increase in the demand (respectively 11 and 9 per cent) have been considered. However one finds coefficients of demand elasticity for equipment goods in relation to the Gross National Product and the manufacturing industry which, in the UNIDO model, are respectively 1.38 and 1.097.

b) Under alternative 2 it has also been considered that rates of growth of production were high over the whole of the period (23 years): 15.6 per cent for the countries with an agricultural base, 11.2 per cent in the countries producing raw materials. This indicates that the results to be achieved:

- do not only concern the satisfaction of <u>essential needs</u> in regard to dwellings, health, food, rural water supplies, etc.,
- but also essential needs in regard to the mastery of techniques.

Conclusions

The position of the developing countries in the production and world trading of engineering products, and more specifically capital goods, is very weak.

Acknowledgement by the international community of the need to enter into, create and develop a capital goods industry in the developing countries is the principal question to be discussed. At the same time the discussion should concentrate on the role, type of products to be manufactured and a technology to be applied in capital goods development in the small and medium-size developing countries. Needs of these countries are considerable and production of capital goods has been concentrated only in a few developing countries while the majority of them are without the production of capital goods. There are several important factors associated with this sector such as limited size of local markets, lack of technical education, specific training requirements, research and development capabilities, engineering infrastructure which need to be overcome while setting up capital goods industries. Out of several possible ways how to meet these limitations some could be mentioned:

- by operating outside the world economic system dominated by developed market economy countries and develop local production of machinery and equipment appropriate to the specific conditions together with necessary engineering infrastructure, training, education and research at the national, sub-regional and/or regional levels;
- by developing production capacities for capital goods on the basis of investment goods imports when the size of local/regional markets makes this possible;
- by negotiating government to government, government to companies, companies to companies agreements and contracts establishing production co-operation (joint ventures,sub-contracting, etc.) with developed countries or more developed developing countries.

In fact the absence of a capital goods industry is undoubtedly one of the most significant signs of underdevelopment.

The new economic order to be created cannot be based on a prolongation of the present international division of labour. There are numerous reasons for this.

- Without a capital goods industry the developing countries, even if they achieve the rate of industrial growth corresponding to the objectives of the Lima declaration and plan of action cannot emerge from dependence. This will in fact even be accentuated by industrialization. Their industrial fabric will depend exclusively on the industrial and technological centres of the industrialized countries. Internal integration of the industries, and even sub-regional integration, will be almost impossible.

The problem is therefore a political one.

- The capital goods industry, by its direct action and the indirect measures necessary for its implementation, is a driving force in development. It creates the conditions not only for operating the industrial system but also for the self-reproduction of this system.

In other words the establishment of a capital goods industry is one of the essential conditions for avoiding pseudo-transfers of technology - that is to say their use without their assimilation. Because it implies the mastery of a wide range of technologies the capital goods industry, and the engineering infrastructure which is associated with it, makes it possible to move away from the path of purely copying transfer and opens up the route to the creation of local innovatory capabilities. The essential condition for the realization of "appropriate technologies" is the establishment of an embryonic capital goods industry and a research, engineering and development capability. Labour-intensive technologies incorporating less fixed capital are not generally produced in the industrialized countries - and there is little chance that they are likely to be in the next decade. This task can therefore only be assumed by the capital goods industries in the developing countries themselves.

- The capital goods industries, taken overall, have the characteristics of being relatively inexpensive in fixed capital investment per job created, particularly if appropriate, labour-intensive technologies are going to be chosen. From this point of view they are not as "heavy" as other industries such as iron and steel. Their establishment and development will therefore contribute substantially to the fight against unemployment and under-employment in the developing countries.

They are, however, industries which require highly skilled labour. Increasing the skill of the labour force could be in itself an objective, since its realization would contribute towards reducing the inequalities which exist between the industrialized countries and the developing countries. The availability of skilled labour requires not only specific training activities but an adequate educational level. Basic training is the "entrance card" into the activity of the capital goods industry. This implies, as a consequence, directing the educational system in the developing countries.

Realization of the Lima objectives means a major increase in manufacturing production and consumption and a discontinuity with the rates observed in the past. From this will follow a proportionately greater demand for capital goods. If this demand can only be satisfied by importing it will result in deficits in the trading balance and the balance of payments, and these will undoubtedly prove unmanageable. At the same time this would result in a major modification in the structure of international trade and industrial production. It is therefore necessary that part of the production of the equipment should be carried out locally.

Capital goods sector is a complex of many industrial sub-sectors. A strategy to develop these industries in developing countries should be worked out having in mind not only classification of countries but at the same time typology of capital goods as a tool to elaborate alternative entries and creation of these industries in respective countries. Only a few developing countries have capital goods industries, about 25 countries have been developing these industries, for the majority of them whick do not have engineering industries there is a need to search for specific and realistic policies for the entry and production of capital goods. In order to assist this process the second part has been devoted to selected sub-sectors, their characteristics, present problems and prospects particularly in relation to capital goods development in small and medium-size developing countries.

Part two: Capital goods development in selected sub-sectors.

Introduction

A typology of industrial production based on a breakdown into the three main sectors of productive system (capital goods, intermediate goods and consumer goods) makes it possible to analyse the process of accumulation, linking capital goods sector with various other sectors of the productive system in a country and furthermore to analyse the international division of labour in the capital goods industry. Although certain developing countries already have a capital goods industry, and others have begun its development, industrialized market economy countries seek to retain mastery of the capital goods sector and control the international division of labour.

The capital goods sector covers the production of machines and equipment and it is advisable to distinguish between:

- Capital goods for the production of capital goods; this means primarily machine tools and automation. This sub-sector constitutes the core of accumulation.
- Capital goods for the intermediate goods sector (for mining, iron and steel, petrochemicals, fertilizers, etc.).
- Capital goods for the consumer goods sector (for agriculture, food processing, textiles, leather, wood manufacture, durable consumer goods and other sub-sectors).
- Capital goods which are common to all sectors, inasfar as they do not have any specific end-use (e.g. electric motors, transmission shafts, clutches, gears, pumps, boilers, containers, tanks, valves, wire cables).

Technical manufacturing processes and complexity of capital goods are very important aspects one must not underestimate. They constitute one of the barriers to entry into production. It is important to analyse various components as design, research, planning, development, quality control, marketing and engineering in detail so as to be able to establish plans of action concerning the mastery of technologies, the transfer of technologies, the training of labour, etc. As far as manufacturing processes are concerned they are less numerous than the products and furthermore are to some extent multipurpose. In this connection there is a need of classifying and regrouping the products according to the manufacturing processes which are necessary for their production(for more detailed information cf. part three of this paper).

A. CAPITAL GOODS FOR THE PRODUCTION OF CAPITAL GOODS

A.1. MACHINE TOOLS[1]

The importance of the machine tools industry, which is an outstanding example of a producer of capital goods, is measured not so much in terms of its contribution to the income of a country[2] than of the direct and preponderant influence it excercises on the productivity and competitiveness of the vast industrial sector to which it supplies the major part of the means of production (almost a third of the investments of engineering and electrical industries is devoted to purchases of machine tools).

Drawing on the most advance techniques, requiring both investment and broad industrial know-how, the machine tools industry plays a strategic economic role, so much so that most of the major industrialized countries devote considerable effort to promoting its development.

The term'machine tools' includes a very wide range of machines manufactured by the engineering industry and functioning as capital goods in various sectors capable of working on the most varied material using different techniques. In what follows, we shall restrict ourselves to the concept of machine tool for metal work, which is defined as "a machine driven by an external power sources, non-portable when operating, which machine-finishes by cutting away or shapping, by physical-chemical processes, or by a combination of these techniques".

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[1] This part was prepared using contributions of Consultants, particularly the Study worked out by the Research Institute of Engineering Technology and Economy, Prague, Czechoslovakia.

[2] The machine tools industry, which employs 600 000-700 000 persons throughout the world, plays only a very modest role in the world economy (in the OECD countries it accounts for only 1.2% of the total production of engineering and electrical industries). In France it employs about 27 000 persons, in the Federal Republic of Germany about 110 000.

1. The world situation

Three important characteristics should be noted:

The strong concentration of producer countries;

Strong trade flows reflecting a certain international specialization;

The growing role of some developing countries.

1.1. Strong concentration of producer countries.

In 1979 production was estimated at $22862 million[1] which is 13.8% more than in 1978. The publication "American Machinist" lists 33 producer countries, but the first four producers (Japan, Federal Republic of Germany, USSR and the United States) account for 60% of world production, the first eight for 78%, and the first 12 for 89%.

The developing countries, including China, ensure approximately 5-6% of world production (2.2% of which is provided by China), the countries of Eastern Europe 24%, and the OECD countries 70%.

Since 1965 the production of the nine leading producer countries[2] has been characterized by:

The growing importance of producers such as Japan and to a certain extent Italy and the Federal Republic of Germany;

The relative decline of France and the United Kingdom;

And the growing importance of the United States after 1971.

The four leading producer countries are also the four leading consumers of machine tools and account for 53.7% of world consumption.

The group of countries listed by "American Machinist" account for 92% of world consumption of machine tools. With regard to world consumption, the following estimates may therefore be made for large groups of countries :

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[1] Or approximately 1-1.5% of world production of capital goods estimated at $1700 billion in 1976.

[2] This refers to production estimated in dollars. The growth is probably highly overestimated owing to monetary fluctuations, especially in the Federal Republic of Germany.

- OECD countries: 62%
- Socialist countries of Eastern Europe: 29%
- Developing countries: 9%, 2.6% of which is accounted for by China[1].

1.2. Strong trade flow reflecting a certain international specialization together with continued weakness in the internationalization of production

Exports represent 41% of world production, a large figure which shows a strong specialization and trade flow. The Federal Republic of Germany remains the leading exporting country, with 21.4% of world exports (30 in 1970), followed by Japan (12.3%), Switzerland (8.8%) and the German Democratic Republic (8.6%). These four leading countries account for 51% of world exports, although two of them are not among the four leading producers: those two countries are Switzerland and the German Democratic Republic, which are highly specialized in this sector.

What is remarkable is that almost all countries are either heavy exporters or heavy importers, and this is a sign of specialization at world level. However, there are differences.

Japan depends least on imports (7.3% of its domestic consumption), but exports heavily (40.4% of its production).

The domestic markets of Brazil, China, Federal Republic of Germany, Italy, the United States and the USSR are not too heavily dependent on imports (less than 30% of their domestic consumption). Brazil and China export very little.

In all other countries about 50% or more of domestic consumption is covered by imports, and a very substantial share of production is exported (up to 80-90% for Austria, the Netherlands, Poland, Romania, Sweden and Switzerland).

This international specialization is undoubtedly stronger than the internationalization of production. However, increasing number of agreemenents between countries and firms and growing investments in third countries may be observed. This is borne out by the following examples:

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[1] Brazil is the eleventh biggest consumer of machine tools, China the tenth and the Republic of Korea the sixteenth.

- Overlapping investments or takeovers among OECD countries;
- Co-operation agreements between OECD countries and countries of Eastern Europe.
- Direct investments by industrialized countries in, and agreements with, certain developing countries.
- Agreement between Nigeria, Czechoslovakia and India for the construction of a machine tools factory.
- Numerous agreements and investments by the Federal Republic of Germany.
- Agreements between Czechoslovakia, India and the USSR[1/]
- Agreements by United States firms with, and investments in, firms in China manufacturing numerical control machine tools for export to Europe and Southeast Asia[2/]
- Agreements between General Electric (United States) and Digicon[3/] (Brazil) for numerical control production.

1.3. The vast majority of developing countries has not yet built this industry but there is a growing role of certain countries.

The share of developing countries in world production is still very small (3-4%, 5-6% including China). But certain countries already have an impressive level of production and have been surveyed.

There are two different approaches we may observe in developing countries

- building up of a production base for domestic demands and meeting part of the domestic demands by import /30 - 40% in Brazil, India/
- export of considerable part of domestic production /90%/ and meeting domestic demands /80 - 100%/ by importing from developed industrial countries /Republic of Korea, Singapore/.

[1/] American Machinist, March 1979.

[2/] American Machinist, April 1979.

[3/] A company in which Embranec (Brazil), Olivetti (Italy) and Farrand (United Kingdom) own shares.

The above mentioned countries with their own production of machine tools have developed production co-operation not only within their countries but also with industrially developed countries, the former partners in the transfer of technology, which today supply them with some special components or groups of assembled elements.

Brazil is the world's fifteenth largest producer, with production worth $250 million. Its first machine tools were built in 1930. According to the IPEA, in 1971 16% of the domestic market was supplied by Brazilian-made machines, 26% by mixed technologies and 58% by imported machines[1]. At present only 29% of the domestic market is supplied by imports.

India is the world's twenty second largest producer and has a Central Machine tools Research Institute which began work in 1962 with the co-operation of Czechoslovakia. The biggest enterprise is Hindustan Machine Tools, which was established in 1949 with the co-operation of Oerlinkon (Switzerland), and which includes nine units working under 30 manufacturing licences.

Next come, the Republic of Korea, Argentina, Mexico, and Singapore. Other countries such as Algeria, Colombia and Nigeria, are establishing a machine tools industry. Conditions for the development of machine tools industry have been created by both the import of necessary machines and equipment and mastering the fundamental technologies. Many of these countries already produce, either under licences or transfer of know-how, machine tools of complexity grades simple to more complex /Algeria, Iran, Venezuela/.

We include in the same rank some countries producing fuel or raw materials with low industrial base which meet only 15 - 20 % of their demand /Iraq, Morocco, Tunisia, Nigeria/. Though none of these countries can build more extensive machine tool industry, they can be included among the possible future manufacturers of simple to slightly

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[1] La machine moderne, January-February 1976.

complex machines to meet a part of their demand/ mainly maintenance shops in agriculture and mining industry/. In connection with this, an integration may play an important role.

Agricultural developing countries have the worst conditions for the building up of their own machine tool industry. Machine tools demand is low and required only for maintenance of agricultural machines and tools. It may be expected that capital goods production will be developed within integration blocks and especially for the agriculture. In this case we may expect that the agricultural demand/tractors, tools/ will result in a concetrated production of these goods and subsequently in the development of production capacities, of material bases, research and testing centres and, eventually, in a transition to the production of simple machine tools.

2. Developing countries imports

The import of machines by developing countries is practically totally covered by industrial nations. The volume of import has an increasing trend and characterizes the needs to build up an industrial base in the developing countries. Currently one third of the world production of machine tools is exported to the developing countries and despite the decrease in import in 1978 it can be expected that this volume will remain stabilized or will increase slightly in the future.

Imports of machine tools in 1969 - 1978 in %

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Developed countries	80.9	83.5	81.3	77.0	77.6	76.1	72.6	66.0	62.7	68.6*
Developing countries	19.1	16.5	18.7	23.0	22.4	23.9	27.4	34.0	37.3*	31.4*
Africa	1.6	1.9	1.8	2.7	3.5	3.0	3.2	3.3	4.2*	•
Latin America	10.5	8.7	10.5	12.2	11.1	12.3	14.2	16.7	•	•
Asia	7.0	5.9	6.4	8.1	7.8	8.6	10.0	14.0*	16.8*	15.4*

*Estimated

Source: 1978 Yearbook of International Trade Statistics

An interesting view is offered also by a survey of the division of machine tool imports in 1978 according to the typology of the developing countries:

14 nations having an important industrial base 63.3%

22 nations in establishing an industrial base 20.7%

21 nations producing fuel and non-fuel raw materials..12.7%

34 predominantly agricultural nations 3.3%

Source: Bulletin of Statistics of World Trade in Engineering
Products - 1978, UN 1980.

The first group accounts for two-thirds of total imports and keeps strengthening its position by a considerable import of machine tools from abroad. In many cases the machines are of high technical level which help to increase the innovation cycle of machine tools or are re-exported after adjustments.

The second group accounts for one fifth of total imports while the last two groups together account for only about one sixth.

In conclusion it should be stated that:

- the share of the developing countries in world machine tool production is unbearably low and most of their demands are met by imports
- a marked "elite" of machine tool producing countries has appeared among the developing countries and the gap between the two groups is increasing
- the share of world exports to developing countries implies practically total dependance on the imports from developed countries; developing countries are thus unable to build up their own industrial base which would meet their vital demands.
- in most of these countries /with the exception of the 14 with an important industrial base/ conditions for the transfer of technology are either absent or exceptionally present as regards both the human factor / insufficient education, manual

skills, management abilities, etc./and the construction of at least of an initial industrial base for industrial production.

- the vast majority of small and medium size developing countries have not the possibilities of developing tool industry. In this respect suitable conditions are nonexistent with the exception of the integration blocks like ASEAN, ALLC /Argentina, Bolivia, Brazil, Ecuador, Colombia, Mexico, Paraguay, Peru, Uruguay, Venezuela/ or the Andean Pact.

  These conditions are practically absent in the developing countries of the African continent with the exception of North African nations /Algeria, Tunisia, Morocco/.

3. Future prospects

3.1. Technological innovations: the growing role of electronics

Broadly speaking, the purely mechanical phase of machine tool production is over. Contributions from other disciplines, such as chemistry, electrochemistry, laser physics, powder metallurgy (cutting tools) and electronics, are becoming increasingly important.

Numerical control has developed along the following lines:

- Conventional numerical control: 1952
- Computer numerical control (CNC): 1971-1973
- Industrial robots,direct numerical control (DNC), Flexible manufacturing system (FMS)and the automated worshop: 1976-1978.

The industrial production of numerical control machine tools (NCMT) began in 1952 in the United States.

In recent years there has been a definite acceleration of technical progress in the field of machine tools, thanks mainly to the widespread introduction of electronics, which gave rise to DNC and industrial robots, thus opening up the prospects of "workshops without workers"[1]. Howevor, an

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[1] Japan is beginning to market robot workers and to operate an experimental workshop without personnel. Le Monde, 18 November 1979.

age analysis of machine tools in various countries shows that there is still a substantial number of machines over 20 years old.

The United States is the country with the largest number of NCMT, the largest number of machinos over 20 years old (34%), and the smallest number of machines less than ten years old (31%). On the other hand, Japan has the largest number of young machines, 60% of the total number being less than 10 years old.

This means that except for Japan, accelerated taechnical progress does not radically change the total number of machines[1]. However, account must be taken of forecasts made in the United States (Delphi forecast of manufacturing technology), which predict the following development by about 1990:

(a) Of the total number of machine tools, 50% will be no longer used alone, but incorporated in a system of machines (flexible manufacturing system) controlled by a central computer with automatic handling systems among machines;

(b) NCMT production will account for 50% of machine tool production value;

(c) Finishing centres will replace 50% of the total number of conventional machines.

3.2. Prospects for developing countries.

We may expect in the next 20 years:

- a more marked transition to the production of complex machine tools with a considerable increase of volume aiming at meeting 30 - 50% of their domestic demands and at decreasing current imports
- a greater concentration of production of these machines into larger organic units with the construction of foundries and the

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[1] If the age of the stock was determined according to value and not total numbers, the results would be very different and would undoubtedly show much greater equipment renewal.

introduction of some elements which are necessary for completing the machines /electric motors, hydraulic components, etc./

- the formation of experimental and research centres which would be able to take over progressive technologies /know-how/and to secure a high quality of the products which so far do not correspond to the world standards
- the establishment of engineering offices attached to the different plants which will be capable of transfering obtained experiences and information to the new products and simultaneously introduce the required standards
- establishment of the necessary service and services for the convenience of customers at the production plants
- increased efforts to master yet other production processes which, up to now, were not essential for the production of simple to slightly complex machines
- a higher degree of concentration of production of the different types of machine tools within the regional and sub-regional integration groups and within their framework the establishment of research and construction centres
- production specialization of the different elements and groups of elements of the machine tools in the different countries within the framework of integration efforts
- increased need for technicians and direct workers with a higher grade of specialized education.

3.3 Measures to be taken in developed and developing countries

The main functions of the State should be the creation of a basis for machine tool industry development inc. assimilation and financing of the imported technology and of exports of products.State organs in developing countries should then take into consideration:

- the structure and size of production

- standardization of products and of their parts and spare parts,
- providing credits,
- the provision of tax alleviation,
- the planning of technical development,
- the establishment of centrally controlled research and development institutes,
- the creation of conditions for further development of new production capacities,
- the planning of the number and structure of students, expanding educational institutions and technical training facilities.

Those countries which intend to manufacture machine tools it would be useful to establish - in order to reach a rational strategy and a uniform approach to the development of these machines - ways and means for goverments to negotiate and formulate contracts with suppliers of technology.

In order to increase the effectiveness of co-operation between developed and developing countries in this field,the consultation, co-ordination and educational centres for the introduction and development of machine tool production should be established in developed countries. Some socialist countries of Eastern Europe e.g. Czechoslovakia intend to create such centres.

Attached to the governments of the developing countries institutions should be established which would organize contacts with these centres and in co-operation with them would help to create necessary conditions for entries and development of machine tool industry.

A.2. Capital Goods for Construction and Public Works[1]

1. Global situation

Manufacturing activity of this type has been frequently combined with the production of agricultural, mining and other equipment. Heavier equipment for excavation and earth-moving is manufactured by small group of developed countries. Production is more evenly distributed in the case of light machinery and cranes in such as Italy, Spain, Brazil, Mexico and others. Value of world production of construction and public works machinery(in millions of dollars) is set out here:

Classification according to main uses	Value:	%:
1. Earth-moving and excavation equipment	12 060	52,8
2. Special transport equipment	3 350	14,7
3. Soil compacting machinery	300	1,3
4. Road construction and equipment for the preparation of filler material	1 150	5,0
5. Cranes	2 280	10,0
6. Other equipment and components	3 700	16,2
Total	$22 850	100,0

Source: International Construction
Techniberia study

Three observations are necessary in this connection:

(a) The statistics do not include production in the countries of Eastern Europe;

(b) The statistics do not take into account more conventional and less complex material (small compressors,concrete mixers, small cranes etc.);

(c) Earth-moving machines (earthwork machinery, excavators etc.) account for more than half of world production (excluding the countries of Eastern Europe).

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[1] Study prepared by the Techniberia Company, Spain.

All construction machinery can be dealt with subsequently according to their level of complexity. Three groups may be distinguished. The first group accounts for 80% of world production and is characterized by considerable size, weight and power, high technical complexity, and a unit value exceeding $10000. It mainly includes excavators and earth-moving machines, machinery for underground work, heavy machinery for preparing aggregates and manufacturing concrete, mobile and tower revolving cranes, and machines for port and marine works.

The second group, which accounts for 8-9% of world production, includes machines with a unit price of $1500 to $10000, such as small concrete batching and mixing plants and road machinery.

The third group, which accounts for 7-8% of world production, includes simple machinery produced on a semi-industrial basis.

2. The role of countries (excluding the countries of Eastern Europe)

2.1. Domination of the United States

The United States controls 45% of world production, and over 80% of world sales if foreign branches of United States firms are taken into account. The Caterpillar (United States) firm alone accounts for 30% of world sales. The sector is highly concentrated, since the ten leading firms account for 85% of total turnover, 87% of exports and 87.5% of research expenditure. A total of 176000 persons are employed. North American production is concentrated in machinery with very high unit values. Exports represent 30% of turnover. The main export markets are Canada (23.1%),the EEC (17.2%) and especially Belgium (6.3%), Latin America (26.5%), the Middle East (9.8%) and Asia (excluding Japan) (13.9%). Exports to Canada and Belgium are strongly linked to the presence of firm branches in those countries.

Imports are very limited and account for 4% of domestic consumption.

2.2 The Japanese breakthrough and its strong degree of autonomy.

Japanese production accounts for 14.6% of world production. It increased by a factor of 900 between 1949 and 1978, rising from a value of 1 billion yen in 1949 to 900 billion yen in 1978.

The capital of the great majority of firms is Japanese, and there are many licencing agreements with United States and European firms. The first Japanese enterprise Komatsu which is the world's second largest enterprise, covers 60% of the Japanese market. The second is a mixed enterprise (50%, 50%) composed of Mitsubishi and Caterpillar.

Domestic production covers 98% of the domestic market, while exports represented 30% of production in 1977.

For 1977 the leading customer was the United States, followed by Saudi Arabia. Developing countries accounted for 60% of export destinations.

2.3 Importance of European countries.

The European countries account for 33.1% of world production. First place goes to the Federal Republic of Germany (12.2%), then come the United Kingdom (10.3%), France (6.8%), and Italy (3%).

Europe is relatively specialized in hydraulic shovels (49.5% of world production) and revolving cranes (35.1% of world production).

European countries have very "wide open" industries, which implies high export and import rates (unlike Japan and the United States). The strong international element in foreign trade is also a consequence of the presence of branches of foreign firms and the specialisation of these branches in certain types of equipment.

2.4 Very weak production in developing countries, which are a major market

Production statistics in developing countries are practically non-existent. It may be stated that heavy material is produced in the following countries: Argentina, Brazil, India, Mexico and the Republic of Korea. Algeria is establishing an industrial complex for public works equipment. However, other developing countries produce less sophisticated equipment such as concrete mixers, cranes and small equipment for preparing aggregates, which are not recorded in the national accounts (cf. the problem of simple agricultural equipment). But the market is very important and in 1977 developing countries accounted for 42.6% of world imports, although they took only 30% of world imports of engineering goods (class 7).

2.5 Internationalisation

The most typical case is the Caterpillar firm, which, with its branches, accounts for 35-40% of world production. It has five production units in the United States, 11 abroad, and two branches (50%, 50%) in Japan and India.

However, internationalization of the production process is not the same as in other sectors such as automobile manufacture and electronics. In these sectors it is possible to delocalise "segments" of production in order to specialise units in sub-assemblies with large production series. In the industry of public works machinery, series are short and the unit value of equipment is very high. This means, and the example of Caterpillar is significant in this respect, that the level of integration in each enterprise is high, with specialization in some products.

3. World trade is marked by two phenomena

- The importance of the market of developing countries
- Intra-OECD trade closely associated with the presence of large firms and their branches.

In 1977 the exporting countries were, by order of importance, the following (export values given in $\$10^6$) (Source: ECE):

United States	2523
Federal Republic of Germany	1082
United Kingdom	799
France	652
USSR	610
Japan	575

3.1 Developing countries are a very important market for the industrialized countries

Developing countries receive 42.6% of the exports of developed countries. However, the oil-producing countries have become the main importers. Thus Algeria, Irak, Iran, the Libyan Arab Jamahiriya, Mexico, Nigeria, Saudi Arabia and Venezuela account for 40% of the imports of developing countries, or $1.377 billion, which represents more than the total exports of the Federal Republic of Germany and 55% of the total exports of the United States.

4. Technological trends

4.1. Declining life span of machinery

Two trends are noticeable: decline in the life span of machines from 20-25 years in the mid-1960s to 8-12 years in the mid-1970s, a longer period of entry into service, and a shorter of period of decline. In the mid-1960s it was still possible to extend the life span because technological changes were not very important and markets not very competitive. This extension was ensured by periodic rehauling and major repair. At present, the renewal of material is much more rapid because of the following three factors: technological changes - electronic systems, hydraulics, special steels; strong competition ; and the emergence of big contracts that must be executed within an optimum period of time.

4.2 Broad trends of technical progress of complex machinery

United States firms devote 3.2% of their turnover to research and development, which involves greater expenditure than many branches of engineering.

With regard to products, steady progress, without radical innovations, is expected in the following fields: improvement in the power of diesel engines; study of alternative fuels such as alcohol and petrol gas; increased engine yield; reduction of noise and pollution; use of hydraulic motor systems for power transmission; electronics applications; use of special rare steels (vanadium, titanium).

With regard to the production process, progress is expected along the following lines: techniques of modular construction; decline in forged and cast parts and increase in mechanical and welded parts; use of numerical control machine tools; and rationalization of assembly operations, which represent a major part of the production process.

5. The establishment and development of the construction machine industry

The decision-making process involved in the establishment or expansion of the construction machine sector should begin with the compilation of extensive data base on production and trade patterns on a world-wide and regional basis. A market-segment approach should be followed, with the principal producers identified and the experience of other countries analysed. Particular attention should be given to the problem of access to appropriate technologies.

The plan of action should consist of the following general elements:

1. An analysis of domestic demand in order to determine the appropriate scale of production. The size of the market, broken down into meaningful segments, is the key to ascertaining whether equipment can be competitively manufactured.
2. Secondly, a survey of the industrial infrastrucutre of the country or region (a group of countries linked by special economic relations) and the identification of the inputs available for supplying a construction machine industry. The points to be considered in this context are the following:

   a) A construction machine industry is viable when the necessary imports are limited to raw materials (steel industry products) and other primary inputs for general use. It is also acceptable to rely on imports for engines, transmissions, electric and electronic apparatus, bearings,etc., i.e., components incorporated externally in the classic system of production. Qualified personnel responsible for selecting, purchasing and accepting these items must be available.

   b) The country's industrial enterprises must be capable of providing assured support in the following areas:

      - Castings and forgings;
      - Heat-treatment and coating processes;
      - Special machining operations.

This is within the reach of countries at an intermediate stage of technological development, whereas in other developing countries that lack this kind of industrial base, efforts must be concentrated on simple products, for which only steel products need be imported. The establishment of an adequately developed industrial environment for the manufacture of the items mentioned under section (b) is a prerequisite to the transition to higher levels of production.

c) The machinery such as small excavators, some cranes, graders and dumpers may be within the technological capacity of developing countries, provided sizes and models are selected that do not require complicated castings. A necessary condition is the availability of good machine shops and efficient assembly plants.

3. The primary emphasis in the transfer of technology should be on manpower training for work in the immediate production area, the indirect services, design and engineering support, and management as well as in the technologies with a bearing on the external branches of industry. On the basis of this criterion, the following scheme may be adopted for technology transfers.

For simple technological lines

a) Training programmes for workers in the fields of light boilermaking and welding of ordinary steel and for basic-level machine-tool operators;

b) Training courses for fitters with the ability to work with standards and perform simple adjustments using manual tools;

c) Training programmes for technical personnel in production organization, blueprint reading and quality control;

d) Elementary practical and theoretical cources for technicians in calculation and design and in the supervision of thermal normalization processes.

B. Capital Goods for the Intermediate Goods Sector

This capital goods subsector may be analysed as a whole, because it is composed of elements with broadly the same characteristics:

- Client industries apply continuos processing[1/] ;
- Equipment suppliers are very often the same, since heavy custom-made equipment manufactured in multi-purpose units are mostly used. The same phenomenon occurs in connection with automatic equipment for continuous processing;
- Equipment sales in these industries are generally on a turnkey basis, unless the product is handed over directly;
- There are the same actors in dynamic relationship with each other (general contractor-project study and development, process owner, equipment supplier, financing body).

1. Selected global data: market, customer, supplier

1.1. A recent study by Eurofinance[2/] contains a breakdown of equipment exports in 1975 and an estimate for the period 1980-1985. Exports in 1975 amounted to $120 billion, $152 billion in 1980 and $198.4 billion in 1985, the growth rate between 1980 and 1985 being higher than during the period 1970-1975.

In 1985 equipment for petrochemicals would be the biggest item, accounting for 45% of the total, followed by the almost equal shares of equipment for iron and steel works, cement factories and electric power production. All these could be seen in the table (next page).

1.2. The same study shows the areas receiving the exports. Approximately 50% of the receiving countries are developing countries and 70% in the case of iron and steel, which is a very large figure, especially when compared with the whole of exports of class 7,30% of which go to developing countries.

1/ The following branches may be listed: power production, fertilizers, steelmaking, cement works, refineries, paper, pulp, metallurgy.

2/ Export markets for major industrial complexes: present position and future prospects - 9 Avenue Hoche - 75.008 Paris, 1978

Evaluation of world exports of industrial capital equipment by consumer sectors between 1975 and 1985 (1975 $ billion and %)

Consumer	Value 1975	Real average annual growth rate 1975-80	Value 1980	Real average annual growth rate 1980-85	Value 1985
Electricity (ex-nuclear)	12.0	1.8	13.1	2.0	14.48
Chemical petrochemicals, gas	51.6	5.4	67.08	6.0	89.77
Oil refinery	8.4	4.5	10.46	5.0	13.34
Steel-metallurgy	9.6	4.5	11.96	5.0	15.26
Cement works	8.4	6.3	11.40	7.0	15.99
Other process industries	30.0	4.8	38.0	6.4	49.56
Total	120.0	4.8	152.0	5.7	198.40

Geographic spread of the activities of the leading world contractors for the process plants and equipment, 1973-1985.

	European contractors			World market		
	1973-76	1980	1985	1973-76	1980	1985
Eastern Europe	10	12	12	12	13	14
Middle East	16	15	12	19	18	14
Asia	12	9	·	17	16	14
Africa	11	14	15	7	8	9
Latin America	6	5	6	8	9	11
North America	19	18	18	14	13	13
Australia, SE Asia	1	2	3	1	3	6
Western Europe	25	25	26	22	20	19
Total	100	100	100	100	100	100

1.3. As far as suppliers are concerned, the United States is the world's leading producer, followed by Japan, the production of which during the 1963-1972 period grew faster than that of the Federal Republic of Germany and France. The United Kingdom should rank at about the same level as France.

The following conclusions may be drawn form the OECD export statistics[1]:

- The five main OECD countries supply 70-75% of the world market, and the socialist countries of Eastern Europe 9-10%;
- The share of those five countries in world trade fell by 2-3 points during the period of 1966-76, which shows that other countries have become exporters of capital goods for basic industry;
- The world market of capital goods for basic industry expanded during the same period somewhat faster (5.18) than the capital goods market as a whole (items 71 and 72, factor 5.05);
- The Federal Republic of Germany is the leading exporter, closely followed by the United States. France ranks third and had the fastest growth rate during the period (factor 8.78). Then come Japan, the United Kingdom, Italy and the USSR;
- The share of capital goods exports for basic industries in exports as a whole (items 71 and 72) is approximately 16-17%.

  However, two countries have much higher percentages: the USSR (27.7%) and France (22.8%), which reflects a relative specialization.

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[1] The following items were considered:

-719, except 711.4 and 711.5
-715, except 715.1
-718.1
-718.51
-718.52
-719.13/14
-719.15
-719.11.19
-722

1.4. United States firms and a few European firms have achieved a position of technical, financial and commercial domination throughout the world. They own the major part of the most advanced technology in the sub-sector, control subsidiaries in both industrialized and developing countries, and carry out most international trade in electrical equipment. Their dominant position is strengthened by restrictive trade practices, so much so that one might speak of an international cartel in the heavy equipment industry;

UNCTAD[1/] has made a study of a powerful international producers cartel.

The study deals with the following topics:

- Agreements between leading firms (participation, reciprocal licences, co-operation in the form of joint enterprises);
- Organization of the cartel within the International Electrical Association (IEA);
- How the cartel tends to limit competition at international level: agreement on the sub mission of contracts. The study estimates that 75% of the industrialized countries' (with the exception of Japan and the United States, where the law prohibits firms from participating in international cartels) exports of material for electric power production, generating machinery and distribution equipment are controlled by international cartels. For other types of electrical apparatus, the cartels are estimated to control 10% of the exports of those countries;

The existence of this cartel has important implications for developing countries. UNCTAD has carried out a study of Brazil[2/]. It shows how the Brazilian market has been slowly brought under control.

1/ Dominant position of transnational corporations on the international market UNCTAD/ST/MD/13.

2/ Implications for developing countries of restrictive trade practices of transnational corporations in the electrical equipment industry. Monograph on Brazil - UNCTAD/ST/MD.9.

2. Situation in developing countries.

Several developing countries have made serious attempts to manufacture equipment for intermediate industries: Argentina, Brazil, India, the Republic of Korea and others which have taken steps in that direction (Algeria, Mexico and Tunisia).

The main characteristics are described below.

2.1 Background: opening a "technological package".

(a) In the most Latin American countries, a technological package was opened according to the following sequence:

- Development of local advisory services for carrying out prefeasibility studies;
- Establishment of planning offices to carry out studies and meet secondary (off-site) investment needs[1];
- Development of local equipment manufacturing capabilities with the necessary planning offices;
- Simultaneous development of engineering companies gradually combining detailed engineering studies, management technology, and process engineering studies[2].

(b) During the 1951-1955 period in India, the majority of investments involved turnkey operations performed by foreign general contractors. The implementation of these projects was beset by many difficulties involving high costs, long delays, and initial production problems. The Government therefore set up a commission, the main practical achievement of which was to emphasize the importance of the owners role in carrying out preliminary studies, and of the need to prepare a technological package.

(c) During the 1960s in the Republic of Korea investments were made in the form of turnkey operation. But in 1969 a presidental ruling

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1/ Using the experience of public works enterprises.

2/ This is the most difficult stage.

on the establishment of local engineering services stipulated that turnkey contracts must be rejected and agreements concluded with foreign engineering firms to establish and develop local structures.

2.2. The State - its decisive role

Some capital goods manufacture arises almost "naturally". Such manufacturing is undertaken at the initiative of private industry or foreign investors. But beyond the manufacture of simple equipment of average complexity, nothing is done without a determined effort in which the State (and the various public or semi-public bodies) play a decisive role.

The action of the State may take various forms:

(a) Promotion of planning studies, as in the case of Mexico for the joint NAFINSA-UNIDO study of capital goods for basic industries and food industries;

(b) Establishment of research and standardization services and of engineering companies:

- Brazilian Technical Standards Association
- Specialized companies within Petrobas and Electrobas
- COBRAPI, which depends on the National Iron and Steel Company (Brazil)
- PEMEX in Mexico
- Fertilizer Corporation of India (FCI)
- Fertilizer and Chemical of Travancore (FACT)
- Engineers India Ltd (EIL) for petrochemistry
- DASTUR and CEDB for iron and steel (India)
- Korea Engineering Co.

(c) Establishment of capital goods enterprises. This is especially the case in India (Bharat Heavy Electrical Ltd (BHEL), for example), Algeria (Socanome, SN Metal, Sonelec), with examples also in Brazil (USIMEC) and Mexico, where the State takes a minority share (33%) in heavy capital goods enterprises;

(d) Establishment of credit financing institutions for the promotion of local equipment industry.

2.3. Research and standardization institutes

The problem of national norms and standards is very important. During the 1960s in Brazil, local enterprises had to face very strict equipment standards for oil and petrochemicals. To deal with these problems, the Instituto Brasileiro de Petroleo (IBP) and the Associacao Brasileira de Normas Technicas (ABNT) were established.

In India, the DASTUR company and the Planning and Development Division of the Fertilizer Corporation of India developed significant research and development capabilities.

2.4. Planning and implementation services (engineering)

It cannot be overemphasized that the establishment of a capital goods industry depends directly on local engineering capabilities.

In India, the Central Engineering Design Bureau (CEDB) now known as MECON, made it possible to achieve international standards in iron and steel plants.

In the Republic of Korea in 1973 a law enacted on the promotion of local engineering services following a presidental ruling of 1969 on turnkey contracts.

In Brazil there are many engineering companies in the field of electric power supply (Hydroservice, Engevix Sa., Promon, Montreal), and iron and steel plants (Cobrapi subsidiary of the CSN). There are also subsidiaries of foreign engineering companies (Lummus-Seral (500 persons), Foster-Wheeler (300 persons), Snam-Progetti etc).

During a symposium on the theme "self-sufficiency in consultancy services" held in February 1969 by the Indian Engineering Association, the statements concerning chemical and petrochemical industries stressed the strategic role of capital goods design studies. While it is important to master process know-how in order to acquire a command of petrochemical production processes, to improve those processes and to innovate, it seems even more important to acquire know-how in the design and construction of capital goods. "Know-how accounts for only 5-15% of project costs. Thus, within the framework of the growing role of India in project execution, greater importance should be attached to capital goods construction know-how as compared with process know-how".

Local mastery of capital goods design is also necessary for adapting equipment specifications to local conditions (materials, production capacity, standards, norms).

2.5. Financing and credit bodies.

It has been noted in Latin America that the unavailability of credit for local enterprises has acted as a brake on local participation in investments. For example, in the case of Brazilian iron and steel works, the appeal to foreign credit for the construction of new units led to substantial capital goods imports. The controversy during the summer of 1976 with the World Bank and in 1978 concerning the Tubarao project demonstrates this process of limiting increased participation in local industry. However, Brazil has set up a financing system for the local construction of capital goods.

3. What type of co-operation?

Co-operation has many forms.

In India, technical assistance from the socialist countries of Eastern Europe seems to have played a decisive role, for example in the establishment in 1955 of Bharat Heavy Electrical Ltd (BHEL) with the USSR and Czechslovakia, and of the Central Engineering Design Bureau (CEDB).

In the Republic of Korea, firms are usually in the hands of local private capital, and many licensing agreements have been completed with the biggest firms in the sector, especially Japanese1/. The 1958

1/ The Japanese company Toy owns 25% of the capital of the Changwon engineering construction complex.

agreement between the Korean company Sinotech Eng. and the United States company Bechtel for the establishment of a joint engineering firm and construction enterprise should also be noted.

In Brazil foreign firms play an important role, especially in the manufacture of equipment for electric power production. However, the role of national private enterprises, such as Villares, is by no means negligeable.

In Mexico, for major NAFINSA/UNIDO projects, the following approach has been adopted: Mexican State participation (33%), private national enterprises (33%).

3.1. However, for the countries often mentioned in this study, co-operation seems to exclude the "hard core" products.

In the case of iron and steelmaking, the hard core consists of :

- Heavy or sophisticated electrical equipment
- High-performance machinery
- Measuring and control apparatus
- Goods closely linked with a process: catalyzers
- In general, all equipment making its possible to complete, modulate and control a system.

The same "hard core" components exist in the field of petrochemicals.

The difficulty of including this "hard core" may be explained as follows:

- An insufficient command of techniques and the most advanced technical fields: precision machinery, high-quality metals, electronics
- A weakness in study and design capabilities, especially with regard to process engineering
- A weakness in research and development

Mastery of the "hard core", which represents 20-30% of equipment costs, requires mastery of a "technological system": capital goods construction, process engineering, research and development. Different methods are used to penetrate the "hard core":

- In India, co-operation with the USSR in establishing the Bhilai and Bokaro steelworks;
- In Brazil there is the example of the contract between Petrobas and technip (France) and K.T.I. (Netherlands).

In 1977 the Brazilian company Petrobas signed a contract for the establishment of a petrochemical complex with the French engineering firm Technip associated with the Dutch firm K.T.I. This contract provided for the construction of a steam cracker for ethylene production. Under the contract, Technip had responsibility for ensuring general co-ordination of the project as a whole.

The most intersting aspect of this project concerns the transfer of ethylene technology owned by Technip and K.T.I. The conditions of this technology transfer are defined in separate contracts signed on the one hand with CENPES (Petrobas Research and Development Centre), and on the other hand with the two Brazilian engineering firms. The technology transfer takes places at three levels:

- A transfer of Technip and K.T.I. know-how concerning ethylene.
- Traning of specialists in design procedures and co-ordination techniques used in the basic mechanical engineering process.
- The transfer of all computer programmes used, together with complete practical and theoretical documentation, training sessions in the use of the programmes, and organization of the sequence of calculations.

It is significant that Technip competed for this contract with other engineering firms (Lummus, Stone and Webster). In the contract negotiations, Technip agreement to the transfer of process engineering technology was a decisive factor.

In the Republic of Korea, mastery of process engineering has taken the following forms:

In 1977 the Korea Engineering company participated in the construction of an urea unit for the Nambhae Chemical Co (75/25 joint venture of the Korea General Chemical Co. and the Agrico Chemical Co. (United States). For the first Nambhae unit, the main contractor was the Japanes firm Toyo Engineering, and Korea Engineering was the subcontractor. In 1979, for the establishment of another urea factory for Nambhae, the Korea Engineering Co. was the main contractor for basic and detailed engineering, and Toyo Engineering was the subcontractor.

The Bokaro steel project is the most important project ever undertaken by India. In the light of the experience gained during the construction of the plants at Durgapur, Bhilai and Rourkela, the Government decided to go ahead with this new project and made an Indian company, DASTUR Co., responsible for carrying out the preliminary study. The DASTUR report was used as a basis for the negotiations with a foreign partner, the USSR being the one finally chosen. The Government had decided to make use of national design capacities and Indian materials for the construction of the new steel plant. However, as the acceptance of the USSR had been made dependent on its being given responsibility for over-all design and study, a compromise was reached, under which the respective spheres of competence of the Indian and Soviet consultancy offices and suppliers of equipment were set forth.

This resulted in an increase in the use of Indian equipment, as compared with imported equipment, as is shown in the next table.

(percentages)[1]

Steel plants	Capacity (Million of tonnes)	Equipment		Structurals		Refractories	
		Indian	Imported	Indian	Imported	Indian	Imported
1955-1961							
Roukela	1.0	-	100	4	96	22	78
Bhilai	1.0	13	87	22	78	6	94
Durgapur	1.0	13	87	28	72	50	50
1961-1966 (expansion period)							
Roukela	1.8	25	75	78	22	57	43
Bhilai	2.5	18	82	29	71	44	56
Dargapur	1.6	49	51	74	26	96	4
1964 -							
Bokaro 1st stage (completed	1.7	60	40	94	6	61	39
Bokaro (expansion)	4.0	88	12	100	-	100	-

Thus during the first stage of construction of the plant at Bokaro, more than 50 per cent of the equipment was for the first time supplied by Indian firms.

The items purchased form Indian suppliers were often made in India for the first time. To encourage national production, orders were placed not only with public sector enterprises, but also with a large number of private companies (approximately 500, large, medium and small)scattered all over the country, and this created difficult problems for the engineers responsible for inspecting the products manufactured and for speeding up deliveries.

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[1] Purchase of capital goods and technology in the iron and steel sector, UNCTAD, TD/B/C.6/27, 1978, page 5.

All the engineering for the second stage has been entrusted to two Indian companies: MECON and DASTUR, with the former having over-all responsibility. It is believed that all the structurals and 70 per cent of the equipment, in other words 88 per cent of all the capital goods, will be purchased locally. India will thus have taken a great stride forward towards acquiring expertise in both:

Iron and steel industry engineering, and

The manufacture of equipment for the iron and steel industry.

3.2. MINI STEEL PLANTS - interesting prospects for small and medium sized developing countries.

The steel production plants called "mini" steel plants first appeared in Italy and the United States of America during the 1960s. Their numbers have grown, particularly in Italy during the 1970s, in in the region of Brescia (the "Bresciani").

A mini steel plant is a semi-integrated steelworks usually consisting of:

An electric furnace charged with scrap or sponge iron (DR);

A continuous casting machine (or perhaps small ingot moulds);

A rolling train for ordinary steel bars.

Mini-plants range from 20,000 to 200,000 tonnes per annum in size - usually between 50,000 and 150,000 tonnes per annum.

The products manufactured by mini-plants are concrete-reinforcing bars and wire rod. The wire rod is very often used as smooth concrete-reinforcing rod, but the trend in the use of concrete-reinforcing bars is towards corrugated bars.

With the wire rod, the mini-plant can supply one or more wire drawing mills for the manufacture of all the downstream products of ordinary steel wire: welded gauze for construction and public works, barbed wire for agriculture, nails, etc. Some mini-plants manufacture small sections. The change then made in the structure of the mini-plant mainly concerns the mill rolls. It is thus comparatively easy to envisage producing small sections in a mini-plant with not very significant changes in the rolling trains. The case of flat products is quite different, however.

There are some mini-plants in the world which manufacture flat products. One may mention the Alpha Steel works in the United Kingdom and Oregon Steel in the United States[1]. The latter is actually a rather special case with regard both to the route used (integrated route) and to the production capacity and products (alloy steel sheet/plate).

Clearly, mini-plants for flat products could open up very interesting prospects for the development of the iron and steel sector in developing countries. There is a need, however, for more complete knowledge of the conditions for the development and establishment of this type of mini-plant as regards production capacities (whether small dimensions are possible or not), products (ordinary steel, high-grade and special steels), etc., and the operating conditions for the rolling mills which some designers propose for this type of factory.

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[1] The Alpha Steel works has a production capacity of 200,000 tons per annum with 4 electric furnaces and a three-line continuous casting machine. The Oregon Steel factory is an integrated production plant based on the direct reduction of 400,000 tons per annum, electric steelmaking, continuous casting and rolling mills.

C. Capital Goods for the Production of Consumer Goods

C.1. Capital Goods for Agriculture - The Agricultural Machinery Industry[1]

1. Characteristics of world agricultural machinery production

1.1. Global data

World industrial production of agricultural machinery in the strict sense of the term (excluding hand tools and most fixed equipment for farming, due to the lack of available or comparable information) calls for the following general comments:

- The value of world production of agricultural machinery in 1975 was nearly $36 billion, 63% of which was accounted for by developed market economy countries, 31% by planned economy countries, and only about 6% by developing countries, within the framework of the"narrow definition", which is the only one currently permitting a worldwide comparison.
- It is important to note that these figures involve industrial production alone (production units of 10 to 20 wage earners), which therefore excludes handicrafts production. For developing countries, such handicrafts production of machines and traditional tools is very important.
- Despite these uncertainties and statistical limits, there is obviously a wide gap between the share of production of developing countries (6%) in the world modern agricultural machinery industry and the general target of 25% for the whole of industrial activities established at Lima.
- The most important group of products in terms of production value consists of machines intended for working the soil - mainly cultivation and harvesting (40%). Tractor production accounts for just over one third of the total value of agricultural machinery (36%). The final share (24%) of

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[1] World study of the agricultural machinery industry. UNIDO/ICIS 119-29 June 1979.

"miscellaneous products" mainly consists of specialized agricultural material (milking machines and creamers, gardening material, incubators, seed material etc.). As previously mentioned, the latter category does not take into account much fixed equipment for the agricultural sector.

- The combined breakdown by country and product group makes it possible to identify interesting phenomena. The structures of production differ form country to country. This characteristic is linked to a certain degree of specialization and differentiation of national industries, which may be explained by various factors:

  (a) First, the agricultural mechanization policies resulting from the requirements of the productive system and of demand in each country (for example in the USSR priority is given to heavy tractors and automatically powered tractors to increase the surface area of cultivated land and yields);

  (b) Secondly, an important role is played by export and commercial and technological breakthroughs on national and international markets (for example, in Japan, the case of power-driven cultivators and combined machinery);

  (c) Thirdly, the primary importance of the manufacture of tractors in developing countries is the result of a number of complex factors: specific policy priorities, use of tractor manufacture as a motor of development in the agricultural machinery industry, weakness of the infrastructure of basic facilities for producing a variety of machines, social symbolism of the tractor etc. On the other hand, it will be noted that the production of "other products" in developing countries (16%) is weakest in relation to other groups of machines or other countries, although the variety of situations in developing countries would undoubtedly require a corresponding diversification of products of the industry.

1.2. Tractors and tractor-drawn machines

World tractor production in 1978 amounted to 2 100 000 units after a strong annual growth of 8% between 1971 and 1976. The USSR and the whole of the developed market economy countries today dominate world production (respectively 27% and 37% of the total). With 15%, Japan has had rapid growth in production since 1972. United States production, which exceeded 600 000 units in 1950, has sharply fallen. This may be in part explained by widespread delocalization of production by the large United States companies, the role of which nevertheless remains essential for the supply of developed market economy countries and developing countries. The role of the first four European producer countries: Federal Republic of Germany, France, Italy and the United Kingdom is equally important (22% of the world total).

The tractor production of developing countries amounted to approximately 324 000 units in 1978, or 15,6% of the world total. In reality, these countries contribute only 11% of the value of world tractor production, because the production process involves many components or sub-assemblies manufactured by large foreign firms and then imported, or is limited to assembly operations.

There is a profound market change toward the renewal of equipment in developed countries and toward a relative saturation of demand in developing countries, despite the role of the economic recession in market economy countries and the vast scale of existing needs. Such a development may have positive implications for developing countries and the demand of poor countries, to strengthen a buyers market, and to promote the establishment of a new type of co-operation and technological transfer.

1.3. Production in developing countries

Hand tools. It is estimated that over 60% of farmers in developing countries use only hand tools in their work, and manufacture approximately 90% of their required tools. The tools are often manufactured at village level in conditions allowing a real adaptation to tradition and local farming needs, but with a limited capacity with regard to the size of latent requirements.

Manufacture of simple machines. The manufacture of simple machines is the first step in an industrial process leading to the satisfaction of the needs of local farmers applying a strategy of "light mechanization", or 15-30% of farmers in developing countries. Indigenous industry (or semi-handicraftsmanship) is estimated to meet approximately 70% of the current domestic needs of developing countries, with considerable variation according to the type of machines: over 80% for animal-drawn machinery; over 50% for harvesting machinery and hand pumps; and less than 40% for devices driven by small engines.

The machinery is manufactured in medium-sized enterprises (10-50 persons). Little information is available on world production. However, it has been noted that this type of production is strongest in countries and regions with highly labour-intensive food cultivation, and those with certain industrial or export crops (coffee, cocoa, groundnuts, tea) based on traditional cultivation.

Manufacture of tractors and tractor-drawn machinery. Developing countries may be divided into four categories so far as concerns the supply of tractors [1]:

A - Those relying entirely on imported material;

B - Those importing partly, semi, and completely knock-down material (respectively PKD, SKD and CKD);

C - Those having local manufacturing capabilities and incorporating 20-30% of local components;

D - Those having local capabilities and incorporating 50-60%, and sometimes more of local components.

Category A includes 70 developing countries accounting for 9.3% of world population. Category B includes the following countries: Burma, Cameroon, Chile, Niger, Senegal, Sudan and Sri Lanka, which

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[1] Source: Mr. Swamy Rao-Practical issues relating to international arrangements concerning imports, local assembly and manufacture of agricultural machinery. Global preparatory meeting for consultations on the agricultural machinery industry, UNIDO, Vienna, 5-8 June 1979. The situation existing in 1978 is dealt with.

account for 5.4% of world population. Category C includes the following 15 countries: Egypt, Indonesia, Iran, Irak, Malaysia, Morocco, Pakistan, Peru, Philippines, Swaziland, Syria, Thailand, Tunisia, Venezuela and Viet Nam, which account for 12.5% of world population. Category D includes the following nine countries: Algeria, Argentina, Brazil, China, India, Mexico, the Republic of Korea, Turkey and Yugoslavia, which account for 44.2% of world population.

Self-propelled machines and specialized equipment. The contribution of developing countries is almost non-existent at this level of production, which requires considerable technological know-how.

1.4. Characteristics of world trade

The value of world trade in agricultural machinery (in the strict sense of the term) exceeded $10,4 billion in 1978.

Developed market economy countries play a dominant role in this trade, as they are responsible for 80% of exports and 60% of imports. The strongest exporters are the EEC countries, which account for 37% of world exports (average export rate of approximately 50), the United States (leading exporting country - 23% of the world total), Japan and the USSR.

The share of developing countries in world trade reflects the gap which they must overcome and the problems confronting them: their purchases account for 25% of world imports and their exports, which go almost entirely to other developing countries, for only 1% of the world total. Moreover, a very small group of countries provide these exports, 75% of which come from Latin America (33% for Argentina, 28% for Brasil). The rest come from India, the Republic of Korea and Singapore. These exporting countries are all semi-industrialized; they also manufacture and import the most agricultural machinery.

Another dominant characteristic is the absence of commercial flows among developing countries, which are supplied almost exclusively by foreign firms based in developed countries. It is therefore essential to analyse the nature and the causes of the technical, commercial and human obstacles to trade among developing countries, because the persistence of such a situation would threaten the success and even the existence of local production units often faced with insufficient internal demand. In many countries production capacity is already to a large extent underutilized mainly because of the limited local, regional and external outlets. The transition of South-South trade from almost nothing to a significant level of development is of fundamental importance.

The tractor occupies a more importnat place in world trade, where it represents approximately 55% of the total value, than in world production. Standard tractor equipment (tractor and tractor-drawn equipment) alone accounts for 80% of trade. This preponderance reaches its peak in the imports of developing countries (65% of total value accounted for by tractors, and 90% by tractors and tractor-drawn equipment).

World trade in agricultural machinery has developed very quickly, with an average growth rate in annual value of 20% between 1969 and 1977. Since then, however, there has been a stagnation in total value, which, taking into account highly fluctuating and rising prices, reflects a substantial volume loss. This was especially the case of purchases made by developing countries (except those of the Middle East), while the most affected supplier countries were Japan and the United States. Such a development confirms observations made at the level of production and supports the hypothesis of a saturation of world demand.

The analysis of trade change would be incomplete if it failed to take into account fixed equipment intended for agriculture. There is considerable trade in such equipment. Thus trade in three types of priority equipment (pumps, engines and construction material for agricultural use) amounted by themselves to a value equal to that of all agricultural machinery. This trade is still rising sharply, which shows the growing role of fixed equipment in the mechanization of world agriculture.

2. Future prospects.

2.1. Decisive role of the large producers

The large producer firms will continue to play a decisive role. Their general view is that the market, including that of developing countries, will expand moderately in future, although they are somewhat skeptical about the growth of solvent demand. The trend toward stagnation would be compensated for by the sophistication of material and a growing number of influential powers. It would make it necessary to take serious steps towards the rationalization and concentration of the productive structure, but would at the same time threaten to worsen the underutilization of certain capacities. Finally, although it seems generally agreed that production and current design standards are ill adapted to the. needs of developing countries, this awareness will probably not lead to radical change at the present time, but rather to simple adaptations.

2.2. Two essential observations

2.2.1 From heavy tractor equipment to combined mechanization in response to diversified demand.

The very nature of demand for agricultural machinery is basically linked to various characteristics of the rural world and of agricultural production in each region or country. This diversified reality may be classified into four main systems of agricultural production, each of them implying different mechanization patterns. The following systems of production are involved: traditional with low intensity of work (countries of the Sahel and the Amazon region, for example); traditional with high intensity of work (countries of South-east Asia, for example); modern with high intensity of work (Republic of Korea, agricultural exporting countries with small-scale farming, for example): modern with low intensity of work (United States, sparsely populated oil-producing countries, for example).

The variety of these different socio-agricultural systems, like the great disparity in levels of economic development and income in developing countries, are objective factors in the diversity of demand for agricultural mechanization in these countries. Making allowance for this diversity is an essential condition for any policy of international co-operation.

2.2.2 The trend must be reversed. Demand must stimulate supply.

It would be useful to recall how supply and demand were ajusted for groups of countries. It seems clear that the extraordinary development of agriculture since the Second World War and the big expansion of the agricultural machinery industry were mutually beneficial, leading in the 1970s to productive and mechanized agriculture, organized and powerful industrial structures, and large trade flows. A similar dynamic process took place and subsequently continued in planned economy countries. But having gradually achieved a high level of mechanization, confronted with other constraints or directed toward other choices, agriculture in developed countries has steadily lost its capacity to generate sufficient demand (at least for traditional equipment), while the vast needs of developing countries were beginning to emerge. Supplies from the industrialized countries, and in particular the transnational corporations, satisfied this demand, at first exclusively through imports, and then through participation in the establishment of assembly and manufacturing units in developing countries by transferring, almost without adaptation, certain types of machinery originally designed to meet the needs of developed countries. At present a new stage seems to have been reached in the development of the world market. Agricultural machinery investment in industrialized countries is mainly limited to renewing existing material, while switching to fixed equipment (for food production) or to intermediate, less capital-intensive consumption (fertilizer, new seeds). But, significantly, there has also appeared a trend towards the saturation of demand in developing countries (only 12% of world demand for modern agricultural machinery), although mechanization needs remain immense.

This stalemate, which is starkly borne out by the statistics (especially for production and external trade) or the ceilings placed on agricultural investment rates in those countries, may be explained by two main factors: a relative saturation of solvent demand in developing countries; a lack of adaptation of supply to specific and varied demand in developing countries.

The relative saturation of demand in developing countries reflects a lack of financial means of the agricultural population and the whole sector (inability to assume long-term debts, to ensure a gradual accumulation of capital in agriculture, to attain satisfactory income levels, etc.). It basically shows the disorganization and irrationality of this demand, which is unable to identify its own characteristics or needs, or to define choices and options at regional or country level; which leads to an ill-considered reliance on imports and to social, financial and technical paralysis; and which makes it impossible to lay down an industrial strategy for the local manufacture of agricultural machinery.

But the current saturation of demand in developing countries is also a direct result of the world supply of agricultural machinery, especially by the large exporting firms of developed countries. These firms have in fact responded to demand from developing countries by transferring products, techniques and methods designed to meet demand in industrialized countries, primarily through the use of heavy tractor equipment. This vast transfer on a worldwide scale is therefore leading to structural paralysis.

Supplies offered by industrialized countries have dominated demand in developing countries, thus leading to the present saturation which is harmful to both. The main change to be carried out is that supply in the future should be offered in response to demand.

2.3. Four possible variants of the engineering design.

The pursuit of the heavy tractor equipment design. This trend is strenghened by the extensive nature of agricultural production, the importance of vegetable production, agricultural export options, or the manufacture of products for industrial purposes. Power engines would be further developed, while the weight of the engineering industry on the agricultural machinery industry would be strenghened.

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Diversification of the engineering design. This is linked to the diversification and intensification of cultivation, to the development of animal production, and to the choice of mixed as opposed to specialized farming. It would favour the multiplication and improvement of tractor-drawn machinery, and progress toward light motorization and fixed equipment. Upstream engineering industries would be much more diversified and would see a strenghening of the role of small and medium-sized specialized enterprises.

Adaptation of the engineering design. A greater diversification and intensification of agricultural production leads to a significant increase in intermediate consumption (improved seed, fertilizer, phytosanitary products) and to an improvement of production infrastructures (drainage,irrigation, buildings etc.); recourse to heavy motorized equipment becomes impossible because of the small size of plots. The use of tractor equipment should be adapted to this growing application of chemical and biological products, to the interrelationship of fixed equipment, to the practical conditions of cultivating the soil etc. At the level of industrial supply, the engineering element would become less predominant and more diversified.

Replacement of the engineering design. A period of adaptation of the engineering designs to the agricultural constraints (intensification) and to the necessary industrial redeployment could be followed by a long-term process of substitution of the "biological-chemical" design for the engineering design. Such a process could only be carried out gradually, and would require the continued intensification of labour, increasing costs of agricultural production and the development of effective biological techniques. The machinery industry would be influenced by other industrial sectors, the role of which would become predominant (chemical-biological techniques, other capital goods industries). These potential innovations may seem hypothetical, or at least very remote and of no direct concern to developing countries, where the urgency of the problems requires the use of current technologies.

2.4. Actions required to promote co-operation among developing countries.

The first Meeting on Exchange of Experiences and Co-operation among

Developing Countries in the Development of the Agricultural Machinery Industry was held at Beijing, China, from 20 to 27 October 1980. The Meeting recommended five priority areas for co-operation among developing countries:

Product/production design and adaptation of equipment in Categories I, II and III[1]

(a) The first area should include agricultural equipment generally accepted, already manufactured and that used with satisfaction by farmers in the developing countries. It should also include basic facilities and ancillary industries for achieving local production.

Training

(b) Fields in which training is needed by developing countries include:

Design work

Equipment used for manufacture of agricultural machinery

Agricultural machinery

Maintenance and repair

Service networks

Training in the above and related fields is of paramount importance at the design, manufacture and utilization stages.

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[1]

Category I	Simple: Hand tools, animal-drawn basic implements and manually operated equipment.
Category II	Intermediate: Tractor-drawn basic implements, low horse-power,simple power equipment including engines, power tiller and irrigation equipment.
Category III	Standard: Standard general purpose tractors, power tillers, engines, pumps, harvest and post harvest equipment, etc.

This list is not exhaustive.

Service network installations

(c) The third area should include services, workshops and units for handling manufacturing equipment and final products within manufacturing establishments and centres created for the purpose of maintenance and repair of products. The final objective of the network is to offer production facilities and utilization of available machine parts. Countries that need assistance in this field include, among others, Algeria, Egypt, Guyana, Niger, Togo, Tunisia and the United Republic of Tanzania.

Information service

(d) The type of information needed by present and potential manufacturers includes that on product specifications; manufacturing products; results of prototype production and testing; types of co-operation between developed and developing countries as well as among developing countries themselves etc.

UNIDO was requested to give priority in its information service to the agricultural machinery industry. In addition, UNIDO was requested to compile surveys on the different experiences of the developing countries in their industrialization and mechanization efforts;

Research and development

(e) Co-operation in research and development activities among more advanced developing countries is highly recommended. Since most of these countries are already engaged in these activities, other countries which do not have such facilities will be permitted to share the reseults of research and development work in subjects of common interest on a cost-sharing or any other basis. Interested research and development institutions in industrialized countries are welcome to contribute to this effort. The result of this collective undertaking will benefit all countries.

It is suggested that, in order to implement the above recommendations, the developing countries may initiate bilateral and multilateral discussions and negotiations with the respective developing and developed countries. In this connection the developing countries may, as appropriate, use the services of UNIDO.

A centre for the promotion of the agricultural machinery industry in developing countries

The Meeting recommended that a centre for the promotion of the agricultural machinery industry in the developing countries should be set up in Beijing. It was suggested that the following terms of reference, among others, might be considered:

(a) To collect, analyse and disseminate information on all aspects of the agricultural machinery industry;

(b) To foster an exchange of experts, designs and prototypes of agricultural machinery;

(c) To establish interlinks with national, subregional, regional and interregional institutions and manufacturers;

(d) To enhance co-operation in the field of design development and adaptation;

(e) To stimulate joint venture investment activities in production

C.2. Capital goods for production of other consumer goods.

In the absence of sub-sector studies related to capital goods for manufacturing industries such as textiles, paper and pulp, wood processing, printing, durable mechanical and electrical consumer goods, we shall concentrate on food industry machinery[1].

1. Introduction

The food-processing industries constitute a group of very diverse activities, all of which have in common some characteristics that make it possible to distinguish them from other industries. These main

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[1] Machinery for the food-processing industry study prepared by INITEC, Madrid, Spain, 1981.

distinguishing characteristics are:

The seasonal nature of production;

The need to observe hygienic conditions in all processes;

The manipulation of perishable products;

The low degree of versatility of machines for processing different products;

The great diversity of products and thus of machines.

The technological level in the food-processing industries varies widely. In the production of fruit juice and in the processing of dairy products, there is advanced technology and modern, high-quality machinery. The same does not apply to the machines used in canning factories, abattoirs and other plants, in which the technological level varies widely, whether they are labour-intensive or not, according to the needs of each country.

As a result of the large number of products processed, the machinery necessary for the food-processing industry is very diverse.

It can equally well be said that many machines and appliances are common throughout the industry, such as service equipment (boilers, transformers, etc.). Such items are not among the basic processing equipment, that is to say, machines that are in physical contact with the food product, for the purpose of homogenization, compressing, conveying, peeling, or working the material, etc.; such machinery usually has specific characteristics for each raw material and product.

In general, relatively low processing temperatures are required, or else very high temperatures for short periods, in the common operation of asepticizing or deactivating the enzymes in a food products. Practically all the perishable foodstuffs that are the raw material of the food-processing industry are sensitive to heat, and important changes in flavour and nutritional value occur when heat treatment is inadequate.

2. Territorial production structures.

(a) The most powerful countries in the whole range of activities are the Federal Republic of Germany and the United States.

The United States has the advantage of a large domestic market and technological know-how at the forefront of innovation in a number of fields (sterilization, conditioning, freezing, dehydration). Moreover, production is structured by large firms of international standing: F.M.C., Chemetron, Penwalt, Chery-Burrel, Chrisholm-Ryder etc.

The Federal Republic of Germany, the world's second largest producer, has remarkable and efficient engineering production in all fields. Like the United States, its market has been penetrated to only a limited extent by foreign equipment and offers a reliable base providing the means for carrying out an ambitious export policy. The advantages of producers in the Federal Republic of Germany consist first of all in the processing of meat , sugar works, refrigeration material, conditioning and liquid foods. The major companies include MIAG, Leybold, Werner and Pfleiderer, Lurgi, Krupp, and the Bosch group. Unlike the United States, the Federal Republic of Germany exports to all countries, neglecting no market, however remote. On the other hand, United States producers continue to give priority to their traditional sphere of influence: Canada and Latin America. A total of 45% of machinery exports go to Canada, Japan, Mexico, the United Kingdom and Venezuela.

(b) Some European countries, although having only limited potential compared with that of the two biggest producers, occupy very strong positions in expanding food sectors and in the most advanced technologies. For example, the Netherlands, which do not carry much weight in obsolute terms, have acquired an international reputation for machinery used in slaughtering, sterilization, dairy production and industrial biscuit and bread making, with firms such as Stork, Tebel,an Van Der Ploeg.

Switzerland also has a world market for its equipment for butchers, food preservation, cereal processing (Buhler), and conditioning.

Finally, the Scandinavian countries, which are involved in a limited number of fields, are in the forefront of technology for equipment used in dairy production, fishing and refrigerated food preservation (Alfa Laval, Niro, Frigoscandia, Tetra-Pak, Atlas-Stord).

The common characteristic of machinery producers in these countries is the fact that they could not rely on a safe domestic market. As a result, firms with a good national image consolidated their technical and commercial reputation by their vigorous activity on foreign markets. In addition, sustained research and equipment innovation enables them to maintain a level of technological excellence that other countries have difficulty achieving.

c) In a third group there are four European countries with significant though varied potential. In the manufacture of food industry machinery, Belgium, France, Italy and the United Kingdom have common characteristics. The most technologically advanced producers are relatively powerful, but isolated.

3. Foreign trade in capital goods for the food-processing industry

The large world markets in engineering goods are precisely those of the great producing countries. This is quite clear in the sector of food-processing machinery. Thus, the flows of exports within OECD are directed basically to OECD countries, a fact which can be explained by the behaviour of the multinational enterprises, which tend to engage in specialization by various plants.

Analysis of export orientation indicated the degree to which the development of production in these sectors is based on foreign markets. Food-processing machinery has a moderate degree of export orientation as compared with other engineering industries, exports accounting for about 30 per cent of the value of production. This is a good indication of the importance of exports as a basis for the development of the food-processing machinery sector.

Just as the production of food-processing machinery is highly concentrated in a relatively small number of countries exports of food-processing machinery are also highly concentrated in a relatively small number of countries. The United States and the Federal Republic of Germany are the leading exporters among OECD countries in the engineering sector, particularly for food-processing machinery.

4. Steps to be taken in order to establish food machinery industry.

It is suggested that, with the purpose of reducing the initial investment and the economic risk, the establishment of the industry should be in stages. The fundamental aspects of the various implementation stages are summarized below.

From the moment at which a company or enterprise decides to set up an industry until the date on which it can commence the manufacture and sale of its products, a considerable period of time usually elapses. The industry under study is no exception, since the periods necessary to obtain the required licences from the authorities, for the construction of the buildings and assembly of the installations and the delivery of the manufacturing equipment are estimated to take about two years.

However, in this particular case, the period for the establishment of the industry can and must be quite productive. Therefore, as soon as it is decided to launch an enterprise, it is immediately necessary to set up the engineering and machine design department, which can be temporarily located in any rented premises; also, the first contacts must be made with specialized research centres. Working in close collaboration with them, design and construction work on original prototypes and prototypes similar to existing machines will be commenced, if necessary importing selected items for exhaustive study. The construction of the machines designed in this preliminary period will be subcontracted to mechanical engineering shops and the equipment constructed will be tested in the related food processing industries.

In its initial work, the section will concentrate on the development and design of new machines and on the construction of prototypes of machines similar to existing ones, such as automatic closing machines, centrifugal pumps for hygienic applications, filling machines operating with valves and pistons and on the overflow and recirculation principles, multipurpose cutters and automatic labelling machines for metal cans.

First stage

In this first stage of implementation, the industry will undertake the manufacture of equipment involving simple technology that does not require large investments in machinery but for which the sales volume is high: boilermaking work in iron and stainless steel,tubular heat exchangers, conveyor belts, sorting and canning conveyor belts, fork lift trucks, static autoclaves, pasteurization and cooling tunnels and pre-heaters.

An estimation of the demand will be made, calculating the initial volume of sales and the time that would elapse before they would materialize.

During this phase the design and construction of machinery similar to that built by major international firms will be continued, but by now the industry will have a small machine tool section intended for the construction of prototypes.

At the end of this stage the industry will normally be able to tackle the construction and marketing of the new equipment developed. In addition it will have acquired a knowledge of the market which will enable it to revise the programming of work and the operation of the enterprise for the following stage.

Second stage

The industry will continue the construction of equipment and machinery involving simple technology. Also, with the machine tools used in the construction of prototypes, it can start the manufacture of machinery involving advanced technology that has been developed in the previous stage, for which purpose it will subcontract the construction of the parts, subassemblies, machine components, etc. as it considers desirable. That will enable it to test again the market possibilities for such equipment without having to invest large amounts of capital for their construction. Gradually, and according to the market response, it will proceed to purchase new machine tools so as to have a production capacity that will enable it to meet the increase in demand.

Third stage

At the end of the second stage, the industry will construct iron and stainless steel boilers and similar equipment, tubular heat exchangers, conveyor belts, belts for sorting and canning machines, fork lift trucks, static autoclaves, pasteurization and cooling tunnels, pre-heaters, automatic closing machines for a capacity of 90 and 200 cans per minute, centrifugal pumps for hygienic applications, filling machines operating with valves and pistons and on the overflow and recirculation for liquids, multipurpose cutters, labelling machines for metal cans. However, in the manufacture of some of this equipment, the construction of various components and parts of machines will be subcontracted to other workshops.

In this latter stage the industry will, if the previous economic studies make it advisable, undertake the construction of parts and components of machines that were previously subcontracted. In addition, it will expand the range of production for new equipment, constructing such items as fork-lift trucks, washing machines for empty cans, and the original machines developed successfully in the previous stage.

In this stage the industry will reach its full level of production. It will probably increase its production, adapting itself to specifications based on demand, and creating new models of different capacities taking existing machinery as a basis.

Staff training needs

Throughout the capital goods sector, there is increasing complexity in staff training needs at all levels. Activities that formerly represented a low profile of knowledge (for example, maintenance operations) now require training at intermediate level particularly with regard to:

The machining of parts;

Automation in the manufacturing process;

The organization of preventive maintenance;

Design, engineering and information science;

The management and quality control of products;

D. Capital goods common to all sectors.

There is a large number and variety of capital goods common to all branches of industry. Moreover, there is no consistency in production statistics, the data available relate therefore mainly to international trade. Nomenclature of product groups covers variety of goods as e.g. electric motors, transmission shafts, clutches, gears, pumps, lifting and loading machinery, boilers, containers, tanks, weighing machinery, wire cables, valves, iron and steel castings.

It is estimated that goods common to all branches represent approximately 20% of world trade (class 7, not including the Eastern European countries). Industrialized countries account for over 95% of world exports and 70% of world imports. Developing countries are virtually absent form the exports scene with less than 5% of trade. However, their share of world imports (app.30%) is significant and increasing.

As far as imports are concerned, six developing countries alone (in 1975- Iran, Brazil, Mexico, Algeria, Venezuela and Indonesia) account for app. 50% of all imports of developing countries. Five of them are oil-producing countries.

Action to be taken in developing countries in co-operation with developed countries

In order to initiate and accelerate production of capital goods common to all sectors in developing countries bearing in mind the significant share of these countries in imports and relatively low complexity of many products and processes it is recommended:

- identification of the most suitable products for which production should be established/expanded
- elaboration of demand for specific products and its confrontation with existing production capacities
- negotiation between developing countries on priority industries and future exchange of goods to avoid unnecessary competition

- identification of the most suitable means of technology transfer, elaboration of appropriate mechanism for the transfer and creation of basic infrastructure
- negotiation of intergovernmental and interenterprise agreements to include economic, technical and financial co-operation.

Conclusions

This part of the Global Study has given some basic characteristics, present problems and prospects for capital goods development in selected sub-sectors. The share of developing countries in world production of capital goods is very low. It can be seen that with respect to machine tool production this share is between 3-4 per cent (including China 5-6 per cent). Certain countries already have an impressive level of production of capital goods, which means that there is an inequality among developing countries evident not only in production but in consumption as well. Brazil is the world's thirteenth largest producer of machine tools and India nineteenth.

Construction and public works equipment is characterized by concentration and domination of United States firms. The Techniberia study has estimated that United States firms, with their production units within and outside the United States, control 80 per cent of the world market. The size of these firms enables them to apply policies of research, development and investment, and to adopt an industrial and commercial organization designed to maintain or develop their position on the world market. On the contrary, in developing countries there is a very weak production but there is a major market for the industrialized countries.

There are some common characteristic with respect to the capital goods for the intermediate goods sector, particularly :

- Client industries apply continuous processing;
- Equipment suppliers are very often the same, since heavy custom-made equipment manufactured in multi-purpose units are mostly used. The same phenomenon occurs in connection with automatic equipment for continuous processing;
- Equipment sales in these industries are generally on a turnkey basis, unless the product is handed over directly;
- There are the same actors in dynamic relationship with each other (general contractor-project study and development, process owner, equipment supplier, financing body).

Several developing countries have made serious attempts to manufacture equipment for intermediate industries: Argentina, Brazil, India, the Republic of Korea and others which have taken steps in that direction (Algeria, Mexico and Tunisia). In the most Latin American countries, a technological package was opened according to the following sequence:

- Development of local advisory services for carrying out prefeasibility studies;
- Establishment of planning offices to carry out studies and meet secondary (off-site) investment needs;
- Development of local equipment manufacturing capabilities with the necessary planning offices;
- Simultaneous development of engineering companies gradually combining detailed engineering studies, management technology, and process engineering studies.

Local mastery of capital goods design is also necessary for adapting equipment specifications to local conditions (materials, production capacity, standards, norms).

It cannot be overemphasized that the establishment of a capital goods industry depends directly on local engineering capabilities.

In India, the Central Engineering Design Bureau now known as MECON, made it possible to achieve international standards in iron and steel plants.

In the Republic of Korea in 1973 a law was enacted on the promotion of local engineering services.

In Brazil there are many engineering companies in the field of electric power supply. There are also subsidiaries of foreign engineering companies.

With respect to food processing machinery, various implementation stages are summarized and described in the respective part of the study in order to assist developing countries in establishing this industry.

In connection with entries into production and expansion of capital goods industry, there are some real pre-requisities, conditions:

- The first is recognition of the role of the State;
- The second is the existence of industrial, sectoral planning.

Some capital goods manufacture arises almost "naturally". Such manufacturing is undertaken at the initiative of private industry or foreign investors. But beyond the manufacture of simple equipment of average complexity, nothing is done without a determined effort in which the State (and the various public or semi-public bodies) play a decisive role.

The action of the State may take various forms: e.g.

(a) Promotion of planning studies;

(b) Establishment of research and standardization services and of engineering companies;

(c) Establishment of capital goods enterprises;

(d) Establishment of credit financing institutions for the promotion of local equipment industry.

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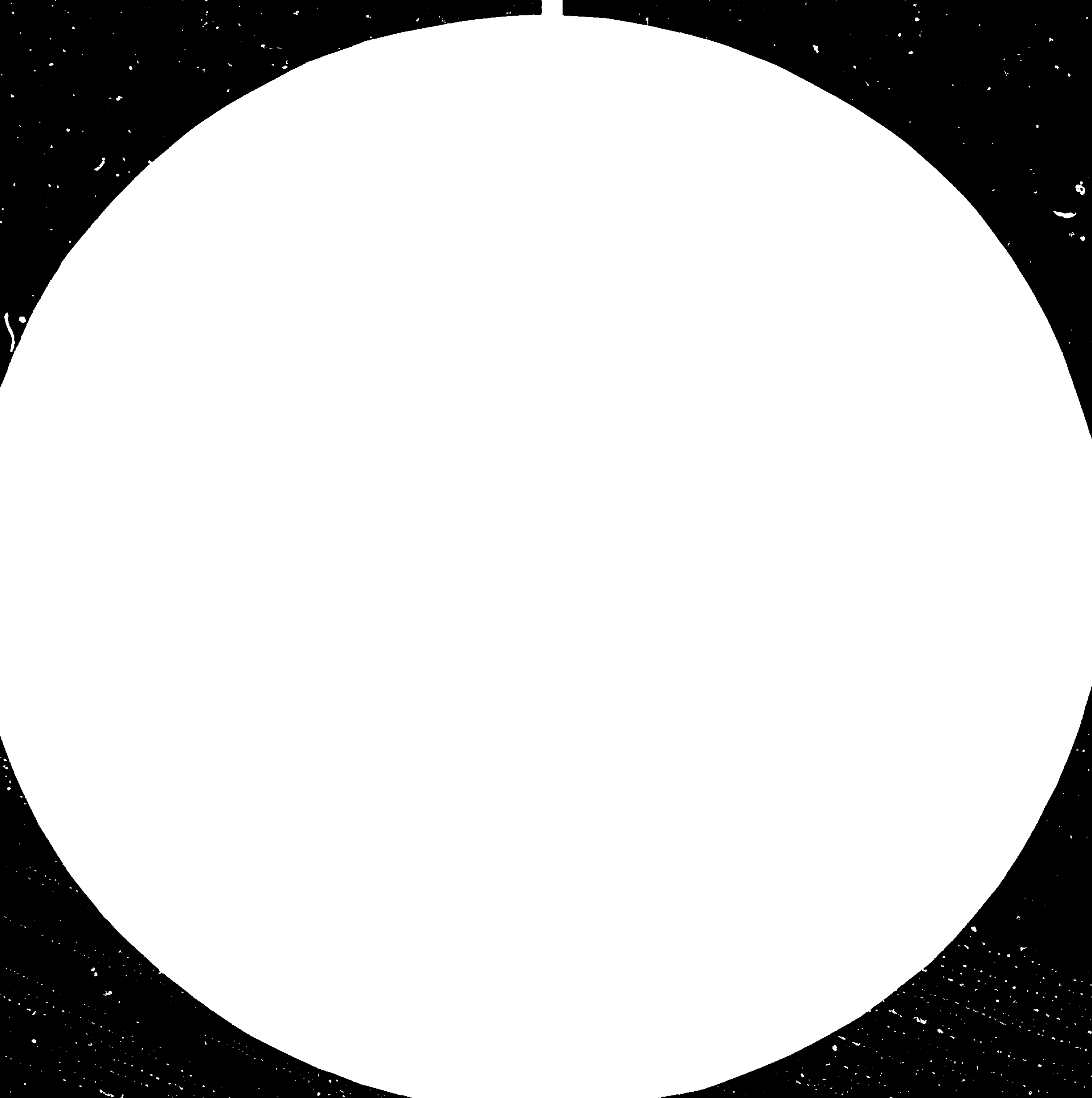

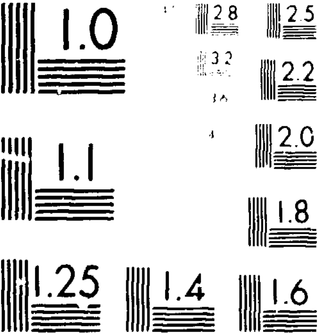

MICROCOPY RESOLUTION TEST CHART

Part three: Type of technologies in the service of development of capital goods in developing countries

INTRODUCTION

The majority of the world poorest peoples live with subsistence agriculture in developing countries and they know mostly simple agricultural implements and machinery often made at village blacksmith level without sufficient technological and engineering facilities. In developed countries one of the characteristics of present developments in machinery and equipment is the major use made of microelectronics, automation of the production process, innovations and the growing complexity of machinery.

Moreover, it may be seen that in many cases machinery and equipment imported from developed to developing countries are not appropriate for local use due to the discrepency between a degree of technological sophistication of machines and conditions prevailing in developing countries. In the context of these conditions, sophisticated, labour-saving design should be considered versus a simple operation, service and maintenance as well as durability and reliability.

Capital goods could be produced through different technological routes. A selection of adequate route to the specific conditions and appropriate entry should be based upon consideration of such factors as e.g. a size of market, development of demand, the level of engineering and technology in industries, availability of skills, technological pretentiousness of a particular route, its learning effects and the period of time required for the assimilation of particular level of technological complexity.

It this connection, experiences of more advanced developing countries in this field should be carefully examined and applied.

It is not feasible to prescribe any uniform pattern of product selectivity or sub-sectoral growths, since conditions in developing countries are widely divergent.

Normally, initial efforts are concentrated on repairs and maintainance facilities, production of parts,spares, hand tools, agricultural implements and equipment. This level has either been reached in medium and small-sized developing countries or could be reached in no distant time. Further stages of capital goods production continue with more complex parts, components, machinery and equipment incl. durable consumer goods.

Labour-intensive technologies, incorporating low fixed capital are not generally produced in the industrialized countries. This task can therefore only be assumed by the capital goods industries in developing countries themselves. In subsequent paragraphs therefore a review of technological trends and prospects for developing countries as well as possible application of technological complexity method will be given.

A. Technological trends and prospects for the next few years[1]

1. Current situation

1.1 The world economy today is in a very serious situation, market economy developed countries are undergoing a period of economic stagnation with increases in unemployment, capital goods sector has been so far less affected than some more traditional ones. The development of the capital goods industry should be seen in a context of crisis and changes as represented by the current period. Such factors as unemployment, energy prices, competition, necessity to reduce manufacturing cost will play an important role and influence.

1.2 As far as current technological development is concerned, microelectronics is a real revolution, whichis more and more influencing also capital goods industries. Today this technology already has many applications. These applications occure at the level of:

- productivity growth by reduction of costs and optimizing the use of resources (labour, energy, raw materials, machinery and equipment); and
- creating new products.

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[1] For more details Cf. "Capital goods industry in developed market economy countries", study, prepared by Mr. L. Demol, Belgium.

Socio-economic consequences of microelectronics are found to be multiple and deep seated. There are attempts to analyse them, but the subject is highly complex and difficult to define. However, the basic current concern is the influence which microelectronics will have on employment, training and the evolution of working hours.

1.3 A brief study of the machine tool industry in some of the more developed developing countries[1], who have fairly well established machine tool industry and a well-founded industrial base, throws up the fact that these countries have been able to build their machine tool industry on modern lines because of the impetus and assistance that they have received from their respective country's governments. As amply indicated in the case study of the Indian Machine Tool Industry, most of these developing countries have obtained their designs and know-how and production technology from the developed countries in building up their machine tool industry and are today in a position to meet over 70 per cent of their own requirements of machine tools - mainly of the general purpose type. Some of them also export their machine tools and in spite of keen competition in the world markets, not only among them-selves but also from the developed countries, they have been able to make a break-through. However, due to their technological backwardness particularly in computer applications and knowledge of micro-electronics technology, their development in machine tool industry and metalworking capital goods industry has lagged behind so much, that over the past decade, the progress seems to be poor and almost stagnant in comparison with that what is taking place in the highly industrialised countries in the field of machine tools and production technology. The technology gap has widened considerably.

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[1] For more detailed study see "Technological perspectives in the machine tool industry and its implications for developing countries" worked out by Dr. Patil, UNIDO Consultant, India.

2. Technological trends

2.1 Materials

The long term prospects of using the various engineering construction materials will mainly depend on:

- availability of raw materials (procurement opportunity, safety and, in the long term, existing reserves);
- availability of adequate production capacity; and
- the total energy cost.

The increase or substitutions in the use will depend on the evolution of these factors, which will not always be justified purely from the technical standpoint.

In the short and medium term, it is generally recognized that the standard construction materials, such as steels and light metals, will maintain their predominant position in spite of the competition provided by polymers or compound materials.

As plastic materials are derived exclusively from oil, their future may well be jeopardised because of this feature. Indeed, if this consideration seems to hold good for mass production goods, such as packing for example, it will not apply for high quality plastic materials for technical applications and for capital goods. Future development of high performance polymers will mainly have three objectives:

- improvement of mechanical characteristics and particularly the modulus of elasticity;
- improvement of resistance to low and high temperatures; and
- reduction of manufacturing costs, including power costs.

2.2 Design and calculation of machines and of structure

For a long time mechanics was the only discipline concerned with the design and calculation of machines and of equipment; progressively electricity, then electronics, at first classical electronics and now microelectronics, have become associated with it.

These distinctions between disciplines will become blurred and their association will be close; the machine will evolve into a system, that is to say an assembly of mechanical, electrical and electronic components. Development will require technical design staff fully familiar with these disciplines, knowing the respective limits and interfaces and able to call on specialists for the construction of specific elements. Progress will no longer be based on mechanics ever increasing in sophistication but rather in the optimal association of mechanics, electricity and electronics, backed by physical and chemical sciences, in particular optics, pneumatics and hydraulics.

For example, the parking meter, when it was designed purely on a mechanical basis, consisted of some 300 parts; this number is reduced to 100 if mechanical and electronic components are combined and drops to about 15 when a fully integrated design is adopted.

Returning to mechanical components, the calculation of their kinematics and of their strength is now usually done by computer, which is also increasingly employed to draw the parts and to prepare the manufacturing work on machines. These operation sequences will attain a highly sophisticated integration of design and manufacturing by computer (CAD-CAM: Computer Aided Design - Computer Aided Manufacturing).

2.3 Manufacturing process

2.3.1 Foundry work

In this field no major innovative development is expected, but rather the objectives will be savings in energy and material, improvement of working conditions and automation of the manufacturing process.

Generally, future foundry work will be the result of the evolution and improvement of the techniques applied or at least currently available. It will be more complex, more productive and will require large investments, made profitable by the increase of thermal and mechanical efficiency, all forms of recycling, automation of the most arduous tasks, both in production and in finishing.

2.3.2 Forging - Stamping

The concern to conserve materials, rising cost of energy and the need to explore new routes of production have given metalforming processes a lot of significance.

Like foundry work, these techniques, at least for the production of standard parts, are not liable to major changes in the near future, for their development will be in particular influenced by material and energy constraints, the necessity of automation and the requirement of raising quality for those elements which, in particular in the transport industry, will have to continue to be made lighter.

2.3.3 Metal machining

Two trends have featured the development of metal cutting machine tools: continuous increase of cutting speeds and automation to a continuing higher level. The productivity increase by automation has been the constant concern of all users. If the transfer lines are still suitable for mass production, its relative importance has decreased, mainly because of their lack of flexibility. The reason is that products become obsolescent quicker and, therefore, are subject to more frequent changes; moreover, several variants of a same product can coexist over a time which will vary in length and, finally, they can still supply spare parts for old products which is found to be a profitable commercial proposition.

The flexible manufacturing systems provide a solution to this problem: they combine the flexibility of numerical control with productivity of transfer lines. They are described as a group of working stations (generally NC machines) connected by a system of transfer of parts, controlled by a computer and for the purpose of manufacturing parts of the same set.

Unlike transfer lines, they are capable of machining simultaneously parts with different forms and the lot sizes are of a few thousand parts.

Depending on the number of machine tools installed, the automatic transfer of parts between working stations is done either by robots or conveyors. In the latter case, the conveyor can interconnect in a rigid fashion the various machines, or be in the form of shuttle guided by electrical donductors installed in the floor. This latter method allows the progressive expansion of the manufacturing line.

The evolution of the conventional manufacturing methods by specialized sections (turning, milling, grinding,...) to flexible manufacturing systems is sometimes made through manufacturing cells. They regroup in the same spot of the workshop different machines - not necessarily automatic ones - but of a capacity so that a part entering a given cell leaves it finished, without having to undergo the usual handling between sections of specialized machining. Here again the distribution of production in sets of parts is the guiding factor in forming the various cells.

2.4 Automation and robotation

Automation, which before had been limited to specific activities, in particular manufacture and assembly, will widen its field of application and make every endeavour to connect all the phases and integrate in a coherent system.

The maximum output of these measures of rationalization which are required in all these phases can only be obtained if man no longer has to transmit from one level to another existing or new information; this role is allocated to the computer, which increases the human capacity to process information, just like machines have increased his physical force. The intensive exploitation of possibilities offered by microelectronics to make common the automation of machines and of manufacturing processes, will be one of the main features of the industrial evolution of the coming years. Technical tools are available for this evolution, but it raises a point connected with social matters, that is to say the consequences of automation and computerisation in industry and services on employment.

During the past five years, the industrialized world has become aware of the increasing importance of the use of industrial robots in all types of manufacturing.

First we must understand what is termed "industrial robot". The Robotics Institute of the U.S.A. proposes the following definition : "An industrial robot is a reprogrammable multi-functional manipulator designed to move materials, parts, tools or special instruments in accordance with programmed variable movements so as to accomplish a series of tasks".

Therefore, an industrial robot consists essentially of three components :

- the mechanical system capable of movements in the three axes of space;
- the control system varies in sophistication, from very simple logic systems to some using microprocessors; and
- the power unit can be hydraulic, pneumatic or electric.

Thus defined, an industrial robot is quite different from the simple "pick and place" units (manipulators with one or two axes of freedor), which are much more widespread.

Going by this definition of the industrial robot accroding to various estimates, at the beginning of 1980 there were some 10 000 industrial robots in operation in the whole world. Thus half of them are in Japan, one quarter in the U.S.A. and the remaining quarter in the whole of Europe.

Industrial robots, as we currently know them, will be developed further technically. Soon they will be fitted with sensor and vision units, and vision-arm coordination systems; finally "superintelligent" robots will be fitted with artificial intelligence which will enable them to decide for themselves in accordance with each situation.

In many industrial sectors, the use of robots is currently the subject of high level studies, where the following considerations favour it :

- increasing cost of labour, specially for heavy, unwholesome and dangerous work;
- high absenteeism in repetitive work;
- lowering of quality;
- flexibility of production tools so as to increase productivity; and
- energy crisis.

It may be expected that during the eighties quite a large number of industrial robots should come into use. However, a specific feasibility study of each robot installation will have to be carefully made, covering technical, economic and social aspects.

3. Implications of technological developments for developing countries

3.1 It is quite evident that in the industrially advanced countries there have been tremendous developments in the production technology employed in the metalworking industry particularly over the past three decades. Most spectacular are the foreseeable future trends in development in these countries, which could carry the industry to a logical stage of a very high degree of automation/ sophistication. It appears therefore nearly impossible for the developing countries to bridge this technology gap. Such unbridgeable technology gap could create a large economic imbalance and great disparity in social standards and living conditions between the developed and developing countries. This technological backwardness in the metalworking industry could be to some extent surmount if the developing countries make determined efforts to push their respective country's programme of industrial development in general and production of capital goods including machine tools in particular as much as possible in line with some of the latest advances in technological developments which are taking place in this field in the industrialised nations. In the case there is an intention to build metalworking export industries or combination of import substitution/export industries, the above mentioned orientation is an obligation.

3.2 Technology gap and its implication

In the developing world, some of the newly industrializing countries like China, Brazil, Argentina, Korea Rep. of, India, Singapore, Mexico and Portugal have a well established metal-working and machine tool industries. In the last three decades some of them have been able to make significant progress in their respective machine tool industry mainly through acquiring design and manufacturing technology from the transnational corporations. Besides, these countries have simultaneously strived to build their own capabilities in developing original designs of machine tools, mostly of the general purpose type.

As a result, most of them are today self-sufficient in their needs for general purpose machine tools. Also, some advance types of machines like special purpose machines, some types of transfer lines, single and multi-spindle automatics, certain types of gear cutting machines, horizontal and vertical boring mills, commonly needed designs of grinding machines of cylindrical and universal types and so on, are also being produced in these countries. The inherent strength of their machine tool industry is further proved by the fact that the newly industrializing developing countries have made a breakthrough in exporting a range of general purpose machine tools to the world markets, not only competing amongst themselves but also facing stiff competition from the developed countries. As the developed countries give up manufacturing many types of general purpose machines in preference to the advance designs due to the relatively high labour content in the former type of machine tools, the developing countries are likely to expand their exports, provided they build high quality, modern machine tools needed in the markets of the industrialized countries and those of less developed developing countries of Asia and Africa.

Notwithstanding such satisfactory progress achieved by the developing countries in the machine tool industry, yet, the vast technological developments which are taking place in the machine tool and metalworking industries in the developed countries, have created an enormous technological gap between the developing world and the advanced nations. Among other aspects, the technological gap seems to be more pronounced in

i) designs of machine tools;
ii) machine tool controls;
iii) cutting tool materials and tool geometry; and
iv) manufacturing systems.

3.3 Economic implication

Economic progress and development depend very largely on improvements in the overall productivity - efficient use of resources (manpower, material and capital). Hence to improve the economic health of the developing countries, it is necessary to improve the productivity of the metalworking and capital goods industry. And since machine tools and production technology are fundamental for the improvement in productivity for the manufacturing industries, production technology have to be more productive and advanced.

Labour intensive technology per se cannot be universal remedy and its applicability to all kinds of economic activities is not advisable. Furthermore, improvement in output (added value) per worker does not come entirely from the labour side.
It is to be emphatically stated that the improvements in productivity come besides manpower largely from non-labour factors through efficient use of material and capital resources. This, in the modern industry is possible mainly through better management of resources employing improved and advanced technology.
Backwardness in metalworking and the rest of manufacturing industries of the developing countries is one of the reasons for poor industrial growth and resultant poorer growth of national economy.

B. The analysis of technological complexity of capital goods - ways and means of possible application

The importance of the relationship between technology and capital goods[1] can be assessed from a two-fold point of view: First, the production of even the simplest capital goods requires some key technologies such as foundry, forging, machining, etc.. Without really mastering these technologies at an adequate level they may be an obstacle to further acquisition of more sophisticated technologies.

Second, with respect to technology as such it appears that capital goods constitute a key factor for its progress and diffusion, not only because of the "embodied technology" in capital goods but also because it is a basic prerequisite for technological innovation.[2] As a matter of fact any **technical** invention requires either new machines or adaptation and use of the existing ones in the production of goods or technologies of production for social use, i.e. **innovations.** It can be further said that capital goods are an important source of external economies for the society as a whole as any major economic progress in this area is of benefit to all the user-sectors of economy.

These considerations have various effects on the technological policies of developing countries and on their efforts to create or expand the capital goods industry:

a) The identification of the key technologies needed to possess a minimum level in the capital goods sector is of interest to national policy-makers optimizing the chances of successfully orienting fundamental technological choices. In this respect technology should not be taken only as a static

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[1] Cf. "Technology in the Service of Development", ID/WG. 324/4 presented at the Warsaw Global Preparatory Meeting, November 1980.

[2] N. Rosenberg, Perspectives on technology, CUP, 1976.

constraint but also regarded as a leverage: in various cases scientific progress has simplified the technologies of production and conception and, accordingly, their assimilation. These elements have to be employed systematically wherever possible.

b) The possession of a capital goods industry is perhaps the only possibility for developing countries to develop their own labor-intensive production technologies[1]. It is a recognized fact that most modern up-to-date technology was thus far directed mainly towards labour saving, which can be explained to a certain extent by the scarcity of the human element in developed countries[2] as compared to the abundance capital and energy resources, all of which are basic elements in production functions. For example, the capacity of developed countries to produce successfully better energy/resources-saving technologies and less intensive energy/resources goods lies eventually with their strong capital goods industry.

If the possibility and economic viability of persuing an industrialization pattern other than that followed by the already industrialized countries is still open to discussion, its social benefits, particularly an impact on employment in developing countries, are obvious.

Finally, the capacity of developing countries to assimilate and master these technologies and to avoid a mimetic transfer will depend to a large extent upon the presence of a sufficient base in the capital goods industry.

This chapter deals essentially with the first point, namely on the identification and use of key technologies of production. This gives rise to the following questions:

1) What are the basic key factors for the production of capital goods (para 1)?

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[1] Ibid, N. Rosenberg.

[2] The phenomenon of technological progress directed towards labour saving is clear in market economy countries. It is also basically the same in the centrally planned economies: Cf. The third world and Scientific and Technical Progress, V.L. TYAGUNENKO (Ed.). NAUKA, 1976.

2) Some capital goods are clearly more difficult to produce than others. How can this be taken into account in the selection of goods to be produced (para 2)?

3) Various groups of capital goods are of special interest to developing countries, e.g. agricultural machinery, equipment for food-processing, equipment for energy production, etc.. What are the possibilities and consequences for developing countries if they adopt a selective growth in those subsectors? What will be the further impacts on the enlargement of their industrial base (para 3)?

4) To which extent may the analysis of production of capital goods be useful in orienting major technological choices at the policy-making level (conclusions) ?

1) Technologies for the production of capital goods

The world of machines is extraordinarily complex. Each generation has created new machines which are then added to the stock of man's means of production. The number of these has increased prodigiously during recent decades. The machines result from the association of multiple production proeess and thousands of technologies in specific combinations. However, these required technologies can be classified into a limited number of meaningful types as described below.

In addition, at the production level an enterprise producing capital goods does not necessarily possess all the technologies required for the production of specialized parts, components, or for some specific services. Instead it relies partially on other firms which are either nationally based, thus constituting parts of the industrial network, or are located abroad because it is more economic to participate in international co-operation.

This leads to the "Simplified Model" described in diagram No. 1, where three basic block of production factors are distinguished:

a) The central production block A is the production unit which supplies the completely assembled product to the client.

b) The infrastructure block B consist of the semi-products and technical services provided by third parties.

c) The components block C lists the parts which are usually furnished by specialized firms.

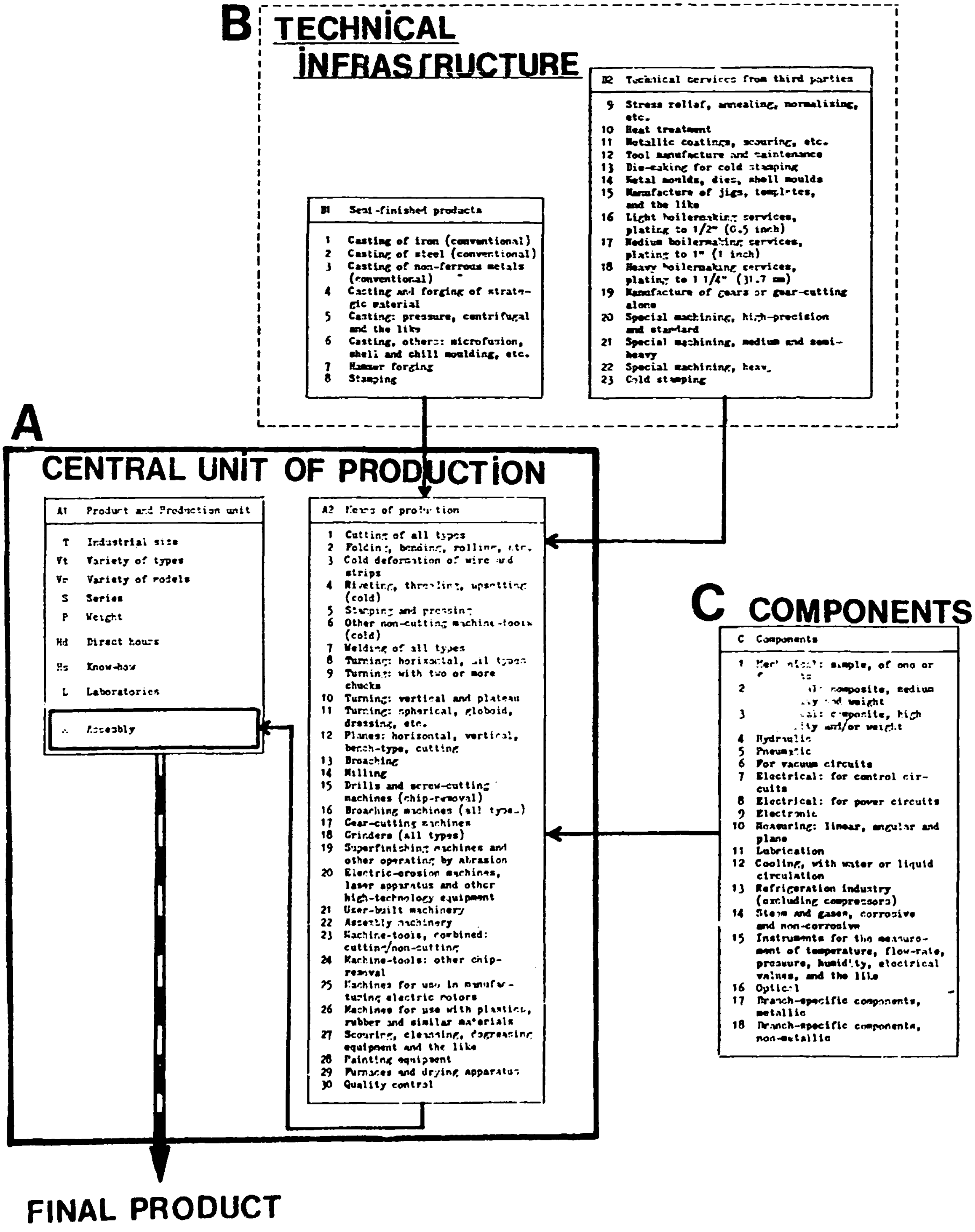
Needless to say, this disposition is subject to differences among countries, or even among enterprises manufacturing the same capital goods in the same country. Therefore, the most important thing is the identification and the content of the 80 factors which directly or indirectly enter into the process of production. However, this grouping has a relative meaning:

a) The central unit of production A comprises two sub-blocks: one is composed of the typical means of production (A2) and the other reflects various economic and technological factors (A1) which influence the production process e.g. management, size of series, know-how, etc.. It can also be said that (A2) represents the "Hardware" and (A1) represents the "Software" for the production of capital goods.

b) The infrastructure block B can function for various capital goods enterprises or even consumer durables enterprises. In the absence of such specialized enterprises, the function of this block could be assumed by the capital goods enterprises which will contain specialized units to perform those services or provide the semi-finished inputs. This is the case in many developing countries where the industrial market is too narrow to justify specialized enterprises in those technologies, and in which the capital goods sector comprises a small number of enterprises, being only one in some cases.

Diagram No. 1

Assemblies and Sub-Assemblies of the Techno-economic Factors in the Structure of the Production of Capital Goods



B1 Semi-finished products

1 Casting of iron (conventional)
2 Casting of steel (conventional)
3 Casting of non-ferrous metals (conventional)
4 Casting and forging of strategic material
5 Casting: pressure, centrifugal and the like
6 Casting, others: microfusion, shell and chill moulding, etc.
7 Hammer forging
8 Stamping

B2 Technical services from third parties

9 Stress relief, annealing, normalizing, etc.
10 Heat treatment
11 Metallic coatings, scouring, etc.
12 Tool manufacture and maintenance
13 Die-making for cold stamping
14 Metal moulds, dies, shell moulds
15 Manufacture of jigs, templates, and the like
16 Light boilermaking services, plating to 1/2" (0.5 inch)
17 Medium boilermaking services, plating to 1" (1 inch)
18 Heavy boilermaking services, plating to 1 1/4" (31.7 mm)
19 Manufacture of gears or gear-cutting alone
20 Special machining, high-precision and standard
21 Special machining, medium and semi-heavy
22 Special machining, heavy
23 Cold stamping

A1 Product and Production unit

T Industrial size
Vt Variety of types
Vm Variety of models
S Series
P Weight
Hd Direct hours
Hs Know-how
L Laboratories

A Assembly

A2 Means of production

1 Cutting of all types
2 Folding, bending, rolling, etc.
3 Cold deformation of wire and strips
4 Riveting, threading, upsetting (cold)
5 Stamping and pressing
6 Other non-cutting machine-tools (cold)
7 Welding of all types
8 Turning: horizontal, all types
9 Turning: with two or more chucks
10 Turning: vertical and plateau
11 Turning: spherical, globoid, dressing, etc.
12 Planes: horizontal, vertical, bench-type, cutting
13 Broaching
14 Milling
15 Drills and screw-cutting machines (chip-removal)
16 Broaching machines (all types)
17 Gear-cutting machines
18 Grinders (all types)
19 Superfinishing machines and other operating by abrasion
20 Electric-erosion machines, laser apparatus and other high-technology equipment
21 User-built machinery
22 Assembly machinery
23 Machine-tools, combined: cutting/non-cutting
24 Machine-tools: other chip-removal
25 Machines for use in manufacturing electric motors
26 Machines for use with plastics, rubber and similar materials
27 Scouring, cleansing, degreasing equipment and the like
28 Painting equipment
29 Furnaces and drying apparatus
30 Quality control

C Components

1 Mechanical: simple, of one or [illegible]
2 [illegible] composite, medium [illegible] and weight
3 [illegible] composite, high [illegible] and/or weight
4 Hydraulic
5 Pneumatic
6 For vacuum circuits
7 Electrical: for control circuits
8 Electrical: for power circuits
9 Electronic
10 Measuring: linear, angular and plane
11 Lubrication
12 Cooling, with water or liquid circulation
13 Refrigeration industry (excluding compressors)
14 Steam and gases, corrosive and non-corrosive
15 Instruments for the measurement of temperature, flow-rate, pressure, humidity, electrical values, and the like
16 Optical
17 Branch-specific components, metallic
18 Branch-specific components, non-metallic

However, when the market is growing this may provoke, under certain conditions, the creation of autonomous enterprises in those technologies[1].

c) The component block C is composed of those specialized parts which can be purchased more cheaply from outside firms. Here again it is theoritically not impossible for a single firm to produce, for example, its own screws, bolts or nuts. However, this is hardly the case even in developing countries with infant capital goods industries for it would represent a dispersion of resources. For the very sophisticated parts, such as ball-bearings, the developed countries themselves do have intensive exchanges reflecting the specialization of some enterprises/countries in the international division of labour[2]. In most of the cases the majority of those components, particularly the sophisticated ones, will be imported by a developing country.

2) The complexity involved in the production of capital goods

a) (The definition of the complexity of production of capital goods)

It is commonly known that, even if two different capital goods use the same basic technology, e.g. heat treatment for various parts, the level of difficulty in each case may be different. This could also be the case for different parts of the same capital good using the same technology.

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[1] Basically by backward linkages; however, this is not automatic as outlined by A. HIRSCHMAN, The Strategy of Economic Development, Yale University Press, 1966. As a matter of fact, when such a specialized firm is created, the capital goods producers may be reluctant to rely only on one supplier. See also in George Stiegler (quoted by ROSENBERG. Op. Cit). "The division of labour is limited by the extent of the market" in the Journal of Political Economy, June 1951.

[2] For this specific item the prominence of Japan and Sweden is known in market developed economy. In the CMEA countries the repartition of the production of the"2549 types"is organized by the organization for co-operation in the ball-bearing industry. Cf. Marie Lavigne Strategies des pays socialistes dan l'échange international. Economica, 1980.

When assessing the difficulty of production of a specific capital goods one has therefore to proceed in three steps:

1) To identify which of the 80 factors are used. Some of those 80 factors are always used, e.g. size of enterprise, number of models, and others are not used for some capital goods.
2) To assess the level of difficulty for each of the factors which are used: for that, each factor has been given a certain number of levels of difficulty, six for all of them, which reflect either the difference in operation intensity or the difference in the nature of the operation.
3) To quantify the difficulty involved in the use of each specific factor of production. Each level of difficulty in a factor of production has been given a standard score reflecting an empirical appreciation based on experience in the sector .

Finally every capital good can receive a quantitative assessment of the difficulty to produce it: It is obtained by summing up all the scores of the factors of production it used[1/].

With the same procedure of summing up within each block of factors A, B, and C one can reach to the score of difficulty for all the Blocks used (A = Hardware +Software, B = Technical infrastructure, and C = Components).

By definition the global score of difficulty of production for a specific capital good is called its <u>total index of complexity of production</u>.

[1/] This procedure has some common features with job classification methods and job - rating through which one can compare very different jobs. Correctly used, and in the right context, it can be a useful tool for management of human resources at the enterprise level. See "Technology in the service of development"(op. cit) for the precise definition of all the 80 factors.

The same definition applies for each of the partial Block scores of difficulty of production.

Finally in order to have a more flexible tool the scoring was not applied to a specific capital good but rather essentially to fairly homogeneous groups of capital goods, such as " hand tools" or "diesel engines up to 500 HP". For production factors this automatically leads not to a single score but to a range of scores where the minimum indicates the lowest technological option and the maximum the highest. Using the same summing-up procedure described above one can calculate various minimum and maximum indices of complexity for a given homogenous group of capital goods. This scoring method was actually applied to 318 groups of capital goods which may be taken as a fair sample of the diversity in machinery and equipment[1].

b) Graph 1, where the groups of capital goods have been positioned according to their average complexity (i.e. average of the maximum and the minimum of complexity) shows the already-known heterogenity of capital goods.

At this point the most striking feature is the increasing role of components with overall increasing complexity, which is of specific interest to those developing countries expecting to expand sooner or later into complex products. This possibly means, and more likely implies, that production of complex capital goods requires imports and, more specifically, external exchanges of components. Such necessary interdependence may be in the form of an intra-regional or interregional division of labour and would appear to be a must especially for small and medium-sized developing countries.[2]

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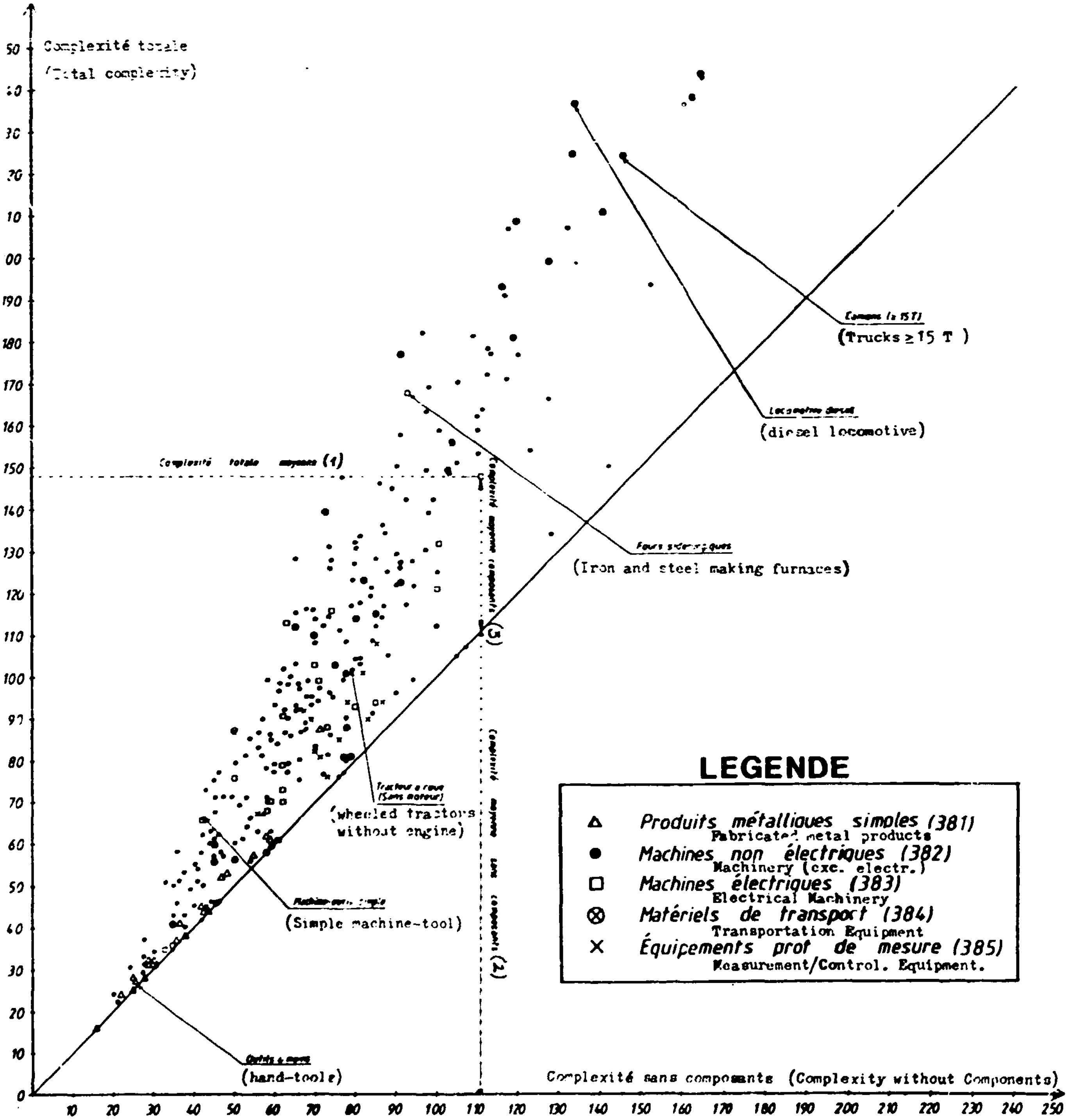
[1] See the list of groups capital goods in "Technology in the Service of Development" (Op. Cit)

[2] A typical case of this situation is for example the Republic of Korea. The dependency on imports for the production of machinery (defined as the ratio of imported intermediate inputs to total inputs) has evolved sharply from 1960 to 1973 from 13.5 per cent to 34.9 per cent (17.5 per cent and 27.5 per cent respectively for manufacturing as whole). Input-Output tables for 1975, Bank of Korea, 1978.

GRAPHIQUE No 1

DISPERSION DES COMPLEXITES TECHNOLOGIQUES DES BIENS DE CAPITAL

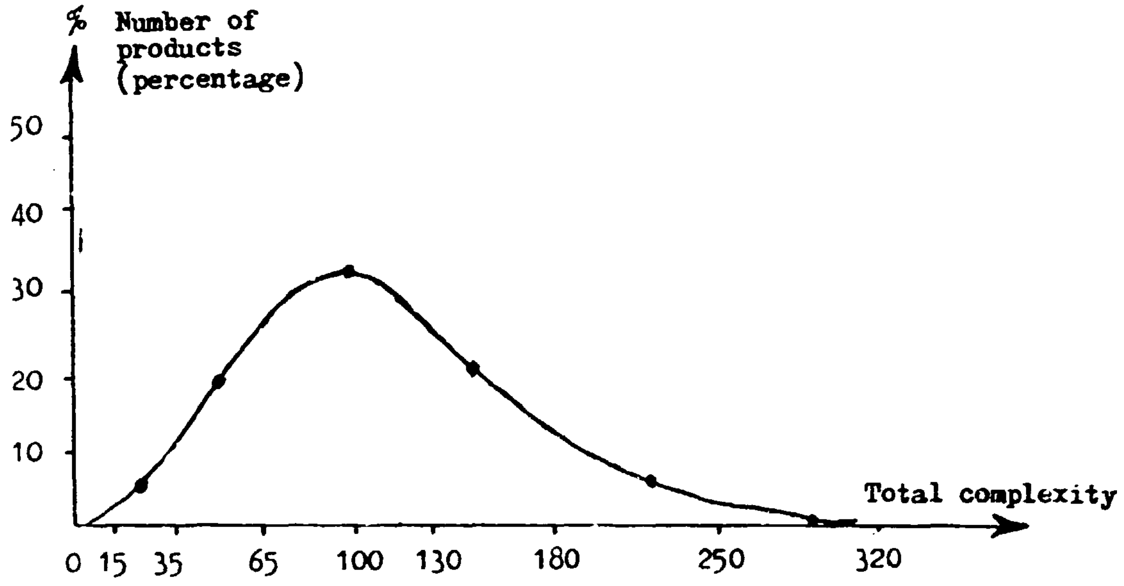
(DISPERSION OF TECHNOLOGICAL COMPLEXITIES
OF CAPITAL GOODS)



1) Average of total complexity
2) Average of complexity without components
3) Average of complexity of components

c) Taking now the range of indices of complexity among capital goods into consideration, a high level of dispersion is revealed.

The distribution of the results is shown in the following graph:



About 85 per cent of the products in the sample fall within the range of 35 - 180, which represents a dispersion of 1 to 5. At the two extremities only 6 per cent of the products [illegible] complexity less than 35, with 9 per cent greater than 180.

These observations lead to the following remarks:

- The wide dispersion of capital goods is likely to reflect also various discontinuities. They will be identified in chapter 3.
- There are indeed many simple or average complex capital goods which are accessible to a great number of developing countries within a sufficient period of time. Among them one can find a good number of

agricultural machineries, structural elements for buildings...,etc.. They will also be analyzed in chapter 3.

3) Technological complexity for various major groupings of capital goods

a) Analysis of basic discontinuities in capital goods

The object of this para is to analyze how envolve the importance of the main blocks, i.e. the block of the central production unit (A), the infrastructure block (B) and the components block (C), when the complexity of the capital goods to be produced is increasing. As has been already seen, the components influence on the overall complexity of the product increases with the complexity.

In order to have more clearcut results, the various capital goods groups have been grouped in six classes in increasing order of complexity as given below:

Definition of the 6 levels of complexity for Capital Goods and examples

Name of the level	1	2	3	4	5	6
Range in terms of index of complexity	between 0 and 30	between 30 and 55	between 55 and 100	between 100 and 180	between 180 and 320	above 320 a/
Examples	Hand tools (30) b/ Stoves (25) b/	Heavy stamped parts (38) Seed drill (50)	Boiler for heating water (64) Equipment for bakeries (80)	Rolling mills (157) Wheeled trac. up to 25 Hp (Without eng.) (101)	Trams cars (194) Equip. for oil drilling (288)	Twin-engine turbo prop.up to 25t (460) Twin-engine jet (620)

a/ In practice the index of complexity does not exceed 650, the maximum is attained by the twin-engine jet and the minimum 15 by simple metallurgical capital goods.

b/ The figures in brackets show the approximative complexity for the capital goods given as examples.

As seen above, the rate of increase of complexity from one class to another is high and of an exponential type, so that the relative changes, and possible discontinuities, if any, in the influence of the blocks A, B and C will be of the most apparent type.

The results given in table 18(annex) for each level or class represent the average of complexity for the groups of capital goods which belong to this class. Examination of these results leads to the following observation:

a.1) The rise in the total complexity is accompanied by changes in the industrial fabric constituted by assemblies A (central production unit), B (technical infrastructure and C (components): At levels 1, 2 and 3, A dominates; at level 4, B and C become equally important while at levels 5 and 6 the influence of components C in the total complexity becomes preponderent.

As a result two fundamental discontinuities are identified:

- First, one major discontinuity appears when one wants to shift from production of capital goods of levels 1, 2 and 3 to capital goods of an higher grade. The difficulty represented by A (Hardware + Software) takes on relatively speaking less importance when one moves from the level 3 upwards.
- Second, another type of discontinuity is obtained from products of level 4 to products of level 5 or 6. The major reason for this lies clearly within the role of components which dominate in these sophisticated products. This is generally of great significance for products with a high technological content for which a very dense network of industrial relations is needed in order to obtain very specialized parts.

a.2) The pivotal role played by the block A for the first three levels can be further clarified by the relative evolution of its two subblocks A2 (Hardware) and A1 (Software):

- At level 1 the influence of the Hardware on the total complexity is dominant, followed by the influence of Software. The technical infrastructure and components exercise a smaller influence.
- At level 2, the influence of Hardware remains high, as does also that of Software. The influence of technical infrastructure and of components increases.
- At level 3, the influences of Hardware, Software, technical infrastructure, components are equalized. However, the central production unit i.e. (A1 + A2), Hardware and Software, continues to exert the greatest role with a little more than half of the complexity.

a.3) Specific role of the technical infrastructure

Close observation of the role of the infrastructure B along the various levels of complexity, reveals that its role increases from level 1 to 3 and remains relatively stable at levels 4 and 5 and declines at level 6. Although there is no major rupture among the six levels of complexity, it would seem that a good level of infrastructure is a basic prerequisite for production at levels 3 or 4 upwards. Inversely, the relatively low importance of this infrastructure for the simplest product leads to the following suggestion: It may be sufficient when restricting oneself to product of levels 1 and 2, to install the internal capacity for capital goods production (A) and prepare adequatly the infrastructure (B) for further progress at higher levels of complexity.

In order to pin-point the above a simulation exercise was carried out which shows that complete mastery of the manufacture of all the products of level 1 necessitates already approximately 50 per cent of the 80 factors. In addition mastery of level 2 implies the inclusion of another 27 factors which, added to the foregoing, amounts to more than 80 per cent of the factors. Attaining level 3 requires practically all factors.

From level 3 onwards the structure of the production apparatus is made from the point of view of the existence of the necessary factors of production. This means that from level 3 upwards the increasing possibility of the production system for manufacturing more complex products is derived almost solely from improvement or increased mastery of already existing technologies and not from the introduction of new ones; this is of course of special interest since at level 3 roughly 40 per cent of all types of capital goods can be manufactured.

It can be therefore suggested that the basis of the industrial fabric is constructed at levels 1 and 2. It is the first accumulation at these levels which allows a considerable gain in the number of machines produced, and in complexity, at level 3. From this levels upwards the increasing mastery of the existing factors of production makes possible the increase in the number of the more complicated machines.

b) Analysis of various groups of capital goods

Various groups of capital goods are of specific interest for developing countries, such as agricultural or food-processing equipment, which are typically produced solely for the use of one important economic sector. It is also necessary to consider classes of capital goods which are used by many or all sectors. In this group are found for example, small mechanical components, some electrical equipments, machine tools, etc.. This class of capital goods common to all branches is of special interest for developing countries of small or medium-sized domestic market. As a matter of fact those goods being used by all branches have greater possibilities for reaching broader markets than goods specific to only a single branch.

Graphs 2, 3 and 4 (annex) show those various classes and their average complexity. At the same time the minimum and maximum are given.

The results and the graphs make it possible to infer various selected statements[1] which should be considered more as suggestive guidelines than formal rules:

b.1) Analysis of capital goods according to final demand (branch specific, common to some branches, common to all branches)

The mean complexity, without components, of capital goods considered according to the nature of the demand, does not seem to vary significantly within the three groups considered. In addition within each group of capital goods there exist real technological alternatives which make it possible to modify the levels of complexity downwards or upwards.

In particular the mean complexity of goods common to all branches is less than that of the mean of all capital goods. The weight of the components is less, but the dispersion of complexity is considerable. There is a technological gap between the products of low complexity and the others. This last statement is clarified by graph 5. Here again it is useful to emphasize again the importance of this group which could constitute a way of entry into capital goods industry for certain developing countries.

If the capital goods specific to one branch are now considered (Cf. graph 4) one can notice the relatively low complexity of agricultural machineries, food-processing equipments and the very high complexity of transport equipment. Also worth to

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[1] More detailed results are given in the UNIDO document "Technology in the Service of Development" (ID/Wg. 324/4) quoted above.

be noted is the high complexity of equipments for production of intermediate goods (mining, iron and steel, chemicals and petrochemicals, etc.).

Considering now specific sectors of interest, especially agricultural machinery, agro-based industry equipment and building and building materials equipment provides other interesting indications. The idea of comparing the technological complexity of these three sectors arises from the following facts: all the developing countries demonstrate a type of agriculture which for several of them, constitute the almost unique if not the principal activity. As a result with regard to agriculture, it would seem worthwhile to study the complexity of the upstream industries, agricultural machinery and the downstream agro-based industries. Those three sectors of economy are therefore constituting a coherent "block of development".

Also of interest are the capital goods intended for the building and building materials industries since every developing country also has to face the problems of building and town planning.

Graph 4 leads to the following observation:
The mean complexity of agricultural machinery is lower than that of the capital goods intended for the building industry and the building materials industry. The mean complexity of equipment goods intended for the agro-based industries is higher than the previous one. These three categories of equipment goods have a complexity which is lower than the mean of capital goods specific to final demand sectors. The gap in complexity without components between agricultural machinery and building is reduced and suggests because the principal technological routes are the same the possibility of joint production. By contrast the gap is greater with capital goods intended for the agro-based industries. For a complete picture of these three capital goods subsectors, i.e. agricultural machinery,

agro-based industries equipment, and equipment for building and building materials, Graphs 6, 7 and 8 (annex) in the Annex should be consulted. Their observations make the following inferences possible:

The group of equipment goods for the agro-based industries has not only a higher complexity than that of agricultural machinery, but also a wider dispersion. The simplest consist of equipment goods with a mechanical predominance. The most complex consist of equipment goods linked to the operations of packaging and production processes with a predominantly bio-chemical character.

The group of equipment goods for the building and building materials industries has a complexity and a dispersion which are higher than that of agricultural machines and equipment for the agro-based industries. The simplest part of these equipment goods is of a complexity similar to that of the lower part of the sample of agricultural instruments and machines.

b.2) Analysis of capital goods according to the international classification ISIC. (at the 3-digit level):

Graph 2 shows clearly the average results for each of major groups (381, 382, 383, 384 and 385). It emphasizes also the anticipated low complexity of fabricated metal products and the already known complexity of transport equipment. Some reservations should be made however, as regards the forthcoming of electrical machinery (383) for which the sample comprises only machines of a rather simple type[1].

b.3) Analysis of capital goods according to their function in the process of industrial production:

This classification involves considering machines according to their possible functions within the process of industrial production. In this way certain capital goods are of a semi-finished type (and hence can also be used as intermediate

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[1] This part of the sample is being improved by the on-going research.

products, such as stamped components), whereas others are goods which may be used in other machines where they constitute sub-systems (e.g. clutches, speed variators, etc.), others are really autonomous finished products (e.g. engines, turbines), while others are finished but integrated products (equipment for petrochemicals, for example). This leads to a functional classification.

Following this grouping the general observation of Graph 2 confirms what was expected. However, the very low complexity of the semi-finished products (mainly included in the group 381 of the international classification ISIC) is of interest since this group is also a main supplier to all other subsectors of capital goods. Its importance is related to the fact that it comprises most of the products belonging to the "second transformation of metals".

At this stage it is interesting to cross the preceding groupings of capital goods and the major levels of complexity (one to six).

c) Repartition of the major groups of capital goods among the six classes of complexity

Before analyzing the repartition of the various groupings of capital goods among the levels of complexity it should be observed that most capital goods are concentrated at levels 3 and 4. (Cf. chapter 2). However, the repartition naturally differs for the various classes of capital goods as considered above. (Cf. table 19 in annex).

c.1) If one considers class 38

- 80 per cent of the simple metallurgical products (class 381) are situated at levels 1 and 2.
- Of the non-electrical machines (class 382) 80 per cent are in levels 3 and 4, and the same applies to 73 per cent of the electriaal mcchines.

- Of the transport equipment 85 per cent is divided between levels 3, 4 and 5, mainly in the latter two classes, and nearly 10 per cent are at level 6.
- Control and monitoring equipment is 100 per cent at levels 3 and 4, 85 per cent being at level 3.

Towards the top of the complexity range, the simple metallurgical products stop at level 4, while electrical machines and equipment and those involved in control and monitoring stop at level 5.

Towards the bottom of the complexity range, electrical machinery and equipment do not begin until level 2. The same applies to transport equipment, while control and monitoring equipment and apparatus begin at level 3.

c.2) If one considers capital goods from a functional and technical point of view it can be seen that:

- all the semi-finished products are in classes 1 and 2;
- practically 80 per cent of the parts and sub-assemblies are at levels 3 and 4, with 50 per cent at level 3;
- more than 70 per cent of the autonomous equipment and machinery falls within the same ranges, with more than 40 per cent at level 3;
- more than 85 per cent of the equipment integrated into a complex process is also at levels 3 and 4, with more than 55 per cent at level 4.

Towards the top of the complexity range, semi-finished products stop at level 3, parts and sub-assemblies stop at level 5 and integrated equipment at level 6.

c.3) If we consider now capital goods from the point of view of the demand:

- more than 90 per cent of goods common to all the branches are contained in classes 2, 3 and 4, class 3 accounts for 50 per cent of these;
- more than 80 per cent of the goods common to several branches are found in classes 3 and 4, mostly in 3;
- less than 70 per cent of the specialized goods are also in these classes, but the remainder occupy all the other levels; this is the only case where this phenomena is observed.

. Concerning goods common to all branches:

- towards the top of the complexity range they do not go beyond level 5;
- towards the bottom of the range their production only appears to begin at level 2.

Graph 3 shows that at level 2 of total complexity one finds within the goods common to all branches, small mechanical components and the steel elements for building. At level 3 small electrical equipment, miscellaneous equipment and materials, pumps, compressors and boilers, mechanical parts and sub-assemblies and storage and handling equipment. At level 4 are the universal machine tools, engines of all kinds, road transport equipment and office equipment.

In the case of the specialized equipment goods graph 4 shows that:

- at level 3 of total complexity agricultural and food industry machinery and, at the limit of levels 3 and 4 are located the capital goods for the chemical and petrochemical industry;
- capital goods for the building and the building materials industries, the engineering industry, the extraction of minerals, agricultural, and heavy metallurgy industries and road transport equipment are found at level 4;
- rail transport equipment is located at level 5;
- air transport equipment is found at level 6.

d) Some conclusions and recommendations on strategic options for entries and development in capital goods production

d.1) Observed practices and analyses of industrial policies show that the main strategic options for entering and expanding in capital goods production eventually articulate with three sets of different (but not indepcndant) components:

- Selection of some, or even one, subsector(s) of capital goods of high priority for entry and growth.
- Selection of specific capital goods or groups of capital goods to be produced at various stages.
- Selection of the technologies for the enterprises constituting the productive apparatus in the area of heavy industries (iron and steel industry, foundry, forging, pressing, machining, etc.). The combination of those technologies constitutes the technological production route and concerns as well the technical infrastructure, the various central units of fabrication and the components types.

It should be noted that the above classification of components constituting the basis of the "strategy-mix" does not always suppose their explicit character.

The interdependence of these choices will be examined with respect to the preceding results and will not only contribute to the identification of real opportunities of entries but also, highlight risks associated with various situations.

In practice those interdependences manifest themselves clearly when one of this type of component is prevailing on the other two, constraining them, which leads to "pure" strategic options being understood that under the variety of situations and goals facing by countries the concrete strategies for capital goods industries are a mix of these "extreme" options:

1. Type I: Pull approach by priority user sectors

   In this case the dominant choice is exerted by the final user sectors which by their priorities induce the choice of selected subsectors of capital goods.

   For many developing countries,one such priority sector may be the agricultural machinery sector.

2. Type II: Pull approach by import substitution/export promotion

   This case relates to choice where special importance is devoted to selected capital goods for their weight in imports or their potentialities for export.

3. Type III: Push approach by the strengthning of the production structure

This is the option where first concern is the mastering of the technologies of production and especially the technical infrastructure B "Heavy industries" and all the processes which are downstream to it, i.e. block A "machining, surface treatment, etc.."
The very logic of this line of action, where the building up of the apparatus of production is the first objective, may lead to the simultaneous mastering of the metal industries and particularly of the iron and steel industry.

Bearing in mind the basic objective of enlarging the industrial base type I and type II may be characterized as "pulling" approaches while type III is a "pushing" approach.

The synthetical tables I, II and III of the following pages describe various advantages and disadvantages of adopting such typical options. Various remarks can be inferred which may be of interest for small and medium-sized developing countries willing to enter and expand a capital goods industry.

The various historical experiences of developing countries having achieved significant breakthroughs in capital goods industry show that the three types of strategic options were adopted either separately during different periods of time or simultaneously.

It seems therefore that there is not an unique normative way of entry in capital goods production but a wide number of possible entries. The challenge for small and medium-sized developing countries willing to enter in capital goods production is to operate over a sufficient period of time, the "best" combination of the approaches described above with respect to their economic and social conditions and objectives, the potentialities offered by international co-operation and the real technological complexities of the capital goods.

d.2) Some historical experiences may illustrate this statement:

Bulgaria, which was in 1944 mainly an agricultural country, has built up in around 30 years a substantial base of capital goods industry. One of the axis of its economic policy was an emphasis on agriculture mechanization and food-processing[1] (type I) and to a less extent on heavy industries of the infrastructure (type III)[2]
The structure of its trade with other CMEA countries, which reflects Bulgaria's relative poor endowment in mineral resources, shows that Bulgaria is still relying on other countries and importing steel and complex products such as trucks and tractors (though various types are produced locally since 1970). However, Bulgaria has particularly since the mid 1960s developed exports in fields where it has an acknowledge expertise (type II) such as: food-processing equipment, some types of machine tools, electrical equipment[3]. At present Bulgaria imports of capital goods are roughly balanced by exports of the same.

Korea Rep. of, of which the industrialization is more recent, has demonstrated since the late 1950s, an important success in capital goods production with a strong support of the state. It appears that the early phases of rapid industrialization were characterized by a composite approach of type I and II, and only later a type III approach towards the strengthening of its heavy industries was adopted, especially in the four years plan 1977-1981[4]

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[1] In 1977 Bulgaria was in value-added among the first 15 countries in the world in food-processing and beverages. See Industrial Development Survey (forthcoming).

[2] See (for various) "Bulgaria Industrialization and farm mechanization under socialism" by I.A. Zakhariev in "Economic Development for Eastern Europe" (Ed. MC. Kaser, 1968).

[3] See UNIDO study: "Development of the capital goods in Bulgaria" and "Trading with Bulgaria", US department of commerce, March 1980.

[4] See "The role of the state in the Economic growth of Korea, P. Judet, 1980, in No. 14 Revue d'Economic Industrielle.

The type I approach is particularly apparent with the textile industries where by its relative low wages, Korea reached a competitive level in this industry. This called for production of textile machinery through an upstream movement from simple assembling to more complex production operations[1]. Also since 1962 strong emphasis has been put to self-reliance in food which calls for production of agriculture machinery and fertilizers.

The type II approach is typical in electrical and electronic equipment for exports where the degree of integration varies from products to products due, to a certain extent, to the complexity of the products.[2]

<u>India</u> with its large endowment in national resources and very qualified labour has after a phase of strengthening its civil infrastructure emphasized a type III approach and also an import-substitution option (type II).

The second plan 1956-1961 which was based on the model of Pr. Mahalanobis says explicitely "the expansion of the iron and steel industry has obviously the highest priority..., heavy industries are a natural corollary of iron and steel works..., in this context the creation of certain basic facilities such as the establishment of heavy foundries, forges and structural shops is absolutely necessary..., (because they) constitute an essential and primary phase of development for the manufacture of heavy industrial machinery.... An important prerequisite for

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[1] Also chemicals industry received, especially after 1970, strong backward linkage effects from textile. However, the impact of textile alone was not enough to create a very diversified industry: for example the key linkages dissimilarities between Japan and Rep. of Korea are in Chemicals(mainly pulled by textiles), iron and steel and electrical machinery. See "Economic development and changes in linkages structures: An input-output analysis of Korea Rep. of and Japan by Y. Torii and K. Fukasaku, 1979, Conference on Input-Output techniques,Innsbruck, Austria.

[2] See"Korea", a World Bank Economic Report, 1979, pages 252-3, "Electronic epitomizes what is found to varying degrees in other sectors. Electronics production is largely an assembly operation, and little infusion of the basic technological know-how has taken place. Korea shows the typical characteristics of a LDC within the product cycle of an industry for which technological advance is rapid. In shipbuilding, too, Korea has yet to realize the full advantage of having a local design capability and of producing associated deck equipment, elements of the drive tram, and so on. In addition most of the machinery-producing sector is immature

fostering the production of heavy industrial machinery is the establishment of organizations which can undertake the task of preparing designs for plant and equipment required by heavy industries..."[1].

Elements of type I approach were also present in effort of promoting equipment for intermediate goods such as cement, chemicals but to a less extent for consumer goods. Without any doubt , India has in the long-term achieved and especially since the third five years plan 1961-1966, a strong mastery of very complex technologies particularly in the heavy electrical equipment[2] and machine tools.

d.3) Those selected positive examples and others suggest that a comprehensive approach of type III has been successfully adopted sooner or later by countries enjoying big economic spaces[3] and with rich endowment of resources and ability to mobilize qualified labour force. On the contrary small and medium-sized countries have instead rather focused on type I and II approaches, and have in some cases adopted after some time a partial type III approach with strong complementarities with countries already possessing a wider and a more ancient industrial basis.

It seems therefore worth to raise the question if for small and medium-sized developing countries willing to enter capital goods production the problem is not to adopt a well balanced type I and type II approaches but complemented at the international level, and for the reason of transportation costs at the regional level, by a type III approach?

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[1] See "Development of capital goods sector in India" by K. Paramesvar presented at the Warsaw meeting in November 1980.

[2] See Bharat heavy electrical limited: A case study by K. Paramesvar, November 1980.

[3] It is also the case for Brazil, see "The Brazilian Capital Goods Industry 1959-1964"; chapter IV, by Nathaniel Leff. Harvard University Press. and China, see "development of Capital Goods in China", by Li Yong-Xin.

For type I the priority sectors may be of three kinds:

Consumer goods: a very favourable subsector for growth is indeed agriculture machinery possibly complemented by food processing machinery and equipment. The position of this subsector of capital goods is unique in the sense that due to the rigidity of the agricultural operations it contains almost all the generations of equipment (hand tools, animal-drawn implements, fixed equipment of all types, intermediate and highly mechanized equipment). Because of the low complexity of its simple equipments it allows a progressive mastering of the basic technologies of manufacturing and makes possible the installation of some elements of the heavy industries of the technical infrastructure[1].

Apart from the car industry for which the process of production has common features with very complex capital goods (e.g. trucks, tractors), various consumer durables are also produced by the engineering industries.

The question may therefore be raised whether a "pull" approach by durable consumer goods is feasible due to a market available for a real mass consumption: the following results suggest that this solution will not

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[1] However, it is not automatic. See Industrial Revolution and underdevelopment by Paul Bairoch, SEDES, 1964. This type I approach is to a large extent an historical approach. The author demonstrates how the demand for steel for agriculture implements in Great Britain has provoked the key technological change of using coal instead of wood for iron and steel industry. It was only around 30 years after that textiles called for a demand of machinery and eventually of iron and steel products. It can also be noted that even until 1880 a good craftsmen could repair any kind of machinery (textile machinery, steam engine, or agriculture machinery). It is nowadays very difficult for a rural blacksmith to repair a tractor because of the various discontinuities introduced by the high mechanization (thermic engines) and electrical parts. Moreover in the early phases of european industrilization the emergence of a class of enterpreneurs and the construction of national capital goods industries were easier than nowadays because of the simplicity of technologies (in particular what differentiated a big from a small enterpreneur was the number of machines of the same type), the low cost of entry and moreover the high cost of transportation which made all the countries self-relient in their capital goods industry by copying (it was at that time possible) models obtained from Great Britain.

Table I: Strategic option of type I: "Pull approach b

<table>
<tr><th>Time
Products</th><th>Short/mid term</th><th>Long-term</th></tr>
<tr><td rowspan="2">Simple or average complex (level 1,2,3)</td><td>Progressive domestic mastering possible for hardware (A2) and software (A1)</td><td>Domestic mastering of hardware (A2) and software (A1)</td></tr>
<tr><td colspan="2">Creation of infrastructure B not automatic</td></tr>
<tr><td>Difficult or very difficult (levels 4,5,6)</td><td>Assembling
+
possible manufacture of some parts (A2)
+
software not dominated (A1)</td><td>Partial domination of hardware, (A2) but difficulty for software (A1)</td></tr>
</table>

NB: At the level of the technological production route this approach put emphasis on the A Block (hardware + software). For simple products A can easily be dominated in the long-term.

y priority of the domestic user sector

General characteristic

- Starting possibly difficult, low process.

Advantages

- National mastering-learning by doing for simple products(Hardware A2 before software A1)
- Weak modalities of dependance
- Possibility to develop inter-sectoral linkages

Disadvantages

- Limitation in know-how A1(for complex products)
- Creation of infrastructure B not automatic

Priority subsectors with potentialities

example Agriculture Machinery, structural elements for building, simple food-processing equipment.

Priority subsectors with difficulties

example Petrochemicals, mining equipments, complex food-processing equipment.

be a very effective one at the early stages of industrialization for developing countries having no industrial base and most of these production will only remain as assembling activities if not accompanied by other measures (of type III for example).

Example of consumer durables	level of complexity	complexity
simple kitchen gas stove	II	44
washing machine	III	80
electric iron	II	41
refrigerator	III	82
air conditioner	III	53
ventilator	II	54
metal furniture (e.g. cupboard)	II	43
electric crusher	II	46
vaccum cleaner	III	66

Intermediate goods (building materials, chemicals, iron and steel)

It appears that the high complexity of those equipment requires a long time for mastering or a strong international cooperation to speed up their production by developing countries. For example the capacity for various Latin American Countries to really enter in the production of mining equipment (at least of level 3, 4) will largely depend on regional co-operation such as the one designed by the Andean Pact[1/].

And finally capital goods itself which need for example machine tools of all types, but this can only be envisaged by most of developing countries at a further stage of development of their industrial base[2/] as machine-tools rank at least at level 3 and for most of them at level 4 upwards.

1/ See UNIDO Study on Mining Equipments.

2/ See UNIDO Study on Machine-tools.

Table II: Strategic option of type II "Pull approach by import substitution or export promotion policies"

Time Products	Short/mid term	Long-term
Simple or average complex (level 1,2,3)	Assembly line (in A) unless agreement of all sides to obtain sufficient integration	idem Creation of infrastructure(B)difficult
Difficult or very difficult	Assembly line (in A)	idem

NB: At the level of the technological production route this approach put emphasis on the easiest part of A, i.e. assembly, and may lead to complete mastery of A by an "upstream" movement.

General characteristic

- Starting may be very easy, quick process

Advantages

- Employment(but most of the time of unskilled labour)
- Some technical exchanges with foreign partners

Disadvantages

- Strong modality of dependence(if no industrial base)
- Limitation in know-how (A1)
- Risk of no creation of infrastructure (B)
- Need a good level of development for creation of intersectoral linkages

Example Simple capital goods common to all branches (electrical equipment, simple machine tool)

For option of type II which present two basic variants, import substitution or export-promotion of specific products, the possibility of creation of an industrial base is less obvious than in the preceding case.

First of all an import-substitution option requires if a real national mastering is seeked after a wide domestic market and a sufficient level of industrial base[1]. Without the later condition it generally provokes necessarily the involvment of a foreign partner which may be reluctant to support a real policy of progressive integration of the production processes, which are upstream from the simple assembly activities. This is particularly the case for complex or very complex capital goods.

For export-promotion option the association with a foreign partner is practically a necessity to have access to the international markets. As the foreign partner may be attracted by this association only by low wages conditions, it may be very difficult to have a progressive integration of the production particularly with complex products involving national inputs other than unskilled labour. Therefore the "industrializing" effect of those operations may be very low, unless the country has either already reached a sufficient level of industrialization[2] or there is from both sides a strong long-term view for reaching progressively a sufficient national integration.[3] In most cases, because in particular of the complexity of the products no linkages, either backward or forward, are created with the other activities of the countries and it remains as an "assembly activity enclave" or an "island" of complexity.

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[1] Typical products for import-substitution are capital goods common to all branches. As seen before they are mostly at levels 2 upwards.

[2] See "Offshore assembly in developing countries", National Westminster Bank Quarterly Review, April 1980, by San Jaya Lall and "Can international subcontrating promote industrialization?" in ILO Review, vol. 119, No. 3, by C. Berthomieu and A. Hanaut.

[3] As an example of the difficulty in import-substitution of complex products see "Capacity of the engineering industry in Colombia" by the Institute of Technological Research, Bogota, in "Technology and Employment in Industry", ILO, 1980.

Table III: Strategic option of type III: "Push approach by heavy industries"

Time Products	Short/mid term	Long-term
Simple or average complex (levels 1,2,3)	Limited but effective results for production of parts. (Few results in the short-term)	Mastering of all the basic technologies especially hardware(A2) and software(A1) Infrastrcture B created
Difficult or very difficult (level 4,5,6)	Assembling + production of simple parts	High level of national integration but necessity of exchange to have sophisticated know-how (software-A1)

NB: At the level of the technological production route, this approach puts emphasis on the simultaneous domination of A and B. By stressing on B this option leads on a "downstream" pattern of industrialization around the nucleus of heavy industries .

General characteristic

- very low process, few results at the beginning

Advantages

- systematic building up of the infrastructure (B)
- National integration of production very high in the long-term. (High self-reliance)
- High intersectoral linkages

Disadvantages

- strong dependence in the short-term (to establish infrastructure B)
- High cost and risk of overaccumulation in heavy industries (versus light industries)

Examples Foundry, forge and stamping, heat treatment, metal cutting ...... etc. and possibly iron and steel industries

The type III option seems very difficult to apply in the early phase of entry for developing countries of small and medium size. It is not meant by that the impossibility for those countries to acquire a nucleus of iron and steel industries and downstream activities to it. On the contrary some process like the direct reduction one permits size of units accessible to many developing countries with possibly a diversified range of semi-finished iron and steel products. It should be however, stressed that the possesion of an integrated heavy industry including iron and steel is not in the early stages an absolute prerequisite for industrialization and development of some subsectors of capital goods industry[1] in small and medium sized developing countries. The cost of building-up all the elements of the heavy industries at the domestic level may be too high as compared with other short-term pressing problems (agriculture, food-processing,... ect.). The very positive example of Bulgaria which had very successfully built up some elements of heavy industries within the framework of the division of labour within CMEA may be very meaningful. Also the case of the Rep. of Korea which entered into its heavy industries very late is worth to be taken into consideration.

Conclusions

The preceding results have already shown interesting applications of the analysis of technological complexity (ATC) in the comparison of strategies of entries and development in capital goods industry.

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[1] The analysis of the preceding chapters also shows that the main effort to penetrate capital goods industry is at the level of the block A (hardware mostly and software). The technical infrastructure plays a less important role for levels 1, 2, and 3. From levels 4 upwards of course the technical infrastructure should be already established and strong enough.

The object of this chapter is to outline the scope of application of the ATC in the orientation of technological policies for the expansion of capital goods production[1].

When planning the future evolution of the capital goods industry the policy-maker is facing essentially two problems:

a) Being given that the needs are correctly formulated, and this may require an intensive work, it is generally very difficult to have a coherent framework for the formulation of the supply.

b) Even if the future supply is assessed, it may be uneasy to design a coherent policy for the planning of technology, the establishment of programmes and finally for the selection of investment projects.

It is fundamentally to contribute to the solving of those practical problems that the ATC was created. It provides to the policy-maker three useful tools for the technological policies:

1) A coherent framework to analyse either the demand for capital goods or the supply, both in terms of the technological inputs required.
2) A system of information indicating the technological complexity of production of a wide number of capital goods.
3) A simulation tool either to analyse the pay-off (i.e. further production of capital goods) obtained by acquiring some specific technologies or to analyse which technologies are required to produce some specific capital goods not yet produced within the production structure of a country.

The diagram No. 2 shows how the ATC combined with other classical analyses permits to reformulate the future demand and supply of capital goods. This being done, and together with the strategic options of entries and development in capital goods, the ATC contribute to:

- ensure the maximum coherence between the demand and the supply
- reduce the gap between the present production structure and the required production structure.

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[1] The ATC will be used for the orientation of major technological choices facing the Popular and Democratic Republic of Algeria in its endeavour to build up a strong base in capital goods industry (June 1981).

In particular the ATC appears to be a reasonable macro-engineering tool for the identification and the evaluation of investment projects. As a matter of fact the analysis of all the potentialities of the capacities of production through the 80 selected factors allows to identify:

1) which capital goods could possibly be produced without any further acquisition of technologies

   Of course the presence of some factors of production, e.g. specialized machine tools, do not mean they can be used elsewhere because of their indivisibility. But the presence of qualified labour to operate them may be meaningful particularly if the machines are universal enough to allow a diversification of production.

2) Which supplementary capital goods could be produced with "minor" acquisition of some technologies

   This could be done by simulation by comparing the national status of the 80 factors and the "closest"[1] capital goods of the information system.

3) and finally a specific investment project can be analyzed through a coherent framework with other projects.

Also of interest is that the ATC with the identification of the 80 basic factors allows to identify which factors are really <u>introduced</u> for the further production of specific capital goods, while some others factors being already present are only improved. These two different cases do not represent the same problem in the transfer of technology as the first one may require a completely new training of labour while the second one only needs a strengthening of the already existing human skills.

x

x x

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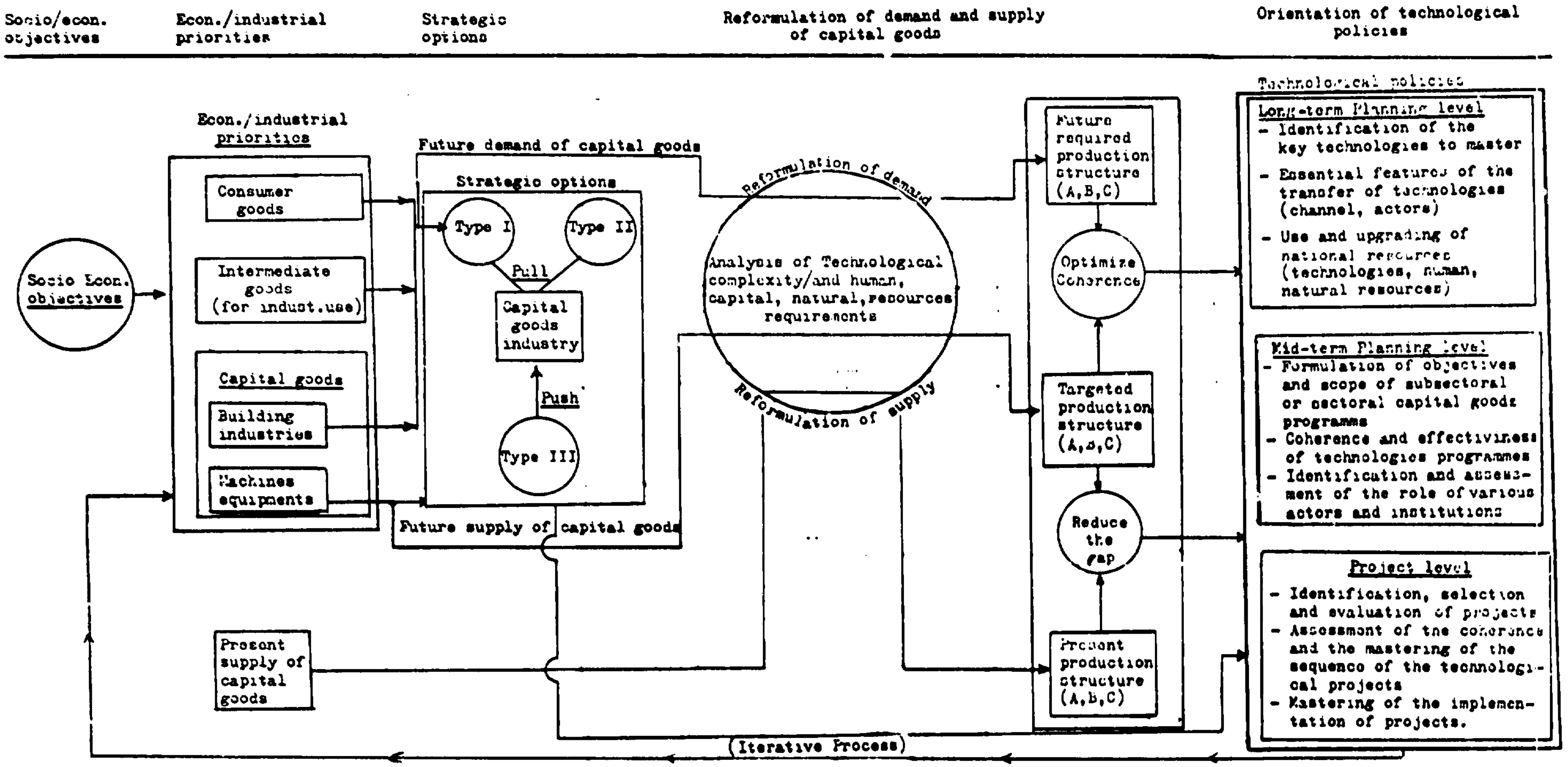
[1] Here "closest" means capital goods which requires for their production a combination of the 80 factors which is very close to the present national status of the 80 factors. The difference may only come from a few number of technological factors, say 2 or 3, which therefore may be good candidates for consideration in launching industrial projects.

Diagram No. 2



Basic methodological framework for the orientation of technological policies

1) The social & economic objectives are the starting point of the orientation of technological policies.

2) Being given the socio-economic objectives this part establishes the priorities in terms of economic and industrial policies. They are of three types:

- consumer goods
- intermediate goods
- or capital goods.

3) The priorities give shape to the strategic mix for entries and development in capital goods industry: The "pure" strategic options are:
Type I: Priority for final sectors (which should be leading sectors);
Type II: Capital goods import substitution or export promotion; and
Type III: Priority to heavy industries of infrastructure needed for capital goods production.

4) This step is to reassess the real content of demand and supply of capital goods in terms of production structure. It is done with the analysis of technological complexity (which says the needed technological factors in A, B and C, a.o) and with the analysis of human, capital and natural resources requirements. The final aim of this exercise is two fold:

- to optimize the coherence between the targeted production structure and the needs; and
- to reduce the gap between the present situation and the targeted production structure.

5) Being given the strategy mix for capital goods and the preceding analysis, this step designs the orientation of technological policies at the

- Long-term planning level,
- Mid-term planning level, and
- Project level.

Basically those orientations should be periodically confronted with the priorities to ensure economic coherence.

Part four: Some aspects of transfer of technology and engineering in capital goods

Introduction

In order to define a strategy for the transfer and acquisition of technology in a given industry it is first of all necessary to identify the various components of this technology. It is not, in fact, possible to transfer the technology of the industry in an overall manner in a "package"; it is necessary to differentiate this technology. When it involves the transfer of technology this differentiation of the technology of a given industry must be carried out by taking into account firstly the various types of supports on which the technology is introduced into and used in the industry.

These supports may be material (technology is incorporated in machines, sub-assemblies, components and intermediate goods), they may consist of written documents (design books and specifications), or again the technology may be "supported" or integrated by individuals or groups of individuals. Another characteristic of technology is also involved in the transfer of technology; this is the level of elaboration of the technology. This level of elaboration of the technology, which conditions its capacity for diffusion and transmission, can be looked at in one of two ways: from the level of conceptualization of the technology (technical know-how, technical knowledge, technological knowledge, scientific knowledge), or on the basis of the degree of socialization of the technology (socialized technology, alienated technology).

- "socialized" technology, that is to say technology which is socially available and accessible without restriction. This includes free information and knowledge of technical processes which have fallen into the public domain
- "alienated" technology, that is to say technology which is retained and only ceded by virtue of a right of ownership or by a special agreement.

Technical know-how is essentially incorporated by individuals or groups of individuals.

The privileged mode of transmission of know-how is by working and collaborating closely with the persons who hold this type of technology. The transfer of know-how is carried out through technical co-operation agreements, technical assistance and, in certain cases, by the sale of know-how licences.

In the capital goods industry (and more generally in the mechanical and electrical industries) certain written documents, the product of know-how and technical and technological knowledge accumulated by firms, play an important role in the competition between firms. These documents often have the legal status of know-how. They may consist of:

- design drawings of assemblies and sub-assemblies
- detailed execution drawings
- specifications for manufacture and assembly
- standards for desing and construction
- standards for management service.

The relative importance of the components and sub-components of the technology for manufacturing capital goods varies as a function of the following principal factors:

- product design (capital goods), whether standard or custom made
- product complexity (number of components)
- the cycle of innovation of the products
- production runs
- production routes
- the mode of evolution of production routes.

These factors are not completely autonomous in relation to the others. These is, for example, a relationship between:

- product design and production runs
- product complexity and production routes
- product design and cycle of innovation.

Implementation of a strategy for the manufacture of capital goods will necessitate special studies for each case in order to determine the components and the sub-components of the technology for manufacturing these capital goods which must be mastered as a matter of priority. The systematic and detailed list of the various components and sub-components, together with their modes of support, is the first task to be carried out in such an approach, so that it is then possible to select and rank the components and sub-components as a function of the choice of strategies for the development of products and routes.

A. Challenges involved in the transfer of capital goods manufacturing technology

When one is led to take an interest in capital goods one naturally gives priority to the material aspect, the machines, the components, the sub-assemblies and the manufacture, that is to say the hardware aspect. In a way which may, at first sight, seem paradoxical the most important aspect in the capital goods industries, and one which is often minimized, is the non-material, the supply of information, the software. This importance of software in the capital goods industries is reinforced by the dynamism of the social division of labour in the industrialized countries between the productive sectors: capital goods, intermediate goods, consumer goods.

1 - The strategic role of the capital goods industries in the mastery of software

1 - 1. The importance of software

The service and design activities, that is to say of software, are essential in the capital goods industries. In terms of number of jobs these service and design activities account for 25 to 30 per cent of the total jobs. In the consumer goods and intermediate goods industries the software activities are in general much lower, representing only about 10 to 15 per cent of the jobs.

We have been able to see, that software activities develop as a function of the complexity of the capital goods to be constructed, and that this development of software activities is carried out through a diversification of this type of activity:

- diversification of design and R and D activities;
- diversification of production organization activities: activities involving methods, planning and supplies;
- diversification of technical support activities;
- diversification of quality control activities;
- diversification of marketing and engineering of demand activities.

It is this important diversity of the software activities in the capital goods industries which makes any analysis of these industries and complex. For Professor T. Vietorisz, who spent many years in research on the capital goods industry: "These industries defy analysis and elude effective policy-making based solely on the traditional approach of tracing the flows of material resources through producing and consuming activities ..... Key issues compel the broadening of the analytic focus from material flows alone to a parallel concern with information flows, especially as embodied in organizational structure and symbolic communication systems"1/.

In attempting to understand the dynamism of operation of the capital goods industries T. Vietorisz suggested looking more to the construction of an information model which would integrate three principal dimensions: the differentiation of structures (or their diversification), external liaisons (extension and diversity of external communications), and structural integration (interrelations, flexibility).

1 - 2. A trend: the transfer of software activities linked with the consumer goods and intermediate goods industries towards the capital goods industries

The quantitative and qualitative importance (appreciated in terms of their diversity) of software activities in the capital goods industries is due in a large part to a movement of transfer of software activities linked with the consumer goods and intermediate goods industries towards the capital goods industries. This movement of transfer is the principal result of technical progress trends in the industrialized countries.

The principal characteristic of technical progress in the industrialized countries for several years has concerned the saving of labour. The widespread and general use of automation, and in particular the recent development in micro-electronics (micro-processes), has accentuated this trend of technical progress and has enlarged its impact. One of the characteristics of automation is to integrate into machines, or rather into complexes of machines, part

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1/ T. Vietorisz: "Structure and change in the engineering industries." Meeting of steel experts on the industrial and technological development of Latin America. Washington D.C. - 21-25 June, 1971. Inter-American Development Bank.

or all of the activities of preparation and work organization. If mechanization has made it possible to integrate into capital goods part of the individual skills of workers automation makes it possible to integrate into capital goods the collective work of the workers by means of the software of complexes of automated machines. The collective labour of workers in a production unit can be appreciated in an initial analysis through the total information (technical and organizational) which the production workers exchange between themselves and also with the workers in the departments dealing with the preparation and organization of production and, to a lesser extent, with workers in other departments (design, quality control, marketing, etc.). "Communication and the exchange of information was one of the characteristics of the groups of homogeneous workers who were trained on the new assembly lines or even, with more effort and difficulty, in spatial isolation, amongst the operators on a long production line. This contributed to the profits of the owner and towards improving the quality of the product, but one can consider as being positive for the worker the fact that he developed a true professionalism"1/. Through the software of automated systems for machines automation corresponds to the monopolizing of the collective know-how of the workers2/ by capital. Now, through automated systems of machines, the "collective know-how confronts the workers: "With the widespread use of electronic systems for process control communication is often replaced, where it exists, by an exchange of information with the computer or with the data processing terminal; the possibility of centralized control in this way is recovered. Better still one eliminates the human intermediary, which can introduce errors into transmission, from the hierarchy of the enterprise; finally this control is effected in real time"1/.

1/ Angelo Dina, La situation actuelle en Italie (The present situation in Italy), Bulletin of the Fondation Renard. Dossier post-Taylorisme, No. 88-89, May-June 1978.

2/ Automation has often been presented as the replacement of the mental activity of man by machines. This type of transfer corresponds rather to the process of automation which is situated in the same logic as mechanization at the level of replacement of the physical force of man.

It is also under the impulse of the widespread and generalized use of automation that innovation in the consumer goods and intermediate goods industries is increasingly taken over by the capital goods industries. The capacity of the manufacturers of capital goods to master the introduction of automation in their machines, to propose new automation processes already partially automated, is one of the increasingly strategic factors for competition for manufacturers of capital goods.

It is again under the impulse of automation which transforms the processes of batch production into processes of continuous production that final clients have not yet been capable of mastering the design of industrial complexes through their new works departments. The widespread and general use of automation has resulted in the creation of autonomous engineering structures, or those linked with the manufacturers of capital goods. The engineering structures integrated in the capital goods manufacturing companies have a tendency to reinforce themselves (to the detriment of the autonomous engineering companies) in the form of specialized design services, of services of assemblers or of a general contractor. These structures increasingly constitute a normal prolongation of the marketing activities of companies manufacturing complexes of automating machines.

Maintenance activities, in the same way as other software activities, have a tendency, under the impulse of automation, to be transferred from the consumer goods and intermediate goods industries towards the capital goods industries (and in certain cases towards specialized companies). It should be emphasized that maintenance activities involve software activities rather than hardware activities1/.

1/ In his book: "La Parole et l'Outil" (The Word and the Tool) (PUF 1975), J. Attali classes maintenance and repair activities amongst dominant information activities under the same heading as the activities of consultancy companies, architects, etc. "Maintenance is an information, since it makes it possible to maintain order in the parts of a machine and to avoid its degradation" (op. cit., p. 68).

2 - Capital goods and the international division of labour

It was emphasized in the previous paragraph that, under the impulse of technical progress and in particular under the impulse of the widespread use of automation, a differentiation took place in the industrialised countries between the following productive sections:

- firstly the consumer goods and intermediate goods industries, with the widespread use of continous production processes and of unskilled labour;
- secondly the capital goods industries, with the polarization of skilled labour in these industries and in the specialized design companies (engineering, management and maintenance) which are increasingly linked to them.

It is on the basis of this social division which operates in the industrialized countries that an attempt has been made to impose the new international division of labour: the industrialized countries specialising in capital goods industries, specialized service companies and research centres, whilst the consumer goods and intermediate goods industries, can more easily be transferred to the developing countries.

Implementation of this international division of labour has been encountering new trends in the world economy:

- certain newly-industrialized countries, such as India, Korea, Brasil and Argentina, are beginning to export capital goods towards the developing countries.
- the relocation of industry is, in certain cases, operating only on certain segments of the production route.
- the industrialized countries are attempting to protect their national industries and are opposed to any competition from the developing countries in certain consumer goods industries (textiles, for example), operating innovations which economize on labour and hence on labour costs.

Despite these trends it is around the capital goods that the principal challenge of the new international division of labour is located, and it is around these capital goods that competition is becoming more intense in the industrialized countries for "exports to the Third World, since the growth of these exports is the inevitable counterpart of the increasing imports of manufactured products, raw materials or energy"[1].

2 - 1. Specialized and complex capital goods

The social division between productive sections in the industrialized countries which depend on the introduction of innovations at the level of capital goods has, as its consequence, the increasing specialization of the manufacture of capital goods and the increasing diversity and complexity of capital goods: "Since the industrial revolution the need for technical innovations in capital goods has not ceased to make itself felt. The search for new models and efforts to improve the reliability in operation of machines have resulted in the increasing specialization of production and the increasing diversity and complexity of products"[2]. This evolution of capital goods in the industrialized countries makes the transfer of technology for the production of capital goods to the developing countries more difficult.

It also makes the capital goods supplied by the industrialized countries less and less suited to the economic and social conditions specific to the developing countries.

1/ Interfuturs - OECD Paris 1979

2/ OECD "La science et la technologie dans le nouveau contexte socio-économique" (Science and technology in the nes socio-economic context) Paris, September 1978, p. 74.

3 - Difficulties in transferring software dominant technology

A large part of the software activities in the capital goods industry involve the technology of organization. The efficiency of a design office, of an engineering department, is based on the methods of organizing work. The technology of organization is concerned essentially with a production and/or design work collective. The software of the capital goods industries therefore has an essentially collective aspect. This collective software is shown through the methods of organization but also through the attitudes and reflexes of the workers which reflect the acceptance and the adaptation or, in certain cases, the rejection of these methods of organization. These attitudes and reflexes of the workers in relation to the methods of organization constitute the collective know-how of the workers. It is through this collective know-how of the workers and the methods of organization that the collective labour[1] of the workers is exercised, that is to say the exchange of technical and organizational information necessary for the production of goods and for the carrying out of design work and engineering.

3 - 1. An aspect of transfer of technology which is still inadequately studied

The transfer of technology of a software character is generally carried out through training programmes in specialized training sessions and in sessions in the production units. This type of transfer is generally concerned with acquisition of the knowledge and know-how which each worker must master individually if he is to accomplish a particular task. The acquisition of collective know-how is rarely taken into account in the operations of transfer.

It can be observed that many operations of the transfer of technology come up against the particular transfer of organization technologies:

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[1] As opposed to individual know-how and the individual knowledge of the workers.

- "It is not basic technical training in regard to manufacture which is lacking in the Indian companies which manufacture measuring instruments but rather the modern management techniques applied in the more industrialized countries"[1].
- According to the Director General of the Algerian National Iron and Steel company: "We have found in Algeria that the transfer of technology through individuals can be carried out effectively; Algerian engineers, foremen and operators have nothing to fear from their homologues in any other country. By contrast, however, we find that the transfer of collective technology is only mediocre. It is in this field that it is necessary to direct our research. How is it that we are capable of assimilating technologies at an individual level, but not at a collective level ?"[2]

The transfer of codifiable knowledge does not, a priori, present any difficulties: the transfer of organizational knowledge should be easier than the transfer of more abstract scientific and technical knowledge. By contrast the transfer of collective know-how relative to the technologies of organization is surely the most difficult to carry out. Difficulties in the acquisition of collective know-how undoubtedly necessitate rethinking training programmes and adapting machines and production systems as a function of the cultural and social characteristics specific to a country.

3 - 2. A preliminary phase: Memorization of industrial experience

Much of the research work which has been carried out on the problems of transfer and mastery of technology from the industrialized countries to the developing countries has placed the emphasis on

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[1] UNIDO - Le développement des services d'études techniques dans les pays en voie de développement (The development of technical design services in the developing countries) - UNIDO ID/67 (I/WB 56/28).

[2] P. Judet, Ph. Kahn, A. Kiss, J. Tousciz - Transfert de Technologie et Développement (Transfer of technology and development) - Paris 1977, p. 532. International study days on the transfer of technology and development - Dijon - 30 September, 1 and 2 October 1976.

obstacles to the circulation of technical information, on different strategies for widespread diffusion, of controlled diffusion or of retention of this information by the companies in the industrialized countries which hold this technical knowledge. By contrast very little work has been done on revealing the central role which the functions of memorization play. Without memorization, without the implementation of structures capable of storing knowledge and know-how which are specific to the geographically socio-economic conditions of the developing countries, the policies of transfer of technology implemented by the developing countries can only result, in the best of cases, in new forms of economic dependence.

The developing countries cannot arrive at technical and hence economic and political independence unless they have this capacity for memorization of the industrial and technical experiences which they have acquired through the operations of transfer of technology[1] organized by companies in the industrialized countries. Implementation of these capabilities for memorization, and the objectives to be assigned to these memorization capabilities, can differ according to the level of mastery of the techniques concerned and according to the industrial branches concerned. In the case of the capital goods industries, characterized by a sofware dominant technology, necessitating considerable collective know-how, the objectives of the implementation of memorization capabilities by the developing countries could be related:

- to the collecting of observations on the difficulties encountered

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[1] In Mexico the Register of Transfers of Technology, created in 1973 to evaluate the cost and content of imports of technology, is beginning to take over this function of memorization of technical experiences. "A second aspect of the Registry's evolving role is increasing the domestic capacity to evaluate technical aspects of know-how and R and D. As a start the Registry is making contact with local information sources such as the State-owned Laboratorios Nacionales de Fomento Industrial - and R and D facility with a reasonably sophisticated information bank - and the Centro de Información a la Industria - also a technical information bank - based in Mexico City. Closer coordination with such agencies could broaden the Registry's own knowledge of technology and enable it to tap sources to help research and evaluate the technology offered" (Business Latin America, June 7, 1978).

by different workers' collectives in relation to the transfer of technology of organization, and in respect of certain types of division of labour;

- to attempt at interpretation of these difficulties;
- to attempt at the adaptation of certain forms of the division of labour and of the technologies of organization.

This memorization of industrial experience relative to the implementation of capital goods industries can only be carried out within the permanent structures linked to these industries:

- structures of specialized engineering for the mechanical and electrical industries (engineering of the supply);
- centres for technical study and research, specializing in mechanical and electrical engineering;
- centres for research, study and training on methods of organization in mechanical engineering;
- reinforcement of the studies and organization structures in companies manufacturing capital goods;
- structures of the engineering of the demand.

B. Routes and channels for transfer of technology to developing countries

1 - Entry routes

One may assume that the developing countries will begin their entry into the manufacture of capital goods by producing those products which call on the least complex production routes, that is to say boilerwork and heat welding. It is this which the sectoral studies have, in general, verified:

- The study on capital goods for the iron and steel industry notes that entry of the developing countries into manufacturing capital goods:

  "commences with the production of metal structures and boilerwork and progresses to the production of medium and finally heavy metal structures.

This is followed by the production of heat welded products such as gantries and elements of sub-assemblies for the treatment of minerals, with the integration of mechanical components such as speed reducers.

This results, progressively, in the construction of the principal upstream and downstream equipment, from agglomeration to finishing"[1].

- The study on capital goods for petrochemicals and fertilizers shows that entry of the developing countries into manufacturing capital goods takes place through:
  - the construciton of metal structures,
  - the assembly of pipework,
  - the construction of boilerwork.

Even in the case of complex capital goods such as process compressors, the sub-assemblies, calling mainly on boilerwork or heat welding (stator, oil unit), can be constructed in certain developing countries.

- The study of capital goods for the production of electrical energy emphasizes that, in the manufacture of hydraulic turbines, the

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[1] Study: IREP: Biens de capital pour la sidérurgie (Capital goods for the iron and steel industry).

developing countries can begin by producing elements and subassemblies (evacuation, man-holes, tanks, reservoirs, footways, pressure vessels, etc.).

"These parts do not demand major industrial resources. They involve sheet metal of less than 60 mm thickness. The resources which are needed are capacities for bending and welding (manual welding, without major quality control). No methods department is necessary. Manufacture can be carried out on the basis of working drawings supplied by the firm owning the technology. Mastery of the manufacture of this type of plant by the developing countries may take 3 to 5 years and represent 25 per cent of the overall price of a hydraulic turbine".

1 - 1. Some examples of entry into the manufacture of capital goods

Before independence Algeria had only one small and old unit for the production of concrete reinforcing rod[1]. The S.N.S., the National Iron and Steel Company, undertook the construction after independence of a first iron and steel unit with a production of 500,000 t/year in the initial phase (beginning of the sixties). Many foreign manufacturers participated in the enterprise from the first phase onwards: Russian, German (Hoesch, then Demag), Italian (Innocenti), British (Davy and Atkins), French (Sofresid and Vallourec) and Japanese (Nippon Steel). From the beginning the S.N.S. clearly showed its desire to participate in the equipment and the erection by systematically promoting its national potential for manufacturing equipment goods.

To this end the potential available in existing units was carefully listed in the metal constructional work, boilerwork and mechanical engineering sectors.

The following were effectively integrated:

- light, medium and heavy metal structures,
- gantries,

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[1] cf. Study: "Capital goods for the iron and steel industry", p. 30.

- speed reducers,

whilst new capacities for erection were developed.

On this occasion the following advances were achieved:

- from the construction of light and medium metal structures to the construction of heavier structures
- from the construction of light gantries to the construction of heavier gantries
- from the production of parts to the production of complete speed reducers, etc.

Tunisia[1]. A small iron and steel unit of about 450 t/year was constructed in Tunisia[2], from 1964 to 1966, for the production of concrete reinforcing rod and small merchant goods. The unit was designed by Atkins and built by Davy Ashmore (cast iron division), Creusot-Loire, (steel division) and Morgardshammer-Asea (rolling mills and finishing). The Tunisian Iron and Steel Company required its foreign partners and suppliers to accept not only local participation in painting and civil engineering but also in metal structural work; the Tunisian SGI company supplied and partly erected the metal framework of the rolling mill and the steel works, and this intervention allowed this Tunisian company to produce relatively heavy structural work for the first time. In the absence of a sufficiently experienced design office SGI could only produce this structural steelwork using the assistance provided by the consultant engineer and by the design offices of the suppliers: this is the basic condition for the effective implementation of a potential production capacity.

Tunisia[3] has for several years been establishing its phosphate fertilizers industry. Production units in this type of industry, which very frequently operate with corrosive materials, require major maintenance work. A maintenance shop was therefore created at Gabés for the phosphoric acid plant, and a co-operation and technical assistance

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[1] cf. Study: "Capital goods for the iron and steel industry", p. 31.

[2] At Menzel Bourguiba a wire drawing plant and then a plant for the production of metal structures were subsequently built.

[3] Study on capital goods for the petrochemicals industry. (IREP).

agreement was signed with a French boilermaking company.

In Morocco[1], which also has a phosphate fertilizer industry, the subsidiary of a French company built the drying ovens (diameter 4 m, length 20 m). The mechanical parts (crown wheels, bearings, etc.) were imported.

In conclusion it can be said that the manufacture of capital goods (or sub-assemblies) such as boilerwork and metal structural work (framework) are privileged routes for developing countries to commence the manufacture of capital goods and then to expand the production towards a more complex products.

2 - The "hard cores"

As a function of the presentation of the complexity of products and production routes, as described in Chapter I, the capital goods in respect of which the transfer of manufacturing technology will be most difficult to realize will be the capital goods which are complex from the point of view of the products (measured by the number of elements, for example the tractor) and those which call on complex routes (forging, casting, heat treatment and machining).

- The study on capital goods for the iron and steel industry observes that in this case the "hard core" (that is to say that group of capital goods which presents the greatest problems for integration in the developing countries) consists of:
  - high-performance mechanical equipment,
  - measuring, control and regulation equipment,
  - goods closely linked to processes, such as catalysts,
  - and, very generally, all equipment which makes it possible to link, modulate and control a system.
- In the study on capital goods for the building industry the capital goods where the transfer of technology is difficult to realize are those which call on the advanced technologies:

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[1] Study on capital goods for the petrochemicals industry. (IREP).

equipment for drilling, dumpers, and sub-assemblies for hydraulic systems.

- In the field of capital goods for the production of electrical energy, and more precisely for the mastery of the construction of hydraulic turbines, the hard core consists of:
  - the active part of the rotating movement (a part of high technicity, requiring very skilled labour, very accurate machines and know-how in respect of control, adjustment and coating with anti-friction metal),
  - the turbine regulation system, composed of electronic and hydraulic sub-assemblies.
- In the case of the study on capital goods for petrochemicals and fertilizers the hard core consists of:
  - some rotating machines, or sub-assemblies of these very high-performance or very specific machines: process compressors (or rotors for these compressors), gas turbines, process pumps,
  - most of the control and regulation equipment.

In conclusion the hard core for complete mastery of the manufacture of capital goods by the developing countries consists of:

- certain sub-assemblies of rotating machines of high technicity,
- systems for electronic and hydraulic regulation.

2 - 1. Examples of capabilities of manufacturing capital goods for petrochemicals of some advanced developing countries

in Brazil:

- Brazilian boilerwork companies can provide 90 per cent of this type of plant used in the construction of chemical investments. The principal firms, which have foreign names (Nordon, Mitsubishi, Creusot-Loire), are now 100 per cent nationalized companies; they have signed licencing and co-operation agreements with their former parent company. Reactors of thicknesses up to 50-80 mm built locally.

- In the field of pipework and valvework all the equipment (pipes, connectors, flanges, valves) are produced locally except for some alloy steel tubes and some spherical valves (necessitating very accurate machining which are imported.
- Mechanical equipment is provided by Brazilian companies which have retained their original names such as Worthington, Breguet-KSB, Gould and Sulzer.

Most of the pumps, meeting API chemical standards, are produced locally (up to a power corresponding to a flow rate of 10,000 m^3/h at 6-7 bars).

Steam turbines (up to a pressure of 40 bars) are also built locally.

Turbo-alternators are built within the framework of co-operation agreements with foreign firms such as Siemens.

- Electrical equipment (motors, transformers, rectifiers, cables) are supplied by Brazilian companies, which also install them. Some variable speed motors are imported.
- Most of the instrumentation equipment is imported. Some foreign companeis (Mazoneillan, Fischer Central) are beginning to produce small control valves locally. The purchase of instrumentation equipment and work is usually the subject of an overall contract with a foreign company.
- Indian boilerwork companies are capable of providing all boilerwork equipment, except when there is a shortage or lack of supply of special steels. Some companies have design capabilities which are still weak, and so have to ask foreign engineering companies to produce the working drawings of items such as heat exchangers.
- In the field of electrical equipment goods the importance of a public company, Bharat Heavy Electrical Ltd (BHEL), must be emphasized, as this has certainly contributed towards favouring the development of the electrical equipment goods sector:

"Founded in 1955 this company signed, during its first years, technical collaboration agreements with the United Kingdom, the Soviet Union and Czechoslovakia to train personnel and to obtain technical designs and machinery. At the present time BHEL, with an annual capacity of 4,000 to 5,000 MW is one of the top ten manufacturers of electrical equipment in the world. This company is currently devoting 3 to 3.5 per cent of its turnover to research and development, and has signed a collaboration agreement with the West German K.W.U. company to make large size steam turbines and generators up to 1,000 MW, and is presently engaged in the manufacture of its first 500 MW set. In all smaller ranges the company is self-sufficient. The increase of the capacity installed in India by 1,720 MW in 1974-75 is 80 per cent due to BHEL, and of the additions which are forecast in the fifth Five-Year Plan 85 per cent will consist of BHEL equipment"[1]. At the present time India has arrived at a stage which allows it to be present on the international market; 15 per cent of BHEL's production goes to foreign users[2], whilst its technical capabilities and its low labour costs[3], both in design and manufacture, mean that this company is able to find large outlets in the developing countries.

- 90 per cent of valvework and valves is provided by Indian firms.
- Pumps are manufactured by the KSB company (subsidiary of the German company), but production is still insufficient to meet the demand.
- In the field of compressors, air compressors are produced locally. Gas compressors are also produced locally as a result of a collaboration agreement with a foreign firm.

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[1] "Energy supplies for developing countries: Issues in transfer and development of technology". UNCTAD Secretariat. TD/B/C.6/31 - 17 October 1978.

[2] During the 1976-77 financial year the company received an order from Libya for the turnkey production of a 2 x 120 MW power station, an order from New Zealand for hydraulic generators with a total power of 544 MW, and an order from Saudi Arabia for the Wadi-Jizou electrification project.

[3] Production costs are, on average, 10 to 15 per cent lower than those of Japanese companies.

- A collaboration agreement for gas turbines has been signed with the American Worthington company.

At the "ACHEMA" world exhibition of equipment for the chemical industries, held at Frankfurt in 1978, Indian firms manufacturing capital goods participated for the first time in this type of exhibition, attended by the main world manufacturers and exporters of chemical equipment.

The principal Indian firms manufacturing capital goods are either public companies or subsidiaries of foreign companies, the most important of which is A.P.V. (subsidiary of the British company). The firms in the public sector were created with the support of technical assistance from the USSR and Czechoslovakia. The production capacities of these public firms are frequently under - utilized.

In the Republic of Korea:

Capacities for manufacturing capital goods have developed very rapidly in Korea. Boilerwork companies are at the present time capable of building this type of equipment up to 100 mm thickness, whilst electrical engineering companies can provide practically all the electrical equipment for chemical investments.

It is in the field of mechanical engineering that the most rapid changes have taken place with the construction of the Changwon complex. "This industrial complex, a pet project of the Government, is supposed to "Korealize" machinery supplies, a basic need for national security"[1]. This complex, in which about a hundred Korean companies are sharing, including the principal machinery manufacturers (Samsung Heavy Industries[2], Doewoo Machinery and Huydai) and the Korean Halla Construction company. In 1968 41 companies were already producing machines or components in this complex.

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[1] The Japan Times - June 7, 1978.

[2] It should be noted that the Sam Sung group, the principal shareholder (50 per cent) in the complex, is also the parent company of the Korea Engineering company.

- for the production of energy (hydraulic, thermal, nuclear): turbines, generators, boilers, nuclear reactors;
- for the iron and steel industry: blast furnaces, convertors, rolling mills;
- for the chemical and petrochemicals industries: tanks, heat exchanger towers, compressors, filters;
- for desalination installations;
- for building and public works.

Licence agreements have been signed on a world scale with the principal machine manufacturers: General Electric (USA), Combustion Engineering (USA), Neyrpic Creusot-Loire (France), Alsthom-Atlantique (France), Krupp (FRG) and Demag (FRG).

When this complex is completed in 1981 it is forecast that Korea will cover 70 per cent of its domestic requirements for machinery. The complex, built on the coast with its own port facilities, is also directed towards exporting (in 1976 $1,055 million were exported out of a total production of $2,876 million).

3 - The channels for transfers of technology for manufacturing capital goods

The various sectoral studies on capital goods summarize the different channels used for the transfer of technology for manufacturing capital goods:

- creation of joint-ventures and subsidiaries
- licences to use patents
- know-how licences
- contracts for the engineering and construction of factories
- contracts for the study of product design
- management contracts
- training contracts
- contracts for co-operation and technical assistance.

The study on agricultural machinery justly emphasized the fact that purchases of patents and know-how licences are the two most widely used systems for transfer, but points out that other channels of transfer could be used.[1]

- "joint ventures" (co-operation agreements). The value of this type of agreement is that it makes it possible for the experts of the holding company to work with the personnel of the recipient company;
- employment of consultants, experts and specialized technical departments to acquire the various components and sub-components in the technology for manufacturing capital goods;
- purchase and detailed analysis of capital goods in order to acquire the principal aspects of design, production and utilization.
- The systematic utilization of published technical information. This type of channel for the transfer of technology should be systematically used. The quantity of information and knowledge assembled in this way is often very considerable. This method makes it possible to reduce the cost of transfers of technology, agreements for transfer being limited only to those segments of the technology which are still alienated by firms.
- Training of the presonnel of the developing countries in industrial complexes located in the industrialized countries or in other developing countries.
- Employment of national workers who have emigrated for some year to the industrialized countries, and who have acquired industrial experience.

This preoccupation of the study on agricultural machinery not to limit transfers of technology simply to agreements for licensing patents and know-how, but to diversify the channels of transfer of technology, links up with one of the conclusions of Chapter I: the technology for manufacturing capital goods calls on technical knowledge and know-how

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1/ "Because of the preoccupation with "contractual transfers" there has been too little analysis of other ways of acquiring technology which might in some cases be useful alternatives. Consequently the range of options in technology markets is only partly explored and still less understood". UNCTAD - Manual on the acquisition of technology by developing countries - New York 1978, p. 5.

which is very diverse, and which can be acquired in many different manners. In order to ensure the maximum transfer of know-how, technical and technological knowledge, to place the maximum number of partners holding this technology in a situation of competition, and to reduce the cost of the operations of transfers of technology, it is of value to the developing countries to diversify the channels for acquisition of technology and to select those channels which are best suited to the transfer of each component and sub-component of the technology to be transferred.

Adapt the media used in the transfers

The study on agricultural machinery draws attention to the fact that transfers of technology between industrialized countries and developing countries operate between partners who do not have the same mastery of technical language and technical symbols (layouts, diagrams, formulae, drawings, standards, etc.), and who do not have the same culture. "This gap cannot be offset by a bridge of paper documents sent by mail". This gap can, however, be bridged in different ways.

- Printed information: drawings, manuals, descriptions, standard procedures can be rethought and rewritten so as to be simpler and more accessible and clearly explaining "how to do it".
- Symbolism: local traditions and habits should be incorporated in the media, avoiding references to unfamiliar environments.
- Visual support: preference should be given to visual supports and images rather than written instructions. Information integrating all three dimensions and photographs are easier to understand than technical concepts.
- Inter-personal relations: the accent should be placed on transfers by means of inter-personal relationships through training on the job, assistance from experts and practical demonstrations of production systems.
- Written language: the written language should be, as far as possible, simple and standardized with a limited use of idiomatic expressions.

4 - The challenges, difficulties and channels for transfer of some components of the technology for manufacturing capital goods

4 - 1. Technology of design of the production process

This component can be broken down into two principal sub-components:

- Analysis of the supply and demand - selection of capital goods to be built (Preliminary studies relating to the capital goods industries).
- Design of production units - Selection of production routes. specification of machines (Study of process engineering).

4 - 1.1. Preliminary studies

This type of study is very often carried out by the specialized design offices of the final clients (New work departments) or by specialized engineering companies. In the developing countries the owner does not have a new work department and must therefore call on specialized design companies or foreign engineering companies. However it is essential that owners in the developing countries should specify at the stage of the preliminary studies the fundamental orientations (alternative technology, products to be produced, routes, etc.) which the design or engineering companies must integrate. If the owner is to be able to fulfil his role of orientation and control of the work of the design and engineering companies he must have his own design office structure. This structure, consisting of engineers and economists, must be capable of carrying out, or at least following, studies in regard to the demand, supply, complexity and technological routes. UNIDO has undoubtedly a special role to play in assisting the developing countries in creating design offices for the final client in the capital goods industry. The organization of training courses in this field would be very desirable.

4 - 1.2. Process engineering in capital goods units

In the process industries petroleum, (petrochemicals, chemicals, iron and steel, food and agriculture and cement) one of the most difficult design tasks to master is the process engineering which, in the industrialized countries, is often delegated to a specialist engineering company. The role of process engineering is to establish the flow sheet which dictates the lay out of the production unit and the principal characteristics of the equipment. The flow sheet of a given production unit is an optimization of the process as a function of the expected characteristics of the final product, the specific characteristics of the inputs, and the other factors involved in production.

For the developing countries the strategy of entry into, and development of, the capital goods industries assumes a concept of production units for capital goods rather different from that in the industrialized countries. In these countries the division of tasks between the production units, the specialization of units on certain well-defined productions and the organization of labour are the product of their economic and social history. In the developing countries it is a question of designing capital goods production units which optimize, as far as possible at a given moment, the demand, the capacity of the supply, the degrees of complexity and the multipurpose production routes. The basic concept, the design of flow sheets for production units in the capital goods industries in the developing countries, is more complex in its realization than in the industrialized countries. It is under these conditions that one can speak, in the capital goods industries to be developed in the developing countries, of the necessity for specialized processed engineering structures in the capital goods industries.

Engineering companies capable of supplying process engineering for the capital goods industry are not very numerous. Such companies must have a very high mastery of the know-how of specific production in the capital industries and, more generally, in the engineering industries. They must be capable of moving outside the classical solutions which they know and of proposing new formulae for the organization and management of production. They must be capable of developing the standardization of equipment and of developing new formulae for modular construction.

The Techniberia study on capital goods for the building industry has defined, in detail, the services which process engineering should provide (engineering for manufacturing and assembly processes) for the production units manufacturing capital goods for the building industry:

- Selecting phases of the production process, and those phases which should be sub-contracted.
- Determining sequences of operations and work cycles.
- Determining times for operations.
- Defining standards and specifications for components and sub-assemblies.
- Arranging machines and work stations in the production units.
- Determining movements of materials and parts.
- Defining quality control tests.
- Selecting and choosing machines and other equipment.
- Determining systems for receiving components and sub-assemblies and systems for partial and final assembly.
- Designing tests and quality control tests.

4 - 2. Technology of product design

4 - 2.1. A strategic technological component for companies in the industrialzed countries

In the case of complex capital goods (public works equipment, tractors, pumps, compressors, gas turbines, hydraulic turbines, etc.)[1] the technology of product design integrates the results of R and D and constitutes the principal factor in competition between firms. As a consequence the transfer of the technology of product design for complex capital goods is sometimes difficult to realize because of the obtacles and limitations to transfers raised by the firms which possess this type of technology. The Techniberia study on capital goods for the building industry and the study on agricultural machinery emphasizes this aspect of the obstacles to the transfer of technology.

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[1] "In turbines there is very considerable competition between manufacturers on the world market, with increasingly rapid obsolescence in the design of turbines and methods of manufacture. This obsolescence does not relate to the whole of the turbine, but only to certain sub-assemblies. What manufacturers seek is the reduction in the cost of manufacture of these sub-assemblies as a result of research carried out in the metallurgy of metals and in the desing of manufacturing methods. R and D effort and design study is essential if the company is to maintain its position in international competition".

In the study on capital goods common to all branches[1] ICME notes two principal obstacles to the transfer of technology concerning the construction of capital goods:

- cartellization and international agreements between firms in the industrialized countries,
- the fear of firms holding know-how of creating their own competitors by signing agreements for the transfer of technology to countries with low labour costs.

Techniberia proposes overcoming these obstacles by reinforcing the capacity for negotiations of the developing countries by concerted action of these countries at regional market level (Andean Pact, Arab countries, EFTA). The size of a regional market makes it possible for the developing countries to negotiate the transfer of technology under better conditions. The strategy for transfer could be as follows[2] :

- Determine the components and sub-components of the technology of manufacturing the capital goods to be mastered.
- Organize a strategy for assimilation of technology and innovation.
- Transfer modular techniques which are not so far mastered.
- Train personnel (innovation, design, process engineering, organization of maintenance, etc.).

4 - 2.2. A priority: adaptation

All the sectoral studies on capital goods emphasize the importance of adapting the design of capital goods to production capacities, to available materials and to the conditions of utilization of the capital goods, which are specific to each of the developing countries.

The study on capital goods for the building industry and the study on agricultural machinery both draw attention to the adaptation of equipment to the geological characteristics of the soils being worked and to the particular conditions of use of these items of equipment. This adaptation of the design of capital goods is not easy to carry out,

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[1] Study: ICME - "Capital goods common to all branches of industry".

[2] Study (TECNIBERIA): "Capital goods for the building and public works industry", p. 195.

even for fairly simple capital goods. In fact the design of hand-tools or animal- drawn equipment adapted to local conditions at a technical and agronomic level necessitates similar knowledge to that used in the design of sophisticated machines, even if the level of production and of technical resources changes.

The adaptation of capital goods does not relate solely to their particular use in the developing countries but also concerns the specific conditions of production and of local supplies of materials, components and sub-assemblies.

The study on capital goods for the petrochemicals industry recalls the experience of Brazil which only began to participate in the supply of capital goods for refineries constructed in Brazil from the time that a group of Brazilian industrialists created, in 1975, the "Association Brasiliena para el desenvolvimiento de las industrias base" with, as its objective, the study of the specifications of American engineering companies and their adaptation to local construction capacities. In India, at a symposium organized by the Indian Engineering Association, it was emphasized that: "If the detailed specifications for an item of equipment are determined outside India, and if this equipment must finally be purchased in India, it can happen that such equipment with foreign specifications is not available in India. However, detailed examination of the specifications may show that the specifications relative to the materials used and to the manufacturing details can be modified and adapted to local availabilities of material and the capacities of Indian manufacturers of equipment goods."

4 - 2.3. Centres for the study of specialized research and design technologies

The study on agricultural machinery emphasizes the role which has to be fulfilled, in the implementation and development of this sector, not only by research and special testing centres for agricultural machinery (Agricultural Machinery and Testing Centre - AMRTC) but also by research and testing centres common to the various mechanical engineering indsutries (Metal Industry Research and Development Centre - MIRDC). In the case where the level of development of agricultural machinery does not yet justify the creation of a centre specific to this sector it is nevertheless suggested that provision be made for a research and testing centre for the engineering industries.

The role of these research and test centres would be to:

- Define technologies and production processes adapted to local materials and components.
- Contribute to personnel training.
- Collaborate with sectors using capital goods in order to adapt, test and improve the machines.
- Standardize and control local or imported materials
- Carry out economic and technical evaluation studies on the manufacture of certain capital goods.

Part of the activities of research and design of capital goods can therefore be grouped in the centres of technical studies which specialize in one sector or are common to the mechanical engineering industries. This is one of the preoccupations of the UNIDO document on "The development of Engineering Design Capabilities in Developing Countries"[1] which gives priority to the need to establish sectoral design centres.

It is nevertheless firmly pointed out that "Design and production should never be in self-contained departments but should rather form part of the same continuum. While it is not always possible to have design and manufacture in the same geographical location it is essential to ensure that there are very goods communication links between these two activities to foster co-operation, for no design can be economical unless it takes cognizance of the manufacturing capabilities of the producing concern"[2].

Within the framework of considerations and research on the adaptation of technologies for the developing countries the United Nations (UNIDO, UNCTAD, Economic and Social Council) have insisted in recent years on "Product Design" and "Plant Design". It can be confirmed, on the basis of what has been said above, that the adaptation

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[1] UNIDO - 1972 - ID/67 (IDI/WG.56/26).

[2] op. cit., p. 26.

of technologies also undoubtedly necessitates the mastery of "Capital Goods Design" as a priority. The mastery of "Capital Goods Design" passes through the organization of the technical design, a division of labour which can be different from that implemented in the industrialized countries.

4 - 3. Engineering of the demand

Once they have been constructed the capital goods must be utilized to constitute a new production unit. This function of supplying capital goods to form a new productive unit is carried out by specialized engineering companies. In certain cases the companies producing capital goods integrate this engineering activity as a complement to their sales activities.

Secondly in order to construct public works (roads, airports, ports, bridges, etc.) or building (including the industrial buildings which house the capital goods), companies involved in building use capital goods. The methods of use, the definition of the tasks to be carried out, the organization of the intervention concerning these capital goods, are defined for the realization of each project by an engineering structure which is either independent or integrated by the public works and building enterprises.

The study on capital goods for the building industry has emphasized the role of engineering (a specialized company, or a structure integrated in the public works and building companies) in relation to capital goods for the building industry.

In the developing countries the role of the engineering of demand is particularly important to favour the adaptation of constructional equipment to geological, economic and social conditions, and in particular labour conditions, specific to the developing countries.

The iron and steel engineering companies in the developing countries are not numerous. One can cite the case of Dastur, the Central Engineering Design Bureau (CEDB), and Metallurgical and Engineering Consultants (MECON) in India. The CEDB was created by way of a co-operation agreement signed with the Soviet engineering organization Gipromez. This form of transfer of technology for the mastery of engineering is also found in Mexico and Algeria.

In Latin America the public petrochemicals companies Petroquisa (Brazil) and Pemex (Mexico) have developed their own engineering capabilities in the field of preliminary studies and project management. The detailed engineering is largely mastered in Mexico as a result of the creation of engineering companies such as Bufete Industrial. Despite the implementation of research structures, in particular in Mexico by Pemex (creation of IMP), process engineering is generally carried out by foreign firms.

In India the public companies producing fertilizers and chemical products have established their own engineering structures:

- The Fertilizer Corporation of India has created its own Planning and Development Division (P.D.).
- The Fertilizer and Chemical Company of Tranvancore (FACT) has created the FACT Engineering and Design Organization (FEDO).
- The Indian Government has created the public engineering company Engineering India Ltd.

These engineering structures carry out preliminary studies, project management and part of the detailed studies, but they have not generally achieved mastery of process engineering.

The private Indian Tata Group has centralized its design and new works capabilities within Tata Consulting Engineers.

In the Republic of Korea the first engineering structures were created in the early seventies with State support. In the field of petrochemicals the most important engineering company is Korea Engineering Co.1/. This firm, after having mastered the engineering of preliminary studies, buying and detailed project studies, has now launched into a strategy of programmed mastery of process engineering. This firm has built a polyester resin unit in Saudi Arabia. It should be recalled that in 1978 the Korean Keang Nam Enterprise Ltd., purchased the American Pritchard Engineering Company, and that the Korean Simotech Engineering Company has created a joint engineering venture with the American Bechtel company.

1/ This company is a subsidiary of a Korean capital goods manufacturing company Sam Sun Co. and of the Japanese Engineering company Toyo Engineering Co.

4 - 3.1. Experiences in the transfer of engineering technology

Within the framework of the realization of the iron and steel complex at El Hadjar in Algeria the state Iron and Steel Company, SNS, established as its objective the formation of its own engineering structure. At the beginning of the project all the studies concerning the production of cast iron and the general engineering of the complex were carried out in Paris by a French engineering company. For the rest there was only a site department, assuming control of the work. Subsequently the SNS has created a new works department at El Hadjar. This department has an operational design office which sub-contracts for the foreign engineering company. Since the SNS wishes to use this design office as a starting point for an engineering department it is looking at different formulae for association with foreign engineering companies with a view to training its personnel in engineering work.

Formula for sub-contracting with Company A

This formula, which lasted for two years, was used for the design of the rolling mill and the general services. However it had two major disadvantages: the first was linked with fact that the time needed for the design work was considerably increased by the many trips back and forth which the drawings had to make between the two countries. The second was linked with the attitude of the specialist engineers and the engineering companies. These are fully prepared to supply the basic data and to check the calculations, but found difficulties in supplying their own working methods.

Formula for integration with Company B

For the project for the cold rolling mill the SNS provided, in the contract signed with company B, that the latter would integrate SNS personnel during the design work with a view to training them. However this procedure was rapidly found to be ineffective. Using as a pretext its responsibilities in relation to the satisfactory realization of the design work as in regard to the time for this company B did not provide for a sufficient number of hours for training the SNS personnel and had not, in fact, integrated these personnel.

Formula for the direct responsibility with Company C

In the light of these two previous experiences the SNS decided to train its engineering department by giving it total responsibility for some less complex sub-assemblies: the plant for coating tubes, general services, fluids, power stations, and administrative buildings. To train the personnel for this engineering department the SNS would recruit some specialist engineers directly and ask company C to second some draughtsmen for a determined period.

In India it seems that they have followed a similar route in starting up and developing their engineering activity.

On the basis of these various formulae for association, as tried out by the SNS, it is already possible to sketch out some conclusions:

- it appears that there is some incompatibility between the responsibility of an engineering company in regard to the satisfactory execution of the design studies and maintaining delivery dates, and its training activity.

It is for this latter reason that only the formula of direct responsibility for the project by means of a national engineering structure can reconcile the responsibility of an engineering company and its training task. Within this framework the transfer of know-how can be realized by the integration of a foreign team provided by the engineering companies in the developed countries. Integration according to such a formula seems to be possible. According to the level of development of the national engineering structure this integration can be effected with a single company over several years or, step by step, as a function of the projects to be handled.

Conclusions

The capital goods industries are at the present time at the centre of challenges of the new international division of labour. The developing countries, which have fixed as their objective the acquisition of the mastery of their process of industrialization, and of orientating the industrialization as a function of their own economic and social needs, must acquire as a matter of priority the mastery of development of their capital goods industry.

The new international division of labour is the prolongation, at an international level, of the trends towards social division in the industrialized countries, shown through the polarization of the activities of software and of skilled labour in the capital goods industries. These trends in the social division of labour in the industrialized countries makes the mastery of the technology of manufacturing capital goods by the developing countries more difficult. They draw attention to the difficulties of transfer of software dominant technology which brings into play the acquisition and adaptation of collective know-how. Furthermore these trends in the social division of labour in the industrialized countries, which have important repercussions on the characteristics of capital goods (highly developed automation, specialization of the machines), pose the problem of adaptation of capital goods by the developing countries.

Mastery of the technology of manufacturing capital goods by the developing countries passes through mastery of various software activities (R and D, design, production management, technical supports, engineering of the offer, engineering of the demand) and mastery of the interrelationships between software activities and capital goods manufacturing activities. It is the mastery of the dynamism of these interrelations, and in particular of the interrelations between R and D, design and production which constitute the real "hard core" in the transfer of technology for manufacturing capital goods.

Part five: Elements of a strategy and opportunities for the development of capital goods industry[1]

A. Components of a strategy common to all countries

The development of capital goods industry should be connected with the goals of economic development of a specific country. Goals and targets differ at different stages of development and for different groups of countries. It could be oriented towards:

- the dynamic development of agriculture and agro-based industries including capital goods for modernization of agriculture and food processing industries to ensure food for the population;
- creation of a minimum industrial complex as a prerequisite for a stable development with relatively high rates of growth and specialization in capital goods industry; and
- predominantly export oriented industrial development incl. capital goods accompanied by emergence of industrial centres (enclaves) in the country's economy; industrial centres for capital goods production will stimulate the development of different country areas, small units, accelarate training, technical education, research, etc..

During the initial stage of development of capital goods, production could be oriented to satisfying local needs while soon after the orientation should be to the establishment of intensive connections with other countries particularly with respect to small and medium-sized developing countries. Such principles as graduality, selectivity, regional co-operation and phase by phase development of capital goods industry should be widely used. Particular attention should be given to the:

- orientation towards groups of products which use local raw materials and semi-finished products or components;

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[1] The problems specific to the two countries, India and China, are not dealt with in this part since we do not have sufficient information on the strategies which these two countries intend to follow.

- initial orientation towards gorups of products with low technological complexity which constitute the foundation of the future production of more complex products including initial assembly and gradual local production;
- broad application of foreign experiences in order to increase qualification of labour; and
- development of production structures based on a long term contractual international co-operation, specialization and stable needs.

Irrespective of the political structure, orientation, diversity of strategies it is possible to indentify, from one country to another, certain common features. We will be looking more particularly at:

1) The role of the State
2) Market mechanism and capital goods industries
3) Analysis of the demand
4) Employment and training.

1) The role of the State

The development of a capital goods industry is not a spontaneous phenomenon. It is true that a certain number of production units appear more or less naturally under the impulse of artisans or small private industrialists. However, these are always simple goods of limited complexity. As soon as it is a question of moving on to the mastery of the manufacture of complex equipment goods, and towards the development of an integrated capital goods industry, nothing will happen without deliberate intentions in which the State (and the various State and para-State organizations) plays a determinant role. The action of the State can take various forms of systematic and necessary planning, in shareholdings and in fiscal and financial encouragements. This activity of the State may obviously relate to the creation and development of production units for capital goods but also may take the form of establishing the economic environment which is necessary for the development of capital goods industries. In this sense the action of the State concerns various fields relating to:

- The planning of capital goods industries
- The technical education and training of personnel
- The development of engineering, technical support and Research and Development capabilities
- Financing
- Production capacities development, and
- Regional co-operation.

These various fields of activity of the State involve actors other than the State. Certain of these fields, such as planning, regional co-operation and financing, will be discussed in the following paragraphs.

1.1 National and sectorial planning

The special features of capital goods and, backward and forward linkages with other sectors of national economy as already described, make it necessary to develop a medium and long term national as well as sectoral planning. In order to contribute to harmonious development and integration of the national economy and to the achievement of the socio-economic goals, the capital goods sector should be an integral part of the medium and long term national plan. Such a plan should contribute to the implementation of national and sectoral strategies, determine development priorities, optimal allocation of resources including capital goods sector, development of engineering infrastructure, technical education, financing, research and development.

The planning organization would also include plan implementation and constant monitoring of the progress made and achievements in capital goods industries. It is part and parcel of planning process and plan adjustments should be done in the line with objectives and goals as well as implementation results.

In the most of developing countries, direct participation of the State would be perhaps the only way for achieving a reasonable progress in capital goods manufacture. For some others a combined efforts by the State and private entrepreneurs may be needed and where the entrepreneurship is well developed, they might be able to play a major role in the development of capital goods industries.

1.2 Regional cooperation

As a function of the present challenge of capital goods in the international division of labour the development of capital goods industries should be a privileged field of cooperation among developing countries, especially small and medium-sized. This cooperation should be reinforced at the regional level, more particularly in two cases:

- Those developing countries which do not have a sufficient market cannot hope to manufacture the entire range of capital goods (this is the case with the majority of the developing countries). Inter-governmental agreements (such as the agreements between the countries forming the Andean Pact) could make it possible to programme the distribution of the various capital goods between the various countries. Allocation of capital goods to each country could be carried out on the basis of the mastery of one or other production route.

- For the construction of certain capital goods (capital goods for public works, agricultural and food processing machinery, etc.), where the technology is held by a limited number of firms, the developing countries often have difficulties in acquiring the technology. In order to increase their negotiating capabilities the developing countries have an interest in regrouping, at regional level, so as to modify force relationships in their favour, both at the level of the volume of transfers of technology and also in regard to the cost of these transfers.

1.3 Financing[1]

The period which separates the commencement of the construction of a capital goods project and the beginning of its entry into production within a production unit can sometimes be very long (3 to 4 years in some cases). The final owner, or his representative the prime contractor, of a production unit, who issues the orders for capital goods, must therefore have credit facilities available to pay the suppliers whilst awaiting the possibility of selling the products from his production unit.

In the industrialized countries various credit formulae have been developed by the banks to cover this type of need. When exporting capital goods the various gevernments of the industrialized countries have taken the initiative in establishing various credit formulae (buyers' credits, suppliers' credits), together with insurance to cover their supplier against the risk of non-payment.

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[1] Problems of financial constraints are specifically dealt within the part six of this report.

It must not be forgotten that the sale of equipment goods to the developing countries has, for several years, formed a field of very intense competition between the industrialized countries[1]. The developing countries having very reduced means for financing, in particular for the construction of major projects, often call on external financing. For this reason competition between firms in the industrialized countries to supply capital goods or turnkey factories to the developing countries is not principally carried out on the basis of the quality of the equipment, its performance or its price, but increasingly on the characteristics of the financial support (credits, rates of interest, payment periods) which the firms are able to offer. One of the consequences of this new level of competition is to reduce the role of the engineering companies to the benefit of the credit suppliers: governments in the industrialized countries, national and international banking organizations and the major industrial groups[2].

The developing countries need sources of financing to build their industrial projects. They are therefore inclined to accept the credits offered by the industrialized countries and, consequently, to purchase those equipment goods which are linked to this supply of credit; this may be to the detriment of the development of their own capital goods industries.

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[1] This competition has been accentuated with the rise in the cost of oil which has forced the industrialized countries to increase their exports to achieve a trading balance.

[2] "The engineering companies (in the industrialized countries) which formerly were in the front line when obtaining contracts are now only involved downstream of the economic and financial agreements, and are only pawns in the industrial operations by the side of the suppliers of credit and equipment". Information Chimie No. 30, March 1974.

Various studies and reports[1] have noted this obstacle to the establishment and growth of capital goods industries in the developing countries.

The development of capital goods industries necessitates the introduction by governments of credit formulae (buyers' credits or suppliers' credits) which must make it possible for the local manufacturers of capital goods to participate in calls for tenders from national clients.

Furthermore those developing countries which have reached a certain level of mastery of the manufacture of capital goods and which intend to export these capital goods to other developing countries, must be able to offer credit formulae which are as interesting as those offered by the industrialized countries. These countries must also develop formulae for insurance in order to cover their exporters in the event of breaking of contracts, non-payment, etc.. Few developing countries have succeeded in establishing organizations specialized in the financing and insurance of exports of capital goods.

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[1] - FINEP - O comportamento technologico das empresas estatais

- Cf. also the insistence at the ILAFA meeting in November 1978 on the importance of this problem for the Latin American countries.
- M. CORTES - Transfer of petrochemical technology to Latin America. University of Sussex, November 1971.
- A. ARAOZ - Consulting and engineering design organizations in the developing countries, IDRC, OTTAWA, December 1978.

2. Market mechanism and capital goods industries

In the search for the most appropriate ways and means of international economic co-operation which would support the creation of capital goods industries to the maximum it is essential to perceive fully the tendencies which are in control of the industrialization process of developing countries in its international setting. Sound knowledge of these tendencies could be of great help in making use of those of them which are in favour of the process and in removing or dampening of those which are working against it.

2.1 It must be stressed that one of the main obstacles hindering industrialization of developing countries in general and the establishment of capital goods industries in particular is the market mechanism which actually is the core of the existing international economic order. It is of fundamental importance that both the developing as well as the developed market economies are fully aware of this fact in view of the ever growing interdependence among all countries of the world.

Owing to the dual character of the market mechanism in respect of the time factor it is extremely difficult to reveal its concrete detrimental impacts on the industrial development in the majority of developing countries. In the short run it is practically impossible to detect how and when the international economic relations based on the market mechanism begin to exert negative influence. In the long run, however, its negative impacts become quite obvious and could be easily revealed as continuous and even increasing lagging behind in industrial development. On the one hand, the economic considerations applied in the pre-investment, investment and operational phases with the aim to make the respective industrial units as effective as possible in order to secure their viability are of utmost importance. In this context the efforts to attain the highest possible profitability of the units cannot be questioned. This sound principle of attaining profitability, on the other hand, could turn into a destructive device if employed through the market mechanism at the macro-level as a decisive long term criterion.

The whole problem could be explained as follows:

It goes without saying that the industrial projects must be identified and evaluated with utmost care taking into consideration all important aspects. In the preparation and evaluation phases their technical and financial feasibility is assessed and the profitability calculated. Due to a host of deficiences existing in developing countries, however, very few industrial projects could as a rule prove to become viable from the profitability point of view. The result is that the productive capital, not finding profitable opportunities in developing countries, looks for them in the developed economies. The overwhelming tendency is the main source of the widening of the gap.

The unequal, disadvantageous positions of developing countries in the world economy are being incessantly reproduced in conditions of increasing interdependence among countries. This trend makes it imperative that the developing countries achieve such a tempo of balanced industrial growth that will bring about the necessary structural change in the pattern of the international division of labour and through it the elimination of the existing economic gap between countries.

The efforts of developing countries to bring about a fundamental change in the above described scenario have produced meagre results. The majority of developing countries, particularly the least developed ones cannot succeed in this endeavour as long as they are looking for a remedy in conditions which are governed by international market mechanism. They cannot make the projects profitable if the necessary preconditions are absent. Only a few industrially advanced developing countries are in a position to offer conditions for certain profitable manufacturing industries. Even these countries have to employ various regulatory functions of the state whenever trying to reduce the dependence of their economies on the big international corporations and to secure steady, balanced growth. It became quite obvious that even the most industrially advanced developing countries cannot rely on market mechanism when trying to steer their industrial development in the long run.

2.2. To make the international industrial co-operation to work successfully towards the basic change at least two very important principles have to be applied in this area. The first of these principles is that the developed economies should secure adequate conditions for the establishment of viable industries which are at present absent in the respective developing countries. If e.g. the market for the output of the respective industrial unit is too small to make it viable the needed outlet should be provided by the developed partner country, if possible by offering its own national market or in other developing countries.

If it is impossible to make an industrial project viable because of lack of skilled manpower it is up to the developed partner country to help in providing the manpower together with the necessary training facilities. Similar actions apply to availability of various materials, know-how and other needed service, as well as to the capital in financial and physical terms.

The second important principle is <u>to make the developed economy partner to become highly interested in the development scheme</u>. If the partners are asked to provide fully or partly certain conditions as e.g. the market, skilled manpower, know-how, capital participation, credit, etc. it is quite natural that they would expect some sort of compensatory benefits. The proposition could be explained with the help of the following sketchy example Let us e.g. assume that a developing country looks for a possibility of establishing a factory to produce electric motors on the basis of her own copper resources. It would be quite natural if this country proposed that producer in a developed country would participate in the construction and operation not only of the factory producing electric motors to cover the developing country's needs but also of additional capacities with a production programme fixed according to the partner's specific requirements as for example certain components, copper wire, motors of special design and the like.

If the developing countries made use of the above incentive by offering the developed economies the possibilities for industrial activities according to their own needs, it would become necessary to make the oconcept of industrial co-operation as broad as possible in order to offer a variety of combination of industrial activities to satisfy all the partners. Such a concept could provide conditions for a special treatment of the capital goods industries particularly in cases when the question of priority is involved. In any case the individual proposals or schemes of industrial co-operation should be of complex, basket like character.

3. Analysis of the demand

This is, at the same time:

- a statistical problem;
- involving techniques for forecasting the demand;
- but above all a problem of choosing an economic policy.

3.1 The problem of choosing an economic policy

Formulation of the demand depends, above all, on the political desire and the capacity to translate this political desire in terms of:

- needs to be satisfied;
- the final products which can satisfy these needs; and
- consequently, the capital goods capable of being manufactured locally in order to produce the products linked directly to the needs to be satisfied.

Satisfaction of these needs means that one takes into account all the needs of the national community, not only those which are expressed directly on the market in a solvent form and which are too often fashioned from the exterior[1]. The satisfaction of fundamental needs is, quite simply, taking into account the needs of the national community.

The question then posed is "How can one, in concrete terms, effect the link betwen the satisfaction of fundamental needs and

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[1] In this case it is a policy of replacement of imports which is in direct liaison, and solely in liaison, with the solvent demand.

the production of national capital goods?"[1]. Firstly the needs are neither indefinite nor numerable, but their number is limited.

"Products capable of satisfying a given need may, in effect, be multiplied and diversified almost without limit in time, each of these products being able to excite the appetite and envy. However, when one presses the analysis further one finds that one can easily establish a relationship between a multitude of goods and a single need. The best proof of this is in the field of food. All nutritive products, from raw vegetables to the most sophisticated dishes, satisfy a single need: the need for nutrition. This does not mean that it is necessary to ignore tastes and improvements...but that it is necessary simply to underline the common characteristics of these goods which make each of them - under different conditions and to different degrees - substitutes for all the others. In such a way that rarity is neither absolute nor eternal but is a relative phenomenon, sometimes manufactured in all its parts"[2].

These comments and these distinctions make it possible to arrive more directly at an opening up offered by the problem of fundamental needs. It is precisely on the distinction between the limited character of the need to be satisfied, and the multitude of alternative products capable of satisfying this need, that this opening up is based. To each product or to each group of alternative products there corresponds a "technical line", a "production

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[1] See on this subject "Satisfaction of basic needs and the production of capital goods in the developing countries", IREP report, 1980.

[2] Ismail Serbry Abdallah "Basic needs: can their analysis lead to a consumption theory?" Seminar, Tripoli, 2-4 April 1979. Industrial development strategy and satisfaction of basic needs. (AIDO Seminar).

route" implying the use of machines equipment, tools, competences, raw materials, etc.. Summarizing, therefore, the limited character of the fundamental needs illuminates the opening up of the technical choices linked to the diversity of the products, and also the capital goods which are linked with them.

3.2 The statistical problem

Formulation of the demand is a statistical problem posed in terms of listing and identifying the products, collected together under different types of nomenclatures. Perfecting these nomenclatures is normally orientated by preoccupations:

- for better international comparisons in regard to production (ISIC) and international trading (SITC) and for better forecasting and planning of the demand, so as to effect the link between forecasting the development of the sectors and forecasting the demand for capital goods (ISIC nomenclature with 6 and 7 digits).

However it can be seen that nomenclatures and lists of products tend to be subject to distortion insofar as they reflect the range of production of an already established capital goods industry, or one which is already well on the way to development. This seems have as its consequence the omission of the less complex goods in the nomenclatures in favour of the more complex goods which the most advanced countries have already mastered or are on the way to mastering.

3.3 Techniques for forecasting the demand[1]

Such forecasting techniques are very numerous:

- Forecasts based purely and simply on imports;

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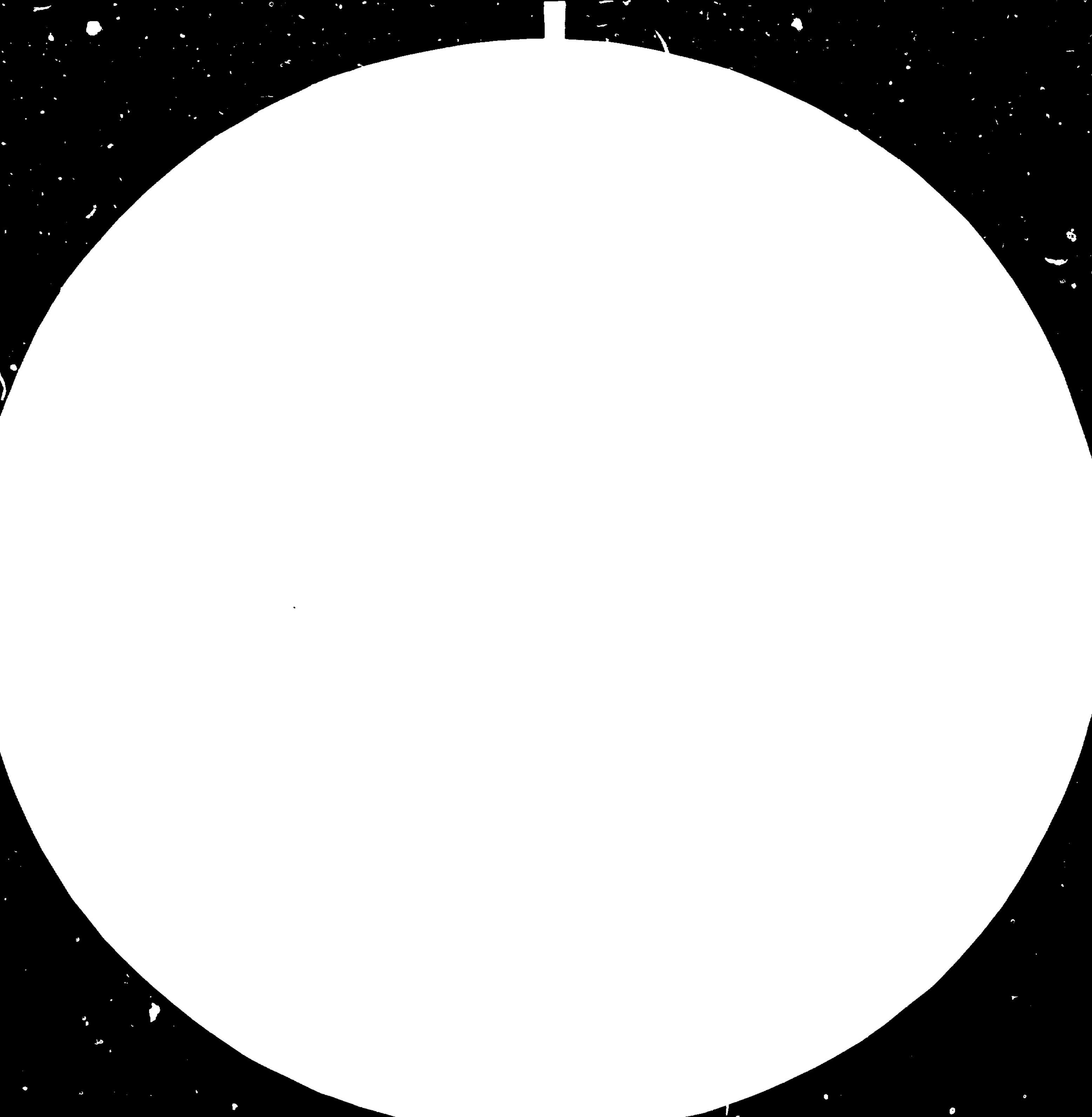
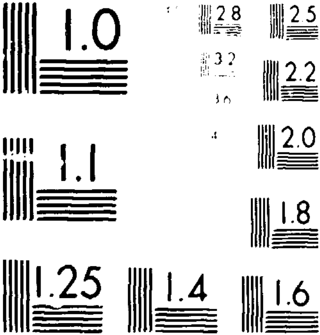
[1] See also "capital goods development project methodology for planning of capital goods industries in Turkey", UNDP/UNIDO Programme, technical report 1981.




1.0
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- Forecasts based on medium and long-term projections of the client branches (agriculture, basic industries, consumer goods industries); and
- Correlation between the demand and the per capita industrial product or the per capita GNP.

4. Employment and Training

- The capital goods industry has contradictory characteristics. It constitutes on the one hand, and in certain aspects, an increasingly sophisticated activity since it calls on automated and computer-controlled processes. It includes, on the other hand, a large number of relatively less capital intensive processes and in this case remains very largely a labour-intensive industry where workers play a central role in the efficient operation of the workshops. The capital goods industry calls both on old skills, where experience is decisive, together with new skills dealing with data processing, electronics, etc..
- At all events the evolution of the capital goods industry is shown by increasingly high demands for skills, as a result of:
    - the new processes to be mastered;
    - the more sophisticated products to be designed and adapted;
    - the increasingly stringent quality controls to be applied; and
    - the machines, which are increasingly costly to run, etc..

The evolution of the capital goods industry is shown much less in a reduction of skills than in an increase of skills, even if the skills are changed.

- The increasing skills required become even greater since the direct skills normally involved have added to them an increasing number of indirect skills.

These indirect skills relate to:

- study and engineering offices;

- methods offices;
- sales and after-sales departments,
- departments involved in innovation and research; and
- technical support departments.

They must not be underestimated for fear of seriously restricting the consistency and, even more, the dynamism of a capital goods industry.

- The skills required by a capital goods industry can be developed more easily within the context of a high level of general and technical culture. They also assume that a specialized technical training system will be organized which gives priority to applied training, as far as possible in close liaison with the workshop and with the factory. Furthermore training "on the job" must never be neglected, particularly when it is able to promote the potential capacities of all the workers who, although not holding diplomas, have accumulated much valuable experience. At all events the emphasis must be placed foreefully on the process of progressive mastery of increasingly complex processes.

- The training required in the capital goods industry, like all industries, is the training of individuals (workers, foremen, technicians, engineers, salesmen, etc.). One must never forget that mastery of higher level of complexity is not solely a problem of skilled individuals but also a question of collective efficiency, in the sense that the successful grouping of operations results from the efficient working together of a work team. This becomes even more true when multiple usage is one of the characteristics of the production process for a large number of items of capital goods. In this way it can be seen how the passage from the production of certain goods to other (analogous) goods depends, in particular, on the dynamism of a workshop and of all the workers who form an effective production cell.

B. Some elements of strategy to develop capital goods industry according to the groups of countries

1. Strategies for countries having a low industrial base (without capital goods industry) and based essentially on agriculture.

1.1 The general characteristics

- The group consists of 62 countries with more than 400 million inhabitants (26.5 per cent of total world without China and India), about half of whom live in a state of absolute poverty.
- 11 countries are of large size e.g. Vietnam, Ethiopia, Burma and Bangladesh, but the very great majority of them have less than 10 million inhabitants (including 28 countries with less than 1 million).
- Economic growth is very slow and agriculture is preponderant (70 to 50 per cent of the population is rural, agricultural products account for 70 to 30 per cent of the export receipts).
- The manufacturing industry is practically non-existent in some areas, in others very little developed. The consumption of capital goods is extremely low (of the order of 20 US dollars per inhabitant, or 7 to 8 times smaller than countries having a major industrial base where the figure is 150 US dollars per inhabitant).

1.2 The strategies

Capital goods are rather difficult industries with diversified services e.g. research, designing, .planning, quality control, marketing, etc.,. It does not mean that all the services should be in the country as a pre-condition. Creation of engineering services together with production of capital goods should be taken as an essential part of a clear sub-sectorial strategy and policy. The strategies are highly dependent on the overall prospects and possibilities of development of these countries, particularly for the poorest of them, but in all cases are closely linked with:

- the satisfaction of fundamental needs such as food, dwellings, etc., ;
- the development of agriculture and the converting of agricultural products;
- the technologies which will be used;
- the increase in incomes; and
- sub-regional and regional co-operation and integration as an important factor in the strategy.

1.2.1 Evaluation of the demand - The challenges

This point has previously been developed, and applies more particularly to those countries wishing to enter the capital goods industry.

Formulation of the demand is not only a statistical problem or a problem of techniques of forecasting the demand: it is above all a problem of political wishes and the capability to translate political wishes in terms of:

- needs to be satisfied: the needs of the whole of the national community, and not only those which are expressed directly on the market in a solvent form;
- the final products which can satisfy these needs;
- and hence the capital goods capable of being manufactured locally.

1.2.2 Mastery of products or mastery of processes and routes

The final objective is that of making locally manufactured capital goods available within the country. However two approaches are possible:

- the first consists of implementing projects linked to a product or to a range of identical products; and
- the second consists of implementing projects depending on the elementary processes of the engineering industry, such as forging, casting machining, etc., and studying those products which can be manufactured if the country masters these elementary processes.

In the first case one utilizes specialized production units, which are not profitable since the market is never sufficient, whereas in the second case one utilizes multi-purpose production units which manufacture goods for various client branches such as agriculture, building, etc.,. The production in these countries could be related to agricultural implements, equipment and machinery, food processing machinery, building construction machinery and equipment as well as to the manufacture of products common to all branches.

The World-wide Study on the Agricultural Machinery Industry[1] has shown clearly that agricultural equipment of complexity levels 1 and 2 calls on various processes:

> **Forging, sheet metal working, machining and welding constitute the basic technological route. Mastery of this multi-purpose route makes it possible to manufacture the majority of the simple machines and other products necessary for rural life, together with the tools and simple machines for their manufacture. Furthermore**

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[1] UNIDO ICIS/119 - June 1979.

mastery of this phase makes it possible to enter to a large extent into the manufacture of more complex equipment.

This approach in terms of processes and routes to be mastered leads to three consequences:

a) The first relates to the importance of maintenance and repair as a way of entry into the basic routes and as a concrete possibility for training skilled labour;
From a qualitative point of view maintenance and repair necessitate work on machining, general engineering, sheet metal working, painting, electrical (winding motors) and welding. From a quantitative point of view this activity creates many jobs. As an illustration it has been found that, for a country of about 1 million inhabitants (a small country) with a per capita GNP of the order of $ 200, the total number of trucks, tractors, miscellaneous agricultural machines, public works plant, irrigation pumps, compressors, etc. represents a total value of the order of $ 50 million and necessitates approximately 600 to 800 persons for maintenance and repair. A unit producing small agricultural machinery for such a country could create, initially, only about fifty jobs.

b) The second relates to the organization of the productive apparatus. In a first stage of development it involves multi-purpose units, that is to say units of low specialization (numerous final products) which should be decentralized as far as possible.

c) The third relates to the technical mastery and transfer of technology. Firstly it is necessary to open the "technological packet" so as to import only what is necessary. Furthermore for capital goods of simple to moderate complexity the transfer relates above all to the production activities (mastery of the processes).

Finally in the selection of the technologies to be acquired it is important to take account of the existing know-how in the country (workers, artisans, technicians) so that the transfers do not stifle but, on the contrary, develop the existing capabilities.

1.2.3 The question of "adapted" technologies and the reduction of complexity

It has already been shown that "adapted" technologies do not solely involve the dilemma of capital-intensive or labour-intensive. A technology is "adapted" if it also makes possible the local manufacture of necessary equipment so that the country has a capability for technical mastery which subsequently makes it possible to adapt and to design their own technologies. This requires, in the initial stage of development of the capital goods industry, the reduction as far as possible of the complexity of these capital goods so as to facilitate the first step in technical mastery.

1.2.4 The role of the State and the national decision-makers

Predominantly agricultural countries without capital goods industry have been facing several major obstacles e.g. limitations in internal demand, underdeveloped system of technical education, lack of skilled labour, capital scarcities and generally low technological base. Under such conditions nothing is done without a determined effect in which the State public and semi-public bodies and corporations play a decisive role. Private initiative alone is not capable for solving of such a complex of problems and limitations.

The State should participate in all phases of production of capital goods and national decision makers must control, as a matter of priority, certain important stages in the process of capital goods production amongst which are:

a) Studies relating to the selection of products and of the routes arising from meeting the fundamental needs, sectoral planning and plan implementation.

b) The listing of all the national technical capabilities, establishment of research, engineering and standardization services.

c) The organization of a maintenance network for existing capital goods, the first step in technical mastery.

d) Experiments and tests on agricultural machinery, whereby the agricultural demand is translated into a supply of machines and tools. These operations open the way to the adaptation of machines to the conditions prevailing in the country. Participation of the State in the construction and production.

e) Technical education and training of the labour force in liaison with the maintenance activities.

f) Establishment of credit financing institutions for promoting of local industry.

g) Sub-regional and regional co-operation and long term arrangements with developed countries in order to enter and develop these industries.

2. Countries where the industrial base is in course of construction

There are two sub-groups within this group of developing countries. First sub-group totalling approximately 22 countries has relatively more developed industrial base, and second sub-group with approximately 31 countries has a low industrial base, but producing fuel and non-fuel raw materials.

2.1 Some general characteristics related to the first sub-group

This involves 22 fairly heterogeneous countries, totalling 270 million inhabitants;

- some are highly agricultural (Ivory Coast, Kenya and Pakistan);
- others are petroleum producers (Algeria, Iran and Venezuela);
- others have mineral resources (Chila, Peru and Zambia);
- about 20 per cent of the population lives in a a state of absolute poverty;
- the countries are smaller than those in the previous group (13 of the countries have less than 10 million inhabitants), and this presents problems regarding the size of the market;
- the manufacturing industry has not an unimportant position (15 to 20 per cent of the National Product) whilst the capital goods industry is in an embryonic state (less than 10 per cent of all the converting industries) and meets of the order of 30 to 35 per cent of the domestic demand; and
- this sub-group of countries should be able to satisfy of the order of 45 to 50 per cent of their domestic demand by the year 2000.

2.2 Strategies

They certainly differ because of the heterogenity of this sub-group, but one can envisage certain convergencies.

2.2.1 The products and the corresponding technical routes

These countries in general master products of complexity 1 and 2, and have begun a process of development of the sector in the following fields:

- agricultural equipment with, very often, an assembly activity with a small level of integration (20 to 30 per cent)[1] for tractors and drawn machinery[2];
- simple to moderately complex equipment for the building industry (cranes, concrete mixers, tools, etc.,); and
- equipment common to all the branches such as electric motors, wires and cables, small compressors, pumps and valves for irrigation, structural metalwork, simple metal fabricating, etc.,.

This corresponds to the mastery of sheet metal and profile working (cutting, shaping, and folding), welding, forging (for the production of tools) and simple to moderately complex machining and cast iron foundries.

One strategy consists in entering totally into level of complexity 2 and partly into level 3, that is to say:

- machine tools (lathes, millers, cutters, folders, drills), the first users of which are the maintenance and repair shops;
- equipment goods common to all branches;

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[1] Except Algeria

[2] One finds the same characteristics in the automobile industry.

- equipment goods for agriculture and building. In this field it is mainly a question of improving the level of national integration; and
- simple to moderately complex equipment goods for the basic industries (iron and steel, petrochemicals, cement and production of electrical energy) wihch call essentially on boilerwork or metal fabricating activities.

The manufacture of these products necessitates improved mastery of certain processes (metal fabricating) and the mastery of new processes (foundry, forging, complex heat treatment) simultaneously with mastery of products design.

2.2.2 Regional integration

This is an important factor in the strategy, particularly for the manufacture of equipment goods common to all branches, of certain equipment for agriculture (tractors) and for the building industry (cranes).

From the Andean Pact countries, a large number of which form part of this group of countries, have already launched programmes for economic integration.

2.2.3 Mastery of the techniques

The principal objective of these countries is to structure a capital goods industry which is not as yet established except in the form of non-integrated, scattered and isolated islands. This absence of structure in the capital goods industries may actually be an advantage for these countries when attempting to design a production apparatus which is better suited to their needs. One of the important difficulties which these countries encounter is that of limiting competition from imported capital goods. This competition operates at several levels:

> imported capital goods are produced in long production run, using a considerable accumulation of know-how; they are therefore generally less expensive than capital goods manufactured locally; imported capital goods, the fruit of long industrial experience and a technical environment of a high level, are generally of better quality with production performances higher than capital goods produced locally. Imports of capital goods are often effected by way of the supply of design or engineering services; they are also frequently the result of long-term credit proposals.

Strategies for establishing a capital goods industry in this group of countries must endeavour to implement the major production routes of a capital goods industry, and to limit imports of capital goods. Such strategies involve the following stages:

- the implementation of a capability for preliminary studies and for engineering related to the construction of a capital goods industry. The object of these study capabilities is to propose, on the basis of mastery of the principal manufacturing routes, and as a function of the specific needs of each country, alternative schemes for the development and structuring of a capital goods industry;
- the imposition of controls on imports of capital goods and the establishment of rules for competition between foreign suppliers and national suppliers of capital goods (prohibition of the importing of certain capital goods, fixing the selling price of certain capital goods, etc.);

- the creation of engineering structures to carry out industrial projects in the client industrial branches of the capital goods industry. Such organization can be created on the basis of engineering structures which already exist and which specialize in the design of buildings and of infrastructure works;
- the creation of experimental and study centres for machines suited to the needs of the client branches and to local availabilities of international products and components;
- reinforcement of the design offices of the manufacturers of equipment goods. At the stage of development of this group of countries it is the design offices which motivate relationships and exchanges of information with the client branches, the experimental centres and the local suppliers of intermediate products and components. It is on the basis of these design offices that the first work towards the standardization of capital goods should be initiated, together with that on intermediate products and components intended for these capital goods.

2.2.4 Employment - Training

For this group of countries the emphasis hould be placed on training:

- production technicians and workers for the engineering industries; and
- designers and study engineers specializing in engineering construction.

2.2.5 The role of the State

The action of the State is essential in initiating the work of planning the development of the capital goods industry[1]. It is also essential for the implementation of the system of controlling imports of capital goods. It is also on the initiative of the State that a system of credit for the purchase of locally manufactured capital goods should be implemented.

The State can play a dynamic role in:

- the reinforcement of the design offices of capital goods manufacturers;
- the creation of engineering structures;
- the creation of experimental centres; and
- the building of new production capacities and participation in production.

The action of the State can be carried out by way of the creation of public study and engineering structures and of experimental stations, by way of fiscal and financial encouragements in favour of private companies which develop such activities and creation of public cooperations.

2.3 Countries having a low industrial base and producing fuel and non-fuel raw materials (second sub-group)

2.3.1 Socio-economic characteristics

It must be recalled that an essential characteristic of the second sub-group is the low development of its industry (an average of less than 10 per cent of the GDP). On the other hand, extracting industries represent more than 10 to 20 per cent of the GDP, that

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[1] Planning work is rare in this field, particularly that which is capable of moving away from the model inspired by the historical development of the industrialized countries.

is over 60 per cent of earnings from export[1].

In this sub-group comprising 31 countries with a population of 340 million, two essential characteristics can be pointed out:

a) The first characteristic is the kind of mineral resources; 16 oil producing countries have been experiencing an important development during recent years, while the earnings from exports of the other countries have been highly fluctuating and dependent upon the evolution of the current prices of raw materials.

b) The second characteristic is the size of the countries; This group includes two big countries. Indonesia and Nigeria (62 per cent of the population of this sub-group) Most of the other countries are small in size (9 countries with between 5-10 million, 10 countries of 1-5 million and 10 countries with less than 1 million inhabitants). The manufacturing industry is weakly developed, but some of these countries have been drawing profit from their fiscal and foreign currencies resources to develop their manufacturing industry (e.g. Indonesia, Iraq, Libyan Arab Jamahiriya, Nigeria and Tunisia) whose growth ratio was about 10 per cent p.a. from 1970 to 1976. Agriculture remains an important component of the economy of these countries - (60 to 70 per cent of the population is rural) - and is still the most important source of income and employment, in spite of the available mineral resources. This characteristic must be pointed out because of the deep dualism those countries are suffering from: dualism between salaries in agriculture and in the mining sector, and dualism in investments. Finally, the capital goods industry is very little developed. Its share is less than 5 per cent of the GDP. On the contrary,

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[1] Some oil-producing countries have been classified in the group 3: Mexico; some others in the first sub-group: Algeria, Ecuador, Venezuela and Iran, shich means that oil-producing countries are not a homogeneous group.

demand (consumption) is very important and being of the same order of magnitude as for the first sub-group of the 22 countries for which the building up of their basic industry is ongoing. This is due to the weight of the oil-producing countries in this sub-group whose imports and consumption represent 70 per cent of the total of the total of the sub-group.

2.3.2 Strategies

The share of national demand met by local production at present lies around 20 per cent; projections have shown that a medium share of 30 per cent can be achieved for this sub-group by the year 2000 whereas some countries could reach 40 per cnet (e.g. Iraq, Tunisia, Indonesia). Nevertheless, the development of the capital goods industry depends very much on certain factors:

Demand:

- development of agriculture and rural income in economies where the mining sector is a "modern enclave";
- diversification of industry financed by fisaal and foreign currencies resources
    (i) industries for consumption goods;
    (ii) industries related to the processing of natural resources (petrochemical, fertilizer, aluminium copper, phosphate industries, etc.);
    (iii) integration of medium and small-sized countries in regional economic framework.

Supply:

As long as demand is high, it mainly concerns complex goods (mining equipment, equipment for basic industries) especially in oil-producing countries and manufacturing this kind of goods requires mastering levels II and III (in part) of complexity.

Thus the development of the capital goods industry will largely depend upon the capacity of most of these countries to rapidly grasp of those complex technologies, and on the type of international co-operation to be agreed.

(a) **Products and technological production routes:**

For this sub-group of countries the range of products is fairly wide:

- capital goods for agriculture and building industries;
- capital goods common to all branches; and
- capital goods for basic industries and the mining sector.

For many countries maintenance and repair in the mining industry, in civil engineering and in public works constitute an important point of entry into the capital goods industry since these activities allow the creation of an important "core" of skilled manpower.

It must be stated that among the wide range of products that are a consequence of the diversification of countries, there are products already mentioned in the first sub-group of countries whose basic industry is being constituted as well as in that of the group of essentially agricultural countries. A range of several technological production routes corresponds to this range of products, the principal ones being sheet pipe and section manufacturing, welding and mechanical machining. However, the mastery of other methods, which are mainly foundry and forging at levels 2 and 3 will permit greater involvement in capital goods production (e.g. Iraq, Indonesia, Tunisia).

(b) **Mastery of techniques:**

For most of the developing countries of this sub-group, particularly for those that are developing faster, the elements mentioned in the study of the preceding sub-group of countries are identical. Briefly, the elements are:

- how to limit those capital goods imports that hinder the constitution of a national industry;
- how to set up capacities of preliminary studies and research offices in building enterprises and in the capital goods industry;
- how to develop centres for research, adaptation and engineering.

For the least advanced countries of the sub-group basic methods must be found to open significant access by the agricultural machinery and building industry to the capital goods (see strategies for mainly agricultural countries).

(c) The role of the State is nearly identical with the previous one of the countries whose industrial basis is now in the process of being settled.

3. Countries having a major industrial base

3.1 Some general characteristics

- The fourteen countries which have been classified in this category are of large size[1/] and can therefore count on a large domestic market. Not all have reached the same level of development, and about 20 per cent of the total population (80 to 100 million) live in absolute poverty. From the point of view of the capital goods industry it is the group having a large base[2/] which makes it possible to satisfy of the order of 60 per cent of the domestic demand[3/]. Some of the countries are already exporters (Brazil, India and the Republic of Korea).

[1/] More than 10 million inhabitants, except Hong Kong, Singapore, Jamaica and Uruguay.

[2/] The share of the sector is 10 per cent to 15 per cent or more, of all the manufacturing industries.

[3/] This is not true for all the countries: for example the Philippines 30 to 35 per cent and Thailand 25 to 30 per cent.

- This group of countries will, by the year 2000, represent more than 50 to 60 per cent of the production of the developing countries[1], and it may be assumed that production will cover of the order of 70 to 80 per cent of the consumption.

There are two types of countries where:

- the production is entirely directed towards the domestic market (without exports); and
- the production is also strongly directed towards external markets, as is the case at the present time with Hong Kong and Singapore, which are special cases, but also with Rep. of Korea where exports represent 30 per cent of the production.

It is probable that, given the characteristics of the International Division of Labour which is shown by a high specialization of the countries and firms[2], the possibilities of replacing imports for this group of countries will fairly rapidly reach these limits[3] (except for the very large countries) and that the development of exports will become necessary to give an impulse to domestic production. As a counterpart these countries import equipment which they cannot manufacture, either for strictly economic reasons (price, quality) or because of the market forces (technological monopoly, etc.).

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[1] Excluding China.

[2] It should be recalled that what characterizes the industrialized countries is the large part of their production which is exported and, at the same time, the high level of penetration of the domestic market by imports (except in the case of Japan and Federal Republic of Germany).

[3] That is to say the real P/C.

3.2 Strategies

3.2.1 The products and the corresponding technical routes

These countries in general master products where the complexity is of level I, II and even III. Entry and development is therefore considerable for:

- capital goods for agriculture and building;
- capital goods common to all the branches;
- capital goods for the basic industries;
- simple to moderately complex machine tools.

This means also that the basic facilities are mastered.

The strategy therefore consists of entering totally into levels of complexity III and partly into that of complexity IV.

This involves essentially:

- complex to very complex machine tools;
- specialized machines (textile machines, machines for papermaking and printing, machines for the converting of plastics materials and rubber);
- more complex machinery for agriculture and building (tractors, bulldozers);
- the "hard core" of the equipment intended for the basic industries, which necessitate the simultaneous mastery of process engineering, process plant and control and regulation equipment;
- industrial electronics (components, computers, telecommunications).

These products call on complex routes and processes:

- the electronics route;
- machining and forming of non-ferrous metals and special steels;
- special foundry and forging processes;

- heavy and very heavy machining which, at the same time, involves micro-machining
- special components of the hydraulic, pneumatic and fluidics type;
- etc..

Furthermore the increasing complexity, diversity and specialization of the industrial fabric necessitate a high level of mastery of the organization of inter-company relationships.

Finally the "market forces" are characterized by concentration and specialization of the actors:

- the major multinationals which control the most complex equipment for agriculture, building, the production of electrical energy and electronic equipment;
- the engineering companies and holders of processes in the basic industries, particularly the down-stream branches of iron and steel and basic petrochemicals;
- the medium-sized but highly specialized companies in the field of machine tools and equipment for consumer goods.

However, whilst developing these types of complex equipment the countries have to solve problems linked to their absolute peverty and the development of rural employment. In this field a <u>wide range of techniques</u> is necessary to create jobs and to improve the technical level of the entire population.

3.2.2 Export

Certain countries are already exporters, but follow one of two highly contrasted strategies:

- India, Brazil and Argentina export mainly equipment goods to the developing countries[1]

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[1] For Argentina and Brazil these exports are carried out by foreign companies, but also by national companies. Cf. the Wrold Bank studies on this subject.

- On the contrary the specific conditions of Hong Kong and Singapore mean that these countries export essentially electrical and electronic products and components to the developed market economy countries;
- The Rep. of Korea at the present time occupies an intermediate position.

We have already seen that exports are essential to sustain and give an impetus to production, and it may be assumed that these countries must above all seek markets in the other developing countries, since the economic and social characteristics of these are reasonably familiar to those which prevail in their own countries.

3.2.3. Mastery of the techniques

The strategies for reinforcement of the capital goods industry to be implemented in these countries relate to very different levels of industrial policy:

- To instigate agreements between several developing countries in the same region so as to reinforce their capabilities for negotiation and the acquisition of technology from the firms which hold quasi-monopolistic positions (control and regulation equipment, certain rotating machinery, certain electrical equipment);
- To reinforce study capabilities in the capital goods industries so as to adapt the standards for the components and sub-assemblies to the supplies available locally. It will be necessary to draw up lists of the materials, components and sub-assemblies produced locally. Work on standardization and standards will be undertaken in the direction of these local suppliers to the capital goods industries;

- The difficulty in arriving at mastery of the technique of organizing the production machinery complex has often been underestimated. In the industrialized countries machinery manufacturing complexes are only the visible part of an iceberg, that is to say of a technical environment (regular supply of components and sub-assemblies, regular supply of maintenance and services, etc.), of an economic environment (adaptation of the supply and demand) and of a social environment (acceptance and integration of factory discipline by the workers and executives). It will be necessary, in the developing countries, to rethink not only the design of production organization but also machine design so as to facilitate the organization of their production. Work on the adaptation of machines, the processes for manufacturing these machines and of methods of organization must be undertaken as a function of the technical, social and cultural environment specific to the developing countries.
- In the mastery of the entire software system the emphasis has to be placed on:
    - demand engineering, which makes it possible to ensure the link between the capital goods industries and the client industrial branches;
    - process engineering, which makes it possible to ensure the link between the research and experimental centres of the capital goods industries on the one hand and the research centres and know-how of the client industrial branches on the other.

3.2.4 Employment - Training

For this group of countries the emphasis has to be placed on the training:

- of workers, technicians and engineers specializing in electronic construction and, more particularly, in the construction and control of regulation equipment;

- of organization engineers and technicians;
- of design engineers and draughtsmen in the various engineering disciplines and, more particularly, in the fields of electricity, control and regulation;
- of technicians and engineers for the research and experimental centres.

3.2.5 The role of the State

The action of the State is essentially in the implementation of cooperation agreements between developing countries of the same region, so as to establish a common position in the face of those foreign firms which own the technology. Action by the State is also essential in the creation of a financial organization specializing in the financing and insurance of capital goods exports.

The State may play a dynamic role:

- in the implementation of a system of standardization of intermediate products, components and sub-assemblies used in the construction of capital goods;
- in the reinforcement of engineering companies and, in particular, of process engineering companies by the creation of public engineering companies or by fical encouragements favouring these private companies which develop such activities;
- in the creation of new capacities and participation in production.

Conclusions

Growth in respect of capital goods in the developing countries necessitate the management of a complex of problems. It arises not only from the diversity of the sector, which covers millions of products, but also from the diversity of objectives and situations in various developing countries. In order to assist these countries in defining and implementing strategies, an attempt has been made, as an initial approach, to classify developing countries taking into account their basic economic characteristics and their potential for development of the capital goods industry. Three major groups of countries have been identified:

- Countries having a low industrial base (without capital goods industry) and based essentially on agriculture;
- Countries where the industrial base is in course of construction including capital goods industry;
- Countries having a major industrial base including some capital goods industry.

The final aim of all these exercises would therefore be in identifying with the close co-operation of developing countries, what strategies are applicable and how can a majority of these countries with practically no capital goods industry effectively enter into such an industry?

It is not feasible to prescribe any uniform pattern of product selectivity or sub-sectoral growth for all developing countries. Conditions are widely divergent, both in terms of levels of economic development and resources and programmed growth of this sector should be considered in stages. Normally, initial efforts are concentrated on repairs facilities, production of parts, spares, hand tools, agricultural implements and equipment. This level has either been reached or could be reached in the near future. Further stages of capital goods production contemplating both processes of import substitution and export promotion continue with manufacture of simple to more complex parts, components, mechanical and electrical machinery and equipment together with durable consumer goods. Adequate technological absorption and adaptation is needed and through subcontracting and decentralization of manufacture greater technolcgical skills can be generated. Such approach would also reduce investments in individual plants and be more efficient over a period of time.

Capital goods could be produced through different technological routes. A selection of adequate route to the specific conditions should be based upon consideration of such factors as a size of market, development of demand, the level of engineering and technology in processing industries, technological level of available skills in capital goods, technological pretentiousness of a particular route and its learning effects. Experiences of more advanced developing and developed countries in this field should be carefully examined and applied.

Imports of technology significantly speeds up the industrial development process. However, it is important to bear in mind that the wish to win time and save resources in that case might affect the creation of science and technology potentials, lead to lower creative activity of the engineers and scientists. Besides, expenditures on the technological adaptation to the local conditions often exceed expenses on similar technology elaboration at home. In long-term prospects only national research and development programms may relieve the budget expenses burden of the country on technology imports and diminish its technological dependence.

The role which the State should assume in the capital goods development needs to be recognized taking into consideration specific characteristics of this sector and its importance for the reproduction process. The action of the State takes various forms of systematic planning including industrial sectoral planning, participation in engineering services, in production of capital goods as well as in fiscal and financial encouragements. This activity of the State may relate to the creation of technical education and training facilities, research and development and regional co-operation.

Part six: International co-operation in promoting capital goods development (incl. forms, conditions and long-term arrangements between developed and developing countries and among developing countries)

Introduction:-

The Third General Conference of UNIDO held in New Delhi in early 1980 had approved a Plan of Action for the restructuring of world industry in the context of establishment of a new international economic order. The Plan calls for an acceleration and active promotion of industrialization of the developing countries. This call reflects the strong desire amongst the developing countries to attain the objectives that had been laid down in the Lima Conference.

To attain a figure of 25% of world production, as envisaged in the Lima Conference, is obviously a very big task for the developing countries and would require Herculean efforts. Achieving any measure of success in attaining this objective, or anything close to it, can be possible only, if there is a joint effort made in this direction both by the developing and the developed countries, duly supported and assisted by international organizations like the UNIDO.

1.0 Concept of international co-operation:-

The extent to which a country may be considered economically and technically independent is as a rule related to the level of national development and integration of capital goods industry into the production system. The term "economic independence" broadly used in many documents should be more clarified in relation to this sector. An attempt to create integrated national system of capital goods production usually results in inefficiency and waste of resources. Nowdays not a single country including rich, large, industrialized can afford to have a whole complex of industries with respective infrastructure and not to benefit from the international division of labour. As an objective tendency, the growth of industrial production is lagging behind the expansion of international division of labour. It makes it obligatory to take into consideration this impact right at the beginning in all developing countries. It does not mean, at the same time, that it is useless to enter and or expand capital goods industries. Positive social and economic consequences of the development of such industries and effects on the economy may be considered by far more significant factors of progress than immediate, short term gains.

The most active participation in international division of labour is the shortest and the most efficient way to rectify structural inbalances in developing countries particularly in small and medium-size countries. International co-operation is the decisive tool for small and medium-sized developing countries to compensate their disadvantages related predominantly to the lack of engineering capabilities and services, limitations of internal market, skilled labour and capital scarcities, etc, and to speed up assimilation and mastering of technology. These countries therefore need a clear sectoral industrial policy supported by an effective implementation mechanism, particularly programming of the whole complex of capital goods industries at the national, sub-regional and regional levels. It includes production, related technical infrastructure, e.g. research, designing, technical training, planning, marketing etc. as well as priorities leading to the specialization of each country and programmes for regional co-operation among developing countries.

The principal instrument for building up the capital goods industries in the developing countries is that of "international co-operation". This encompasses a total economic interaction between a developing country and its partner:

- An interaction that goes much beyond the sale or purchase of goods and services;
- An interaction that includes a set of complementary or reciprocally matching operation -- in planning; in production; in development; in financing; in training; and in transfer of technology and trade.

This interaction takes place both at the inter-governmental level as well as the level of the enterprises.

Besides the traditional type of co-operation like direct foreign investment, joint sector ventures and commercial transactions, it also involves a long-term and complex interaction with matching mutual performance and with the institutionalization of the system to establish long lasting interest in co-operation.

1.1 Area of international co-operation:-

The field of international co-operation in the capital goods sector is a vast one. It may cover, in respect of each industry, either one or several of the following areas:

- financing (aid or credit);
- training (skilled workers as well as high level personnel);
- establishment of vocational training centres and educational institutions like industrial training institutes, polytechnics, institutes of technology, schools of business management, etc.;
- development of infrastructure (roads, railways, ports, etc.);
- purchase of equipment/sale of goods — national and international;
- transfer of technology including build-up of indigenous know-how in design, engineering, research and development;
- redeployment of industries and restructuring of world capital goods production.

The developing countries may also have to seek co-operation in fields like planning and in the determination of the technological complexity of the equipment which is to be taken up for manufacture.

1.2 Mutuality of interest

International co-operation in world industry, especially capital goods industry, has undergone a gradual transformation from ordinary technical assistance to a much wider form of industrial interaction. This interaction now encompasses an increasingly complex area covering a mutuality of economic interest between the two partners, i.e., the developing and the developed country. This depicts a substantial change since 1950s when the developed countries used to consider the problems of the developing countries as one of enlightened charity.

This thinking has given way to the recognition that a quickened pace of development in the South also serves the people of the North and, therefore, helping the developing countries to improve their economic condition would also be of benefit and advantage to the developed countries.

The developing countries too, on the other hand, have grown conscious of the fact that they would not be justified in expecting unlimited help from the developed countries without taking into consideration its impact on the economy of the developed countries themselves. To ignore the economic health of the industrialized countries would be foolish and the developing countries would gain nothing from this.

In other words, there is now a new perception of mutual dependence of the States and a realization that none of the important problems between the developed and the developing countries can effectively be solved by a confrontation.

Mutuality of interest may lead to an interaction involving:

- the purchase of industrial equipment and technology from the foreign country may be extended to include long-term technical assistance, designing of industrial complexes, and civil engineering;
- the supply of finance, technology, plants and equipment may be undertaken by the foreign supplier in return for the products from the plant or other products from the developing country (e.g. energy, materials);
- a packaging of services and equipment may even result in part of these transactions being converted into different forms of investment;
- redeployment of industries from the developed to the developing country along with trade linkages for the products from the plants;

- a long-term training programme to help the developing country to absorb and assimilate the fast changing technology in the developed countries in the capital goods sector.

2.0 Forms and conditions of international co-operation and long-term agreement:-

Adoption of the concept of international co-operation by the developing country involves seeking out a partner who would be able and willing to provide the type of assistance needed by the developing country. The pattern of this co-operation may be of diverse nature, both with regards to the partner and the manner of assistance covering investment, supply of equipment and technological know-how, training, financial assistance, management, research and development and trade.

In most cases, the partner in this co-operation has to be a developed country which possesses the technical and financial capability and can provide the required assistance to the developing country. An interesting development has been the growing co-operation amongst the developing countries themselves — primarily in the field of management and training — and in some cases, transfer of an appropriate technology also, which may be better suited to the conditions prevailing in = the developing country.

Whatever be the form of co-operation, the developing country has to recognize the fact that it has to pay a certain price for the assistance that it is seeking from the foreign partner. Efforts that are needed, however, are to see that the price paid is not excessive and that other terms and conditions of the co-operation do not impose too heavy and too onerous a burden on the developing country.

2.1 Need for consultation

Global and regional consultations between the developed and the developing countries can be of help in **focusing** the attention on all such issues and from these discussions might emerge the solutions to the problems — solutions that are of mutual advantage to both the parties. It could also provide the inspiration and the guidance to the parties who are desirous of entering into the co-operation agreements, which, in most cases, is likely to be a bilateral one.

2.2 A broad categorization of the co-operation form is as below:

(a) with a developed country (market economy);

(b) with a developed country (centrally planned);

(c) with a developed country <u>plus</u> a more developed developing country;

(d) co-operation amongst the developing countries;

(e) with a financially affluent developing country;

(f) regional co-operation.

These different forms of co-operation have been further elaborated in the following paragraphs. This elaboration depicts the advantages and disadvantages of different forms of co-operation and the difficulties experienced by the developing countries in the long-term contractual arrangements. The purpose of doing so is not to belittle in any way the extremely important role played by the developed countries in the uplift of the economically and industrially backward developing countries, but instead to focus the attention on some of the problems of the co-operation, so as to be able to try and find their solutions.

3.0 (a) Co-operation with a developed country (market economy):-

3.1 Importance and advantages

The developing countries have achieved varying degrees of progress in the implementation of their programmes for development of capital goods industry. Some countries have been markedly successful; some others are making rapid advancements. The major credit for this progress rightly belongs to the market economy countries which have been ever willing to extend their helping hand to the developing countries in their ventures. These market economy countries of the North possess vast resources, technical and financial, which have been made available and which continue to be made available to the developing countries for economic and industrial development.

This form of co-operation is, therefore, of vital importance to the developing countries. The altruistic approach of the developed countries has been of tremendous help to the developing countries in the implementation of their industrial programmes.

3.2 Benefits to both partners

The developed countries, motivated as they are, by a genuine desire to help the underdeveloped, are also appreciating the fact that there is a mutuality of interest between the North and the South — as has been highlighted in the Report of December 1979 of Willie Brandt Commission. This report refers to the North's dependence on the South in the sense that "South can be an engine for growth". In other words, the policies of assistance and concessions adopted by the North for development of the South could be the instrument in solving the problems of the North and, therefore, such policies that result in co-operation with the developing countries would yield benefits to both partners.

A standard form of this type of co-operation has been through investment by the enterprises — generally large companies — from the developed country. This type of investment, which is a direct foreign investment', has played a major role in helping the developing countries in the establishment of their industries.

The direct foreign investment has been, either through the establishment of a local subsidiary, or a joint sector venture, with the partner from the developing country being, either a private sector company or a public sector enterprise. This form of direct foreign investment means that the operations of the enterprise continue to be effectively controlled by the parent company in the developed country.

3.3 Unpackaged form of co-operation

The pattern of co-operation has undergone a slow change over the years with the corporate control being gradually replaced by a non-corporate, non-equity structure. The legal standing for the new arrangement is established on the basis of a contract. Of course, control can still continue to be exercised by the foreign company through non-corporate instruments of influence -

- equity being replaced by supply of loan/credit;
- direct control over the subsidiary being exercised through management contracts, technical assistance agreements and production sharing and/or service contracts.

Other forms of co-operation may be for various types of services -- in a packaged or an un-packaged form, e.g.,

- sale of industrial equipment and transfer of technology; this could be further extended and expanded by inclusion of technical assistance, design of industrial complexes, civil engineering work and other forms of interlinking, which ensure continuous co-operation between the two parties.

Some examples of this type of long-term interaction are:-

- supply of technology and complete equipment linked with an exchange of products from the two countries;

- extension of contract — including post operational assistance — being linked with payments being effected by the developing country with the help of the products from the plant;
- the respective performance guarantees given by the foreign contractor, replacing the old and traditional form of investors' risk through foreign investment;
- the foreign contractor supplying a package comprising physical capital, technological know-how, marketing knowledge and management.

The governments of the market economy countries operating under a free economic system respect the autonomy of their enterprises. Consequently, they do not, normally, get involved directly with either the co-operation agreement or the long-term contractual arrangement in respect of specific projects.

Co-operation may be confined to issues like providing aid or loan for the development programmes or for specific projects in the developing country.

Or there might be matters associated with the investment climate, investment protection, financial incentives, etc., which are of interest to the government as well as its enterprises of the market economy countries. Inter-governmental agreements on these issues help to encourage participation of the enterprises in the development programmes of the developing countries.

The government of the industrialized country, while providing help to the developing country, has to also ensure that its own interest and the interest of its enterprise are duly protected. The developing countries do appreciate this, though, at times, they feel that perhaps there is an insufficient appreciation of their problems by the governments of the industrialized countries.

There have been cases, where the governments of the market economy countries have also entered into intergovernmental agreements for providing a framework for industrial co-operation at the enterprise level, so as to facilitate the establishment of joint ventures. Example is that of the agreement of 1975 between Brazil and the Federal Republic of Germany on co-operation in the field of nuclear energy. Perhaps, such exceptions are there because of the involvement of strategic natural resources, which the developed country is interested in procuring. Entry by the governments into such agreements, directly, concerning and regulating project contracts, appears to be governed by a desire of self-interest, since the developing country agrees to provide them, on a long-term basis, with a secured supply of vital raw materials.

5.4 Centres for promotion

The efforts of the governments of the developed countries have also been directed towards establishment of institutions which help to promote investment in the developing countries. Besides providing information on investment possibilities in the developing countries, these centres also carry out promotional work for helping the enterprises from the developed countries to undertake ventures in the developing countries.

For example, Sweden has a National Board for Technical Development; West Germany has set up an Agency for Technical Co-operation; France has a Centre for Industrial Promotion in Africa; U.S.A. has the Overseas Private Investment Corporation (OPIC) for encouraging investment by small and medium scale industries in the LDCs.

The West German Centre (DEG) concentrates on the lesser developed countries and promotes the partnership investment by West German companies in these countries, by making available equity investment or quasi-equity loans, and by providing advisory services for the planning and execution of the project.

An interesting example of a co-operation agreement is the one signed by the European Economic Community with African, Caribbean, Pacific-region countries in 1974 and with Algeria, Morocco and Tunisia in 1976 at the Lomé Convention. As a concept of international co-operation these agreements indicated an interesting innovation. As to its actual implementation, there have, apparently, been some difficulties and doubts have arisen on the effectiveness of such agreements in encouraging the LDCs to industrialize. Some of the signatories to this agreement probably feel that this has benefited only a few of the countries at the cost of others.

Qn. 1 Would the Consultation like to discuss the usefulness of such agreements in the context of international co-operation and whether these could serve as models for emulation by others to cover specifically the capital goods sector?

3.5 Co-operation by large companies

Such examples, where the governments of the market economy countries have participated directly in the co-operation agreements, including the contractual arrangements, are rather small. It is mostly the private companies - mostly large companies from the developed countries which possess the resources and the know-how - that have been able to go into the developing countries to co-operate in their programmes of capital goods development. Undoubtedly, entry of these companies into the developing countries has been of immense help in their programmes of industrialization. But, this has also, at times, given rise to certain problems -- political and financial -- which, the developing countries have not found it easy to tackle.

3.6 Contractual arrangements - turn-key

Earlier, when most of the developing countries did not have much of a technological base or indigenous expertise, the best form of contractual arrangement was found to be the turn-key contract with a large company from the market economy countries. In this type of contract, the foreign company had the sole responsibility for execution of the total works, including delivery of the industrial complex, its design, procurement of equipment, engineering and construction work and initial operation of the plant for proving its performance.

3.7 Shortcomings

Unfortunately, the turn-key contracts, at times, suffer from certain shortcomings. The obligation of the contractor is normally limited to his ensuring that the plant will function properly on the date of the initial acceptance. Since he does not have to worry about post-start up performance of the plant, he prefers to concentrate on the satisfactory initial demonstration tests. Sometimes, the payment to him is on a lumpsum basis and then there is a temptation for him to reduce the quality of the plant, thereby increasing his own profit margin.

3.8 Quality

The foreign contractor may also pay inadequate attention to providing enough facilities to the local personnel for training and acquisition of expertise that would enable them to run the plant properly. As a consequence, one finds that, after the plant has been completed and delivered by the foreign contractor, the enterprises of the developing country encounter serious difficulties in operating and maintaining the plant and equipment.

3.9 Transfer of technology

In the turn-key contract, the transfer of technology, when provided for, is dealt with in a rather brief or vague manner. It is treated more as an intention within the framework of the future development of work between the two sides rather than as an immediate aspect relating to the terms of the contract.

3.10 Performance

A serious problem that arises in such contracts is with regard to the guarantees for the project quality and output. Though the contractual arrangement does include clauses relating to such guarantees, they are formulated in such vague terms that they turn out to be either inneffective or create more problems for the developing countries.

In fact, they are worded in such a way that, in case of a dispute, the contractor is invariably successful in transferring the blame for the shortcomings of the

3.11 Responsibility

plant, on to the enterprise of the developing country. Very often, the foreign contractor takes the plea that the poor quality of the product or the poor performance of the plant is due to faulty operation, defective organization or maintenance. In other words, he contends that if the plant fails to work well, then the fault lies with the developing country itself.

In case the developing country is desirous of a prolongation of the contractor's guarantee of the product quality and output, the latter insists on obtaining additional remuneration and also a prolongation of his dominant and active position in the relationship with the partner from the developing country.

3.12 Usefulness of the turn-key contracts

Despite these drawbacks, there is no doubt that the turn-key contract system has played a crucial role in the development of industries in the developing countries. This system has enabled a number of developing countries to obtain industrial plants of high technology levels from the market economy countries — a success achieved despite encountering difficulties in the form of scarcity of qualified and trained personnel, absence of engineering and design capabilities, and lack of research and development facilities within the developing country.

Some countries which are extremely keen on achieving a rapid development of their capital goods industry, may still choose, with advantage, this arrangement for its projects.

3.13 Unpackaged form of contractual arrangement

Looking at the problems of turn-key contracts, a number of developing countries are now slowly switching over to a more unpackaged form of contractual arrangement. This form envisages a greater emphasis being placed on the development of indigenous capabilities and of absorption by the local organizations of the imported technology;

The developing country makes better use of its local expertise and talents in matters relating to design and engineering works;

There is a better utilization of local production capacities for the manufacture of some of the equipment or its components, spare parts, etc.

3.14 Separate agreements

This approach signifies that, for each type of co-operation, the developing country enters into a separate contractual arrangement. This sometimes makes it easier for the developing country to exercise checks and controls for ensuring the reasonableness of the agreement and its proper implementation.

3.15 Contractor's obligations

Attempts are made through these agreements to obtain an increasing participation of the local enterprises in the project implementation, while at the same time not permitting any decline in the performance of the plant. In other words, the contractor has to recognise that his obligations are not only to provide the means but also to concentrate on the achievement of the results. He is aware that, unless he fulfills his obligations satisfactorily, his responsibility might still continue. Consequently, the contractor tends to take more interest in the implementation of such agreements. He also tries to provide more facilities for the training of the plant personnel from the developing country. Sometimes he even undertakes to set up a training service and training workshop in the plant or attached to the enterprise in the developing country, a facility that may be in parallel with the vocational training facilities in the country.

3.16 Shortcomings of contractual arrangement

The contractual arrangements, whether on a turn-key basis or in an unpackaged form, contain a mixture of clauses -- some standard and some unstandard or of restrictive nature. While the standard clauses present little or no difficulty, it is with regard to the unstandard clauses or the restrictive clauses that the developing country faces lots of problems.

The main handicap is that the developing country or its enterprise lacks the expertise for dealing with the negotiations for finalising the contractual arrangements. Its sources of information, technical and economic, are rather limited and its position for negotiating with the companies from the developed country is rather weak. Its counterpart in the developed country, on the other hand, is either a multinational or a big company having enormous skills and tremendous information sources at its disposal.

In other words, it is an unequal match where the developing country or its enterprise gets out maneuvered by the enterprise of the developed country into acceptance of a contractual arrangement which is disadvantageous to the former.

How does the developing country overcome this problem?

A permanent answer, of course, would be for the country to train its own personnel, who would then be in a position to hold the negotiations. But this is a time-consuming process.

Qn. 2

For a short-term solution, would it not be more advantageous to form a pool of experts, under an international organization like the UNIDO, whose services could be made available to the interested country at the time of the negotiations?

Or could the developing country have a bilateral arrangement with the consultancy organizations in another developed country or a more developed developing country, which would then provide the required expertise?

Would it be more practicable and yield better results if this problem is tackled on a regional basis?

3.17 Restrictive clauses

The contractual arrangements, sometimes, result in the inclusion of clauses which are of a highly restrictive nature, covering the export rights, sometimes even internal sales, use of trade marks, patent rights, etc. There are also restrictions imposed by the foreign contractor on multiple or horizontal transfer of technology.

The high price that the developing country has to pay for this co-operation from the enterprises of the developed country, very often, bears no relationship to the actual cost that may have been incurred by the enterprise of the developed country. These relate to matters like the price of plant and equipment, payment for royalties, use of trade marks, patent rights, training of personnel as well as supply of trained personnel by the developed country, and for transfer of technical know-how to the developing country. Added to this is the problem of disguised payments — most acute in the packaged form of transfer — present, to a considerable extent, in the unpackaged types of joint ventures. This refers to the overinvoicing of imports and underinvoicing of exports.

A vital aspect of the contractual arrangement concerns the satisfactory performance of the plant and that the terms of the contract make the contractor fully liable for ensuring this. Consequently, the foreign contractor has to guarantee not only the quality of the equipment supplied by him or procured through him, but also the quality and quantity of the production attained by the plant, the consumption of energy, of raw materials and other important inputs, the competitiveness of the output, the cost of the repair and maintenance, and eventually the profitability of the plant.

3.18 Performance guarantee

Most of the contracts do contain a set of performance clauses including provisions for liquidated damages and penalty which are further backed by bank guarantees or other forms of security. These provisions provide certain measure of security on malperformance. But experience has shown that sometimes this proves to be insufficient for protecting the complete interest of the developing country. In such an eventuality, a system of sanctions becomes necessary for imposing the obligations on the part of the contractor. Unfortunately, the enforcement system not being particularly strong; the judicial and arbitration proceedings being very time-consuming; and the outcome being difficult to predict, these proceedings instead of finding a quick solution to the problem, tend to become protracted and ultimately do not benefit the developing country.

The system of liquidated damages and penalty clauses included in the contract are sometimes being further strengthened by means of bonds and bank guarantees in the following forms:-

a) Advance payments bond to guarantee repayment for covering the cash advance of the client (normally up to 20%);

b) Bank guarantee and performance bonds (generally from 15% to 20%) as security against non-performance or malperformance.

Sometimes, the contractor manages to persuade the developing country to accept a conditional bond or guarantee. A number of developing countries, however, insist and quite often succeed in obtaining unconditional guarantees or bonds from the contractor.

Even these bonds and performance guarantees, very often, prove insufficient for covering fully the performance obligation of the contractor. They also may not provide coverage for a long enough period of time **after** the commissioning of the project.

3.19 Developmental damage

Another shortcoming is that these guarantees fail to take into account any developmental damage that may occur on account of a failure or inadequate performance of the project in question. The economy of a developing country — even more so of a least-developed country — is highly vulnerable to the consequence of manfunctioning of an industrial project that is being taken up for implementation. In the country's planning, there may be several other projects which would be linked either horizontally or vertically to this project. Its failure, therefore, would create multiple damage which may not easily be repaired by the developing country. True, an advance assessment of this type of developmental damage is not easy to evaluate. However, in the planning process an effort could be made in this direction, so that while making the contractual arrangements, the terms and conditions of the contract could keep this aspect also in view while formulating the system of guarantees.

3.20 Training

One feature of the contractual arrangement which is of prime importance, but which sometimes gets neglected or overlooked, is the training aspect and the training obligations of the contractor. This refers to the training of the personnel from the developing country covering various fields like erection, operation, repair and maintenance and marketing. In the provision, of guarantees, the adequacy of the training needs to be fully covered and the guarantees should be able to operate **long after** the stated demonstration period and should tie the contractor to the performance of the plant for an extended period of time.

To have such guarantee means that they need to be suitably and carefully incorporated in the contractual system in clear and unambiguous terms so that the contractor is linked with the enterprise of the developing country on a long-term basis. Such a system could make both the partners share the risks and the benefits that would accrue from the project. The security instruments could relate to the performance obligations by providing a protection up to and beyond the start up of operations and also cover any likely developmental damage.

How does a developing country find a most satisfactory arrangement? -

- a linkage through a system of buy-back or barter like arrangement? or
- a system of payment linked to the plant performance? or — Qn. 3
- a linkage with the profit of the enterprise?

If the system of guarantees insisted upon by the developing country results in placing a rather heavy burden on the contractor, he might get discouraged in the venture. Perhaps, to give him support and backing, one could consider a method of fulfillment of the

3.21 Insurance consortium

performance guarantee through some form of an insurance consortium. This consortium could be jointly funded by the financial agencies as well as the government and the enterprise of the concerned developed country. In some cases, even the developing country may be able to participate in the funding arrangement. Such a consortium could help to give a total backing to the contractor's guarantee with regard to the performance of the plant covering all its parameters relating to quality, quantity, consumption of input materials, etc. It could also cover the contractor's liability for any likely developmental damage.

The important questions that arise, therefore, are:-

Qn. 4

- Should there be a form of a contingent liability insurance consortium for supporting the contractor's guarantee? Who should be the members of this consortium - the government of the developed country and the foreign company participating in the contract?
- Would it be more advantageous if in specific projects, the government of the concerned developed country also backs the guarantee given by the foreign contractor?

3.22 Direct participation

While the governments of the developed countries have been continually encouraging their enterprises to co-operate with the developing countries, they have been reluctant in a direct participation in the co-operation and contractual arrangement. Effect of this non-participation of the governments of developed countries is that the developing countries are deprived of the expert assistance that could be made available by the developed country and which could help the developing country in negotiating successfully with the foreign enterprise — which in most cases are multinationals. Presence of a representative of the government of a developing country could not only protect the national interest of the developing country but also help to temper the attitude of the foreign enterprise.

The legal instrument designed under a system of traditional, commercial transactions assumes an equal distribution of knowledge and capacity of evaluation between the contracting partners. In actual practice, however, the position is quite different. Many developing countries are hardly in a position to be able to properly select and evaluate the equipment and the process needed to establish the industry. They may also not be in a position, because of lack of expertise, to negotiate favourable contractual terms.

Association of the government of the developed country in the contractual arrangement could considerably strengthen the hands of the developing country by improving its negotiating ability. It would also ensure a more satisfactory and more complete implementation of the contract by the contractor, thereby guaranteeing the success of the co-operation venture.

Qn. 5 Would the governments of the developed countries, therefore, not like to consider a closer and a more direct participation in the contractual arrangement between the foreign contractor and the developing country?

Would the Consultation like a specific working group of UNIDO to consider these questions further and give its recommendations?

3.23 Small and medium-scale industries

Participation of small and medium-scale enterprises from the developed countries in the capital goods production programme of the developing country could help to accelerate the pace of development. The problem that these enterprises face is that, having limited resources, they hesitate to risk their capital in ventures in strange foreign lands. They also are uncertain of the policies of the governments of the developing countries with regard to investment, import of equipment, trade, taxation, etc. Consequently, lacking the resources, financial and technical, and the international contacts — which their big brothers, the multinational companies possess in plenty — they prefer to be more conservative in their approach. They find it more prudent, therefore, to confine their activities to the home market rather than risking an investment in distant developing countries.

How does one encourage these smaller sized companies in co-operating with the developing countries?

Perhaps, a larger measure of assistance by the government of the developed countries may be the solution to the problem. Perhaps, some specific incentive schemes could be formulated for providing the financial help to these companies which would give them the courage and confidence to invest in the developing countries. The incentive scheme could cover both the financial grant as well as concessional credit. These could be channelled through the centres which are already functioning in the developed countries and which are rendering very useful assistance to the enterprises.

Qn. 6 Would the governments of the developed countries consider formulation of such incentive schemes for helping their small and medium-scale enterprises.

3.24 Redeployment

A linked issue is that of the redeployment of industries. This is now fully accepted as a means of rationalization of the production and for making better use of the existing resources. It does not necessarily imply the dismantling of uncompetitive industrial capacity in one country and its re-establishment in another. Instead, the term is being used in a wider context as a form of international industrial co-operation for the stock transfer, with a view to increasing the developing countries' share in the total world industrial production. The transfer is to be done on the basis of each country's factor and skill endowment, its development objectives and other socio-economic considerations.

It is not intended here to discuss the advantages or disadvantages of the philosophy of redeployment. What is being stressed is that, if a developed country adopts the policy of redeployment, it could be of benefit to the developing countries in the context the internationalization of world industries. Keeping in view the mutuality of interest between the developing and developed countries, the redeployment could facilitate the movement of a number of industries from the developed to the developing countries. The fact that in the developed countries, technology particularly in the capital goods industry is changing, the redeployment of industries of not the latest technology may be welcomed by some of the developing countries. The technology change in the developed country may result in some of the equipment also becoming redundant and no longer needed by that country. Transfer of such equipment - on a selective basis - could be effected at very low prices to the developing country which might be interested and willing to adopt the older technoligies. Such a transaction could be of advantage to both partners.

It may, therefore, be advantageous if the governments of the developed countries give guidance and help to those small and medium scale enterprises, which are interested in such redeployment and are desirous of setting up their industries in the developing countries. Such a redeployment could be closely linked with the re-import of the products of the industry by the developed countries from the developing countries.

Qn. 7 Would the governments of the developed countries like to consider devising specific measures for helping in such redeployment of capital goods industries.

3.25 Trade

Another important issue is that of trade between the developing and the developed countries. It is expected that by the year 2000 AD, the deficit of manufacturer trade in the developing countries may be of the order of $275 bn. (at 1974 prices).

With the increasing use of the concept of barter like deals in financing and with greater facilities being provided by the developed countries in the capital goods production programmes of the developing countries, a closer look will have to be given by the governments of the developed countries to their trade policies. Considerable relaxation of the trade barriers by the developed countries would be of great help to the developing countries in the implementation of their capital goods development programmes.

4.0 (b) Co-operation with a developed country (centrally planned):-

A characteristic feature of co-operation of this type is that it is at two levels -

(i) macro economic -- where the co-operation is at intergovernmental level; and

(ii) micro economic -- where the enterprises of two sides enter into specific project agreements.

4.1 Intergovernmental action

At the intergovernmental level, the normal pattern is to set up joint commissions which meet, at least once a year, to have deliberations covering long-term planning and co-operation in important sectors like economic, scientific and technical. The agreements reached as a result of the meeting of the intergovernmental joint commissions identify the main directions and the field of mutually advantageous co-operation in these areas. They also lay down the guidelines to be followed in implementing the co-operative endeavours in the various sectors and usually contain the provisions for setting up the appropriate institutional framework.

The agreements also contain:

- an analysis of the major problems of co-operation between the two sides;
- and the joint measures needed for stimulating trade, production, scientific and technical links and the co-operation aspects for dealing with the practical issues which arise in the course of the implementation of the agreed co-operation schemes.

4.2 Working groups

The joint intergovernmental commissions are further structured into various working groups. These groups consider, in more detail, areas of co-operation in specific fields like planning, industry, iron and steel, energy, science, research and development, finance, and trade, etc.

In other words, the intergovernmental agreements on co-operation contain the concrete content, which is then implemented through individual contracts concluded between the industrial or science or trade organizations/enterprises of the two sides, i.e., the CMEA country and the developing country.

4.3 Direct obligation of CMEA countries

Under this intergovernmental agreement, the CMEA country assumes a direct obligation with regard to the supply of credit, the delivery of equipment and the performance of the plant. The general terms of technical assistance, i.e., obligation and duties of parties in respect of various elements of technical assistance (payment terms, financing, training arrangements, etc.), which are contained in the agreement, therefore, become automatically applicable to the individual contracts which may be signed separately at a later date. In other words, with the questions regarding financing, technical assistance, etc. having already been settled, it no longer becomes necessary to discuss these issues in detail while negotiating each contract.

4.4 Contractual arrangements

With regard to the contractual terms for specific projects, most of these are on lines similar to those adopted in international contracts. There are, however, some very significant exceptions.

4.5 No restrictive clauses

The CMEA countries do not insist on inclusion of restrictive clauses pertaining to export, use of trade mark, royalty payment, patent rights, etc. Further, because the general terms and conditions on financing, payment terms, technical assistance, etc. have already been included in the joint commission agreement, which is an intergovernmental agreement, their inclusion separately in the individual contracts presents no obstacles.

4.6 Pricing issue

The price for the supply of equipment, or of any other services that are included in individual contracts, become matters of detailed negotiations.

Experience of the developing countries has shown that the CMEA country, usually takes a very firm stand on the question of prices and insists on acceptance of the price asked for by them. The justification advanced by them is that the prices being charged compare quite favourably with the international prices. Unfortunately, this is a matter where any acurate assessment is extremely difficult to make because of the complex technical problems involved.

4.7 Concessional financing — tied credit

The fact that, very often credit at highly concessional rates is also being made available by the CMEA partner, necessarily ties the developing country to procuring the equipment from this partner. Of course, if the project report has also been prepared by the CMEA partner or the design and engineering for the plant has been undertaken by them, the procurement gets linked with the question of performance guarantee. It then becomes even more difficult for the developing country to purchase the equipment from any source other than the concerned CMEA country.

In this type of arrangement, therefore, the danger of the developing country paying a much higher price for the equipment, exists.

Similar problems arise with regard to the technical specifications also, which are laid down by the developed country and whose adoption may not be the most advantageous for the developing country, from the techno economic angle.

Undoubtedly, there are some shortcomings as outlined above. However, the experience of the developing countries has also been that, once the contractual arrangements have been finalized, no serious problems arise with regard to its implementation. In fact, there have been instances where the CMEA partner has gone, even beyond the provisions of the contract in assisting the developing country in getting over its problems relating to the erection or commissioning or operation of the plant.

In other words, while the negotiations for the contract finalization may present lot of problems for the developing country, and may also be very much time consuming, once the contract has been signed, the CMEA partner appears willing to put it aside and devote all his energies in helping the developing country in the successful implementation of the project.

4.8 Buy-back or production compensation arrangement

An interesting feature of the contractual arrangement with CMEA countries is the increasing use of the concept of "buy-back" or "production compensation". Under this arrangement, the CMEA partner has been providing comprehensive assistance in the supply of equipment, erection and, sometimes, operation of the plant while the cost of assistance which is covered by long-term credits is repaid through delivery of the output of the established plant.

Sometimes the buy-back arrangement can extend even beyond the limits of loan repayment, thus providing a long-term market link between the developing country and the developed country for the newly established capacity.

4.9 Difficulties

While this barter like arrangement does have considerable merits, it is not free from certain problems. A prerequisite for negotiations for a barter like deal requires a good knowledge of international norms and standards of industrial goods, its prices and the anticipated fluctuations in the future. In short, the developing country has to have a well-developed machinery of economic planning and administration. In cases where such a machinery is not developed, their attempts to enter into negotiations for a barter like deal may not be free from serious risks.

4.10 Government participation in contractual arrangements

There is a direct involvement of the governments of the CMEA countries in the contractual arrangements. This is of help in ensuring successful implementation of the agreement. The projects got implemented without any serious obstacles; the performance guarantees get fulfilled; and the project agreements, normally, do not contain any restrictive clauses of the type that one finds in agreements with private companies.

A slightly negative aspect is that, because of the involvement of the governments of the two sides, the negotiations sometimes get protracted and their finalization takes a lot of time. But once the agreement has been signed, its implementation gets done smoothly.

4.11 Technical assistance

There is also an easy flow of technical information to the developing country. The CMEA partner is normally prepared to provide, willingly, all the technical data concerning the project in question. Further, he makes his country's facilities available for training the personnel from the developing country in areas like erection, operation, maintenance, research and development, etc.

If needed, the CMEA country, has no hesitation in providing adequate number of trained personnel for assisting in the execution of the project as well as in providing on-job training to the personnel. The experience of the developing country has been that the cost of such technical personnes from the **centrally** economy country very often turns out to be lower than what the developing country may have to pay if it obtained such personnel from the market economy countries.

The developing countries, being aware of the fact that technological self-reliance is absolutely essential for ensuring successful industrialization, is, therefore, desirous of developing the indigenous expertise through assistance from the developed countries. In this effort, they find that the co-operation arrangement with the **centrally planned** country is of advantage. Depending on the priorities attached by the developing country, generally, adequate help and co-operation becomes available from the centrally planned countries for the promotion of the national organizations promoted for acquisition of various skills in diverse fields like consultancy, design and engineering, erection, operation, maintenance and research and development.

4.12 Credit facility

Some of the developing countries face problems of financial stringency which impede the implementation of their industrial programmes. Availability of credits from commercial market being quite costly, the developing country finds the assistance from the centrally planned country very welcome. This assistance in the form of credit at highly concessional rates is available from the centrally planned country and has a repayment period spreadover 20 years or so with the interest at about 2.5% per annum. Sometimes, the repayment terms are being tailored to suit the nature of the project involved.

4.13 Infrastructure development

In several developing countries, non-availability of infrastructure is a serious constraint in the implementation of its industrial programmes. Infrastructure development involves investment in high magnitudes with a very slow return. If the developing country is not able to divert enough money from the internal savings, it has to look elsewhere for funds. Sometimes, help is available from the centrally planned countries for this purpose also. Assistance is, either as aid or as loan, on concessional terms.

4.14 Emphasis on small and medium scale industries.

The centrally planned countries now have agreements with more than 78 developing countries for various types of projects. The general pattern, however, is that the co-operation is mostly with regard to large size projects. For the development of capital goods industry, a greater emphasis needs to be placed on development of small and medium scale industries also. This calls for a reorientation in the thinking of the centrally planned countries.

Would the governments of these countries not like to consider a policy change in their approach towards assisting the developing countries — a change that could help their enterprises to concentrate, to a much greater extent, on helping the developing countries in the promotion of small and medium scale projects? Qn. 8

5.0 (c) Co-operation with a developed country plus a more developed developing country:-

This is a variation in the form of co-operation between a developing country and a developed country. Here advantage is taken of the fact that some developing countries have been able to make considerable advancement in the field of industrial development and, therefore, the facilities are available for utilization by the developed country in assisting the lesser developed country in its programme of capital goods industrial development.

Countries like Argentina, Brazil, Mexico, India and South Korea have, over a period of time, been able to establish a wide industrial base. They now have facilities in fields of consultancy, training, production of various types of equipment, supply of skilled labour or personnel. In some cases, they are even in a position to export their own technology of an intermediate type, which is perhaps more appropriate and better suited to the developing countries.

5.1 Contractual arrangement

The co-operation here envisages a contractual arrangement between a developed country and a developing country which is further supplemented by a separate contractual arrangement between the developed country and the more developed developing country. Under this arrangement, the developed country supplies the technology and major equipment to the developing countries, assists in the implementation of the project and also, sometimes, provides the finance. From the more developed developing country, assistance is obtained by the developed country in areas where suitable facilities are available, e.g., part of the equipment could be manufactured in the more developed developing country; or the training facilities available there could be utilized; or technical personnel for working on the project in the developing country could be obtained. In some cases, even the design and engineering is done in the more developed developing country because of the lower cost at which this work could be executed.

5.2 With centrally planned economy country

Several examples of this type of co-operation are available between the CMEA countries and developing countries in Africa where a comparatively more developed developing country (e.g., India) is also assisting by undertaking part of the work as a sub-contractor for the CMEA country.

5.3 With market economy country

A variation of this type of co-operation is, where a private sector or a public sector enterprise from a comparatively more developed developing country has joined forces with a large enterprise from the market economy country and has set up a joint sector company. This company then tries to take up works in the developing country. These may be in the form of construction of projects or design and engineering work or consultancy. (e.g., MECON of India, a major public sector consultancy organization linking up with M/s. ALLUSUISSE of Switzerland to form a joint sector company for co-operating in works in developing countries on major projects especially relating to aluminium).

5.4 Advantages

This form of co-operation is proving of advantage to all the parties concerned:

- The developed country is able to get part of the work executed with the help of the more developed developing country at costs much lower than what they would have themselves incurred;
- The more developed developing country finds this arrangement of advantage as it enables it to find an export outlet for its surplus manufacturing capacity and surplus trained manpower;
- The developing country finds this combination useful as it is able to get its projects executed with lower investment costs. In addition, it finds, in the more developed developing country, a partner who is more reliable and sympathetic to its own aspirations for development.

6.0 (d) Co-operation amongst developing countries:-

A very important development in the field of international co-operation is the increasing effort being made by the developing countries in providing assistance to each other with regards to their developmental programmes. There are, of course, obvious limitations in providing such help But despite these limitations, the co-operation efforts are increasing at a fast pace. This is proving to be particularly beneficial to the lesser developed countries, which are able to find, in the comparatively more developed countries, a partner who is much more considerate and sympathetic to its feelings and objectives of the lesser developed country. The assistance that becomes available to the LDCs, therefore, is invariably without those political overtones that exist in the co-operation ventures with the developed countries.

Some of the developing countries like Argentina, Brazil, India, Mexico and South Korea can claim today to be the possessors of a broad technological base and a well-developed capital goods industry. During this process of development they have not only imported and assimilated foreign technologies, but, in several cases, been able to develop their own technologies also, which are more appropriate for use in their own country as well as other developing countries.

These countries had adopted a deliberate policy which aimed at self-reliance in the industrial field. They encouraged their own organizations to develop and acquire expertise in areas of consultancy, design and engineering, construction, management, manufacturing and research and development. Consequently, they have now reached a stage of development where they are able to, not only meet their own requirements in these diversed fields, but are also in that fortunate position of being able to provide assistance to the lesser developed countries in their capital goods development programme.

6.1 Joint sector

Several examples are available of such co-operation amongst the developing countries. The form of co-operation has been of a varied type. In some cases, there has been a direct investment, generally, through joint sector ventures; this has enabled the local entrepreneurship also to be developed.

6.2 Construction

In other cases, the construction organizations from the more developed developing countries have taken up works in the LDCs for execution. Here again, the emphasis has been to link up with one of the local organizations. This has been of help in the development of local expertise. Use of indigenous equipment has encouraged the development of the local capital goods industries.

6.3 Training

An important area of co-operation has been with regards to technical training and supply of trained personnel. Some of the more developed developing countries have built up a large capacity for training facilities in their projects, and through technical schools and polytechnics, institutes of technology and schools of business administration. A part of this capacity is being made available by them to other developing countries for getting their personnel trained in the technical skills required. (e.g., training of Nigerian Steel Industry personnel in India). As a result of this type of co-operation, the developing countries are successfully increasing their availability of trained manpower which is participating in the construction, operation and maintenance of their capital goods projects.

6.4 Contractual negotiations

One of the big problems that some of the developing countries face is with regards to contractual negotiations with a foreign company. They suffer from the handicaps that adequate local expertise is not available with them. This is an area where the more developed developing countries are in a position to provide valuable assistance. Example are available where such assistance when provided, had helped the developing country to negotiate much better terms with the foreign partner from the developed country.

6.5 Financial assistance

In a limited number of cases, even financial assistance in the form of aid or credit has been provided. Obviously, the more developed developing countries are not in a position to give this type of help in large quantities. Notwithstanding their limited resources, they have been extending some financial support to the LDCs. In most of the cases, this help has been through their export financing agencies or development banks.

6.6 Unity of purpose

An important characteristic of this form of co-operation amongst developing countries is that there is a closer bond of friendship and a unity of purpose between them, which ensures success in their efforts. Considering the importance of developing national self-reliance, there is full co-operation available from the more developed developing countries in support of the priority programme of those LDCs which aim at building up their own expertise in the various fields of capital goods development.

6.7 Appropriate technology transfer

Besides offering assistance in the shape of experts, sometimes, these countries may also be in a position to offer a technology which is more appropriate and better suited for adoption in the developing country. In the field of capital goods industry, the technology in the developed countries is changing at a fast pace. New technologies tend to become more capital-oriented and less labour intensive. Some of the developing countries which have problems of unemployment or underemployment may find these technologies not of as much use as the earlier technology which may be more labour intensive. These countries may find it easier to obtain such a technology from the more developed developing country.

6.8 Tripartite agreement

Perhaps, some developing countries may, therefore, find it a good arrangement where it is able to obtain financial assistance from other sources, e.g., a developed country, while rest of the assistance could be obtained from its partner in one of the more developed developing countries. The sophisticated equipment may still have to come from the developed country, while the appropriate technology and the supporting equipment could be procured from the more developed developing country. This may, perhaps, be the answer to the question that every developing country asks — how to attain a rapid rise in the capital goods production in the country with a simultaneous development of indigenous capabilities and skills.

The co-operation is, generally, in the form of a bilateral arrangement. One could consider a regional approach also, especially on the question of supply of expert services to the developing country. Some of the comparatively more developed developing countries could consider forming a joint consultancy organization that could provide assistance to the developing countries in their capital goods programme. Such an organization could cover the fields of planning, feasibility and project reports, project implementation and assistance to the developing country in contract negotiations with the foreign partner.

Qn. 9

Would the consultation like the UNIDO to pursue this matter further through a special group meeting of these comparatively more developed developing countries and some of the developing countries?

7.0 (c) Co-operation with financially affluent developing country:-

This is a variation of the earlier form of co-operation amongst the developing countries. Finance being a major constraint in the capital goods production programme, co-operation with a party who is rich in financial resources, e.g., a member of OPEC, could be particularly beneficial to the developing country.

7.1 Form of co-operation

The arrangement in such cases is that the developing country with surplus financial resources makes available financial assistance in the form of aid/loan, which is then utilized by the developing country in the establishment of its industries. For the technical part of the assistance, however, the developing country will have to turn to other developing or developed countries. Sometimes, the financial assistance from the rich developing country could also take the shape of direct investment through equity participation in a company in the developing country or through establishment of joint ventures.

7.2 Linked arrangement

In several cases, this co-operation also becomes **"a two-way traffic", where the financial help enables** the developing country to establish its project. The developing country, in turn, supplies its products for use in the country, which is providing financial assistance. (e.g., the Kudremukh Iron Ore Project in India for producing iron ore concentrates with the help of loans amounting to over 600 million dollars provided by Iran. The concentrates are to be shipped back to Iran for use in a new steel plant proposed to be set up there).

Some of the developing countries with surplus financial resources, e.g., members of OPEC, are already providing an increasing amount of financial assistance to other developing countries for implementing their industrial development programmes. A special emphasis on capital goods projects would be of advantage.

7.3 Liberal investment policy

A liberalization of the investment policies of the developing countries would be another way of attracting the surplus funds from other developing countries (e.g., recent relaxation by India with regard to foreign investment from members of OPEC). Other developing countries may find this of interest and may like to review their policies with regard to foreign investment.

8.0 (f) Regional Co-operation amongst developing countries:-

This is one more variation in the form of co-operation amongst the developing countries. Instead of being bilateral, it is regional and cover a number of countries.

8.1 Joint programmes

Several examples are available where such co-operation, on a regional basis, has been effected by devising a system of joint sectoral programme for economic and industrial co-operation. This type of co-operation is not free from problems, and its success or failure is dependent mainly on the prevailing political climate in the region. However, while the bilateral co-operation has, admittedly, better chances of success, the concept of regional co-operation is not without its merits.

8.2 Uniformity in incentives

One important feature of such regional co-operation is that it could help to strengthen the bargaining position of the region vis-a-vis the developed countries. The developing countries could adopt a joint approach on issues like investment policy, incentive schemes, etc. Such an action would prevent the foreign enterprises from taking undue advantage of any unhealthy competition amongst the developing countries of the region for inducing the investments.

A joint system of conflict resolution and a joint measure to control abusive behaviour by the enterprises of the developed countries (e.g. restrictive practices, transfer price, excessive payment for supply of equipment, for transfer of technology, etc.) could also be worked out on a regional basis.

8.3 Collective bargaining

Other concepts for regional co-operation could be that of collective bargaining of foreign investment linked with the regional programme of industrialization purchase of technology, collective marketing, etc.

The regional approach can also help in the negotiations with the developed countries on matters like liberalization of trade and introduction of changes in the tarrif policies of the developed countries.

Establishment of regional organizations for such co-operation has proved beneficial, particularly to the African and Latin American regions. Organizations like the Economic Commission for Latin America, Latin American Economic System, Caribbean Free Trade Association, Economic Commission for Africa, West African Economic Community, etc. are promoting the concept of regional co-operation. The special problem of financing is being tackled by regional institutions like the Inter-American Development Bank, Central American Development Bank, Caribbean Development Bank, etc.

8.4 Industrial survey

An interesting industrial survey had been carried out in 1973 by ECAFE, for exploring the possibilities of regional co-operation. The survey came to the conclusion that there was considerable potential for establishment of different types of projects like fertilizer, paper and pulp, newsprint, mechanical engineering industry cement, etc. in different countries of the region. It was felt that large size projects, which would be economically viable, could be located in individual countries. The raw materials for the project could be supplied from one or several countries of the region and in return the marketing of the products also would be throughout the region.

8.5 Role of UNIDO

For the lesser developed countries, this type of approach towards regional co-operation may be of advantage. **Perhaps, a survey could be carried** out in these countries for considering the establishment of capital goods industries on a regional basis.

Qn. 10

Would the consultation like the UNIDO to carry out such a survey in some of the regions, which have the largest numbers of LDCs?

9.0 Promotion of indigenous research and development:-

This issue is very closely linked with that of import of technology. The developing countries, initially, may have to depend on external sources for procurement of technology. But, simultaneously, to reduce their dependence on foreign countries for technology, they will have to develop their own research and development centres.

The task of establishing indigenous research facilities, whether basic or applied, is by no means, an easy one. The expense involved is enormous and the return on the investment made is, often, extremely low. Despite these drawbacks, developing countries have no option but to devote special attention to this problem.

In most of the developing countries, the private entrepreneur would hardly be in a position to find adequate resources that could be devoted towards research and development. Thus the burden of finding the funds has to be borne by the governments of these countries. They will have to find the money from internal savings duly supplemented by special financing arrangements with the developed countries.

An example that may be found of interest, is that of India. The Indian steel industry now has a very large centre for research and development. This centre is engaged in not only doing basic research, but has also got over 70 projects of applied nature dealing with the specific problems in the various steel plants in the country.

Establishment of this centre in India has come up because of the special assistance provided by the government and also the co-operation received from some of the developed countries. Initially, the long-term agreement with the USSR helped in the formation of the centre and in obtaining certain technological inputs. Subsequently, the centre was further strengthened and expanded through technical assistance obtained from other developed countries.

Another interesting example is that of Peru in South America, where the government has managed to raise funds to finance central research by means of a special tax policy. A tax of 2% is levied on net pre-tax income of the industrial firms. This is then utilized towards research and development projects, both at the central level as well as through the various firms.

Several developed countries, both of the market economy and of the **planned** economy types, have been extending financial and technical assistance to the developing countries for establishment of research and development facilities. **The developing countries would welcome the developed countries' placing greater emphasis on this activity.**

10.0 Training:-

Any action plan for the development of capital goods industry requires a simultaneous development of the manpower resources. In fact, this applies to the entire plan of industrial development that is drawn up by a developing country.

10.1 Manpower planning

In other words, the central planning and monitoring organization will need to devote a special attention to the drawing up of a national manpower plan. Such a plan would take into account the future needs, both short-term and long-term, of technical personnel of every category and level, the available facilities and the additional capacities which need to be established. Such a plan will be able to indicate the way in which the developing country will meet its future requirements of -

- industrial leaders and managers;
- engineers and scientists;
- industrial technicians;
- technologiests;
- skilled and semi-skilled shop-floor workers, etc.

The plan will show the types of training institutions which have to be set up, e.g., industrial training institute, polytechnics, technical schools, institute of technology, institutions of business management, etc.

The plan will also indicate the availability of resources; from internal savings as well as through external assistance and the manner in which the trained personnel would be absorbed in the industries.

The plan would also show the linkage of the technical institutions with the central planning mechanism, in industrial and business communities, various national and international institutions.

A number of developing countries have already been following this path of a planned manpower development and this has paid rich dividends. For example, in India a very large number of technical institutions are functioning, which are capable of training technical personnel from the lowest to the highest level. There is also a close linkage with the existing private sector and public sector enterprises, which makes it obligatory on the part of these industries to take in apprentices and train them in various skills.

The result of the sustained effort at training programmes is that today the number of trained personnel that is coming out of these institutions exceeds the annual demand.

10.2 Experience of some developing countries

In Algeria, systematic studies have been carried out which helped to identify with considerable precision the needs for industrial training. Consequently, a systematic and successful effort could be made by the government in close co-ordination with the industries in fulfilling these needs. An interesting feature of the training programme in this country is that there is a very close linkage between the training institutes and the industry. Such a linkage ensures that the training is given for a specific activity and for a particular enterprise and that after the training, the trainee is assured of a job in that enterprise.

The large output of trained personnel from these institutions constitutes the real strength of the system for taking the country closer towards its goal of technological self-reliance.

Brazil had established in 1942 two institutions, SENAI and SENAC, which have played a major role in the efforts made for attaining the industrial development objectives of the country. SENAI provides facilities for training semi-skilled and skilled workers for industry. It also has access to industrial establishments and a substantial part of its activity is carried out in the plants as on-the-job training.

SENAC operates more than 100 occupational training centres, a network of commercial training units, mobile units, tele-educational centres, etc. Training is provided in office work, communication, administration and management.

The government of Brazil has promulgated a number of laws and regulations designed to encourage industrial investment in manpower training. Examples are the schemes of income-tax deduction and manpower programme for research and development activities.

Nigeria, while embarking on its programmes for development, simultaneously concentrated on the training aspects by setting up a large number of institutions. The Nigerian Council of Management and Educational Training has the responsibility for stimulating and conducting the management training throughout the country working in close co-ordination with the public and private institutions in industry, education, business and commerce. Another interesting feature is the establishment of an industrial training fund financed by means of a pay role levy.

Nigeria has also taken full advantage of the training facilities available in other developed countries as well as developing countries. One example is Nigerian Steel Industry personnel, who have been successfully trained with the Indian Steel Industry in various disciplines.

The purpose of citing the above examples is only to emphasize the importance of training in the context of capital goods industrial development and that unless a technological base is built up quickly, the developing country will never be able to be self-reliant and will continue to depend upon other countries for every little help. The role of developed and more developed developing countries and of international organizations like UNIDO becomes very important for purposes of providing the facilities and assistance to the needy developing countries in their training programmes. In other words, the concept of international co-operation would be very much applicable in the field of training.

As an initial step, therefore, those developing countries which need some assistance for preparation of a comprehensive manpower plan could draw upon the expertise available with the developed and developing countries and with the international organizations like the UNIDO.

Other developing countries which already have a manpower plan may be interested in obtaining assistance from other countries for supplementing the training programmes. This could be done either bilaterally or through the **Secretariat** of UNIDO which can provide experts as well as arrange the linkage between the interested parties.

Qn. 11 Would the consultation like the UNIDO to make a special study of the manpower planning in the developing countries, especially the LDCs, with specific reference to the development of capital goods industries through international co-operation?

11.0 Problems of financial constraints:-

11.1 Quantum

A recent study carried out by UNIDO has revealed that, to achieve the Lima target, the developing countries will need a total investment in manufacturing of about $ 1,411 bn. in the period 1980 - 2000. The growth in the manufacturing investment will be from an annual level of $56 bn. in 1980 to $427 bn. in 2000 (at 1975 prices). Of this, a substantial portion will have to be for the capital goods sector.

Looking at the size of investment required, the developing countries may find it extremely difficult to find enough resources from their own domestic savings. The other sectors like agriculture, irrigation, education, and health will, probably, be placing a heavy demand on these savings. Consequently, the money available for capital goods sector may be rather limited. The extent to which each country will be able to divert its internal resources towards capital goods programme will, of course, depend on its national policy and the priorities accorded to each sector. In all likelihood a major portion of the financial resources will have to be found from outside areas. This may be in the shape of governmental aid or loans as well as assistance from various commercial and international institutions like the World Bank.

Some of the developing countries may also be able to obtain credits through export financing agencies in the developed countries and through the Euro market.

It is obvious that unless the developing countries are successful in their quest for funds, -- adequate and sufficiently low cost -- their ambitious programmes of capital goods development may end up in failure.

11.2 Cost of financing

The issue that confronts the developing countries is, therefore, of not only finding funds in adequate quantity, but also that the funds obtained are at a reasonable cost. In other words, the cost of financing projects to be undertaken by the developing countries should be low enough to make the venture economically and financially a viable proposition.

For example, if the developing country has to finance its project by obtaining credit through Euro market, cost of financing may prove to be too heavy. If the present inflationary tendencies and the price rises continue, there is every possibility that the average cost of financing through the Euro currency credit may be as high as 20% to 25% in the next few years. Very few industries would have a cash flow that would enable repayment of this type of loan.

11.3 Suggested action by developed countries

Sources of financing being mostly in the developed countries (exception being the OPEC countries), it is for them and their governments to seriously consider the ways and means of helping the developing countries to find adequate low cost funds for their programmes of capital goods development. Some suggestions for their consideration are outlined below:-

a) Larger quantum of aid/loan and in an untied form;

b) Change in the concept of project financial appraisal;

c) Special financing for infrastructure development; and

d) Encouragement to financial institutions and to small and medium scale industries.

11.4 (a) Increased aid/loan - untied

The overseas development assistance provided by the OECD countries will have to be raised substantially. At present, this ODA represents only 0.31% of the GNP. The contribution from the centrally planned economies is even lower. In contrast the OPEC countries have provided over 2.0% of their GNP in aid each year since 1974.

The credit which is provided by a number of developed countries is, generally, in the form of a tied credit. No doubt, this is done with a view to promoting the export of equipment and technology from their own country. Unfortunately, the effect of tied credit of this type turns out to be disadvantageous for the developing countries. The higher price that the developing countries have to pay for their purchases, as a result of the credit being tied, is well-known.

Qn. 12

Would the governments of the developed countries, appreciative as they are of the problems of the developing countries, not consider providing larger quantum **of** aid and of loan in an untied form or devise a system whereby the price paid to the supplier from the developed country for equipment, technology, etc. is at a reasonable cost and not higher than the world prices?

(b) Financial appraisal

An issue closely linked to the question of financing is the assessment methodology for determining the viability or the bankability of the project. The conventional methods preclude the possibility of a large number of projects in the developing countries passing the test and consequently they would **not qualify** for any assistance from the financial agencies.

But would this stand be justified on socio-political **grounds?**

There has to be a radical rethinking by the financial institutions and the governments of the developed countries on the question of such project appraisals. **New criteria need to be worked out** which must take into consideration a total quantification of all the social benefits which would accrue over a long period of time to the country, in case the project gets established. Unless this issue is given a serious consideration, most of the projects for capital goods industries will continue to be denied financial assistance in the shape of long-term loans on the plea that the projects are not bankable or viable.

Whenever the problem of financial requirement for the industrialization of the Third World countries is raised in an international finance forum, the response is that adequate funds are available for the "worthwhile" projects. Unfortunately, this only presents a distorted picture and in the final analysis, a large number of projects which may be highly beneficial from the countries point of view might not succeed at all in getting financial help.

Qn. 13

Would it not be appropriate for the developing countries to expect that the lending agencies and the developed countries consider the adoption of a new criteria for judging the viability of the projects in the developing countries?

(c) Finance for infrastructure

A serious problem that is faced by most of the developing countries is the absence of infrastructure facilities for the development of capital goods industries. Consequently, the priority area in which they have to concentrate is the development of infrastructure, involving construction of roads, railways, port facilities, water supply, power supply, etc. Such developments will, however, need large sums of money. Further, the financial resources utilized for the infrastructure development would not be able to yield adequate returns for quite some time. Hence the source from which these funds come will have to be either the domestic savings or aid from foreign countries or, in the last resort, credit at extremely low rates of interest.

Special financing

A direct participation by the governments of the developed countries is needed for tackling this problem. Besides providing larger aid, they could also influence their financing agencies like the commercial banks to consider a system of differential rates of interest under which, the developing countries, particularly the LDCs, would be able to obtain concessional finance with long repayment periods.

Another alternative could be for the governments of the developed countries to set up a special fund for subsidizing the financing agencies for the loss of income likely to be suffered by them in charging a very low rate of interest.

Qn. 14

Would the developed countries not like to consider devising special measures for financing infrastructure development in the developing countries?

(a) Encouragement to smaller banks/ industries

The governments of the developed countries could also consider encouraging their smaller second line banks to invest in the developing countries. These banks are hesitant to participate in the development programme of the developing countries mainly because of their lack of experience or their ignorance about the investment climate and the investment policies of the developing countries. The governments of the developed countries, which have already set up centres for investment promotion, could direct their attention towards these second line banks and provide them with all necessary information regarding investment possibilities, investment security, etc. in the developing countries.

Besides the governments of the developed countries, other agencies which do the bilateral or multilateral co-financing would also have to give their active help and encouragement to these banks.

Participation of the smaller second line banks from the developed countries would be doubly beneficial to the developing countries. It would help to increase the funds availability. And it would encourage the small and medium scale enterprises to go in larger numbers to the developing countries to co-operate in their industrial programmes.

Under the present system of borrowing, the larger borrowers or in other words, the larger projects get preference from the lending agencies. Consequently, it is the multinational companies or big companies, participating in the capital goods development in the developing countries, that are able to corner most of the financial resources from the large banks and financial institutions. The small and medium scale enterprises do not find it easy to obtain the finance.

Qn. 15

Would it, therefore, not be of advantage, if the developed countries give a more concentrated help and encouragement to these second line banks for financing the smaller size companies from the developed countries in their capital goods ventures in the developing countries?

There are also the two bilateral financial institutions that are functioning at the EEC group level (European Investment Bank) and the CMEA group level (International Investment Bank), which undertake the financing of industrial projects. These two institutions need to be strengthened so as to enable them to extend their area of operation more intensively in the developing countries for financing their capital goods industry programme.

A more concentrated support by the governments and the financial institutions of the developed countries to their small and medium scale enterprises would generate in them, the confidence needed to participate in the industrial programmes of the developing countries.

11.5 Buy-back system

The concept of barter like deal or buy-back system, relating to long-term investment, is also closely linked to the problem of financing. Under this system, the loan is to be repaid through sale of product -- or products -- by the developing country to the developed country. Fixation of the price of the products, therefore, assumes considerable importance.

It is not easy to make a deal of this type. This requires considerable knowledge with regard to the prices and the market conditions. The developing country has to be fully conversant with the international pricing system, demand forecasts for the products and the future fluctuations of the prices.

To have the above knowledge means that the developing country should have a strong planning and monitoring organization, which could advise the agency that is trying to enter into a barter like deal with a foreign partner. Not many developing countries can lay claim to such a system or to the possession of this type of knowledge.

Unless, therefore, the gap in the knowledge of the developing countries is filled, they would invariably lose out in the adoption of this barter like system. The developing countries will have to draw upon the expertise available with in international organizations like the UNIDO in advising them on such barter deals. In specific cases, they could also obtain assistance from some of the more developed developing countries which may be in a position to help.

In view of the importance of industrial financing **UNIDO has already set up a working group on the** subject and this group is studying the entire question of financing in its full details.

In the meantime, would the Consultation like to recommend that the developing countries continue to avail increasingly of the expert assistance available with the international organizations like UNIDO in making the financial arrangements for their capital goods projects? Qn. 16

12.0 Role of international agencies like UNIDO:-

In their drive towards industrialization and rapid development of capital goods industries, the developing countries could draw heavily upon the expertise available with the international agencies like UNIDO.

An intensive integral industrial investment and project service could be provided by UNIDO in all fields of capital goods programme development right from the project conception stage up to its implementation. The assistance could be in the form of experts, seminars, consultations and manpower training programmes.

In the field of international co-operation, UNIDO's function would be as a catalyser and a co-ordinator for bringing the two parties together.

With regard to the contractual negotiations, certain models and manuals prepared by organizations like UNIDO, World Industry Property Organization (WIPO), etc., already exist, which could serve as a guide for the developing countries. In addition, UNIDO, in co-operation with other organizations like the Centre for Transnational Corporations (CTC), could provide expert advice on all matters concerning negotiations with the large companies for making contractual arrangement.

In specific cases, participation of a UNIDO representative in the contractual negotiations, where the parties are the governments of the developing and of the developed countries and the enterprises of the two sides, would be of help in ensuring the reasonableness of the terms of the contract and in protecting the interest of the developing countries.

The development of capital goods industries needs to be examined further on a regional basis. For this purpose, UNIDO could organize regional consultations and also could carry out survey for determining the possibilities of establishing industries under the Regional Co-operation concept.

UNIDO could also help the developing countries in the formulation of their co-ordinated policy with regard to their national manpower plan, incentive schemes and guidelines.

Conclusions

International economic relations are characterized by more and more distinct interdependence in the future. Developing countries have gradually realized the necessity of putting this emerging interdependence on a more equitable footing having been aware of their own economic backwardness but also of the value of their resources. To this end, various paths and forms have been opened for negotiations between developed and developing countries. Exchange of technology against natural resources leads to a better balance between partners and equal exchanges.

Industrial co-operation, particularly in the area of capital goods requires the establishment of long-term economic relations between the parties involved. There is therefore a need for long-term industrial arrangements suited to individual industrial sectors. Direct state involvement is needed in order to secure energy and mineral resources as well as technology needed for development.

Co-operation among developing countries is another important area leading to collective self-reliance and progress. The scope for technical and economic co-operation among developing countries is immense and should be broaden in the future. Exploiting this potential should be a key element in the strategy of developing countries and a concrete step in strengthening the solidarity in this part of the world.

Summary and recomendations

In the process of industrialization of developing countries a variety of capital goods have been purchased, installed and put into production or construction in industry, agriculture, transport, building and civil engineering, telecommunications and services. Therefore in all developing countries capital goods are there, known through production operations, maintenance, spare parts production, etc., though in different stages and profundity. Some small and medium-size developing countries have penetrated into the capital goods industry and have been able to produce simple agricultural machinery like hand-tools for agriculture and agricultural implements drawn by animals, hand-tools for mechanical purposes and for the building industry, containers, water boilers, pumps, parts and components for maintenance and repair, assembling of tractors, trucks, busses and cars, some are at the beginning of this process.

There are many developing countries, particularly small, essentially agricultural, with no production of machinery and equipment but with experience in operating and maintenance of capital goods. Some of these countries have small scale production of parts and components for maintenance purposes, undertake repairs. In many of these countries there are workshops, including rural, which have been doing repair and maintenance jobs and could be a nucleus for expansion, modernization and provide better capital goods with wider possibilities in import substitution and export promotion. Such expansion has to be well prepared and managed in order to avoid excessive losses in foreign exchange through imports of parts, components, necessary for final assembly as well as to secure utilization of installed capacities and profitable operations. In this connection, experiences of some more advanced countries are of interest.

The development of capital goods industry should be connected with goals of economic development of a specific country. Goals and targets differ at different stages and for different groups of countries. It could be:

- the dynamic development of agriculture and agro-based industries including capital goods for modernization of agriculture and food processing industries to ensure food for the population;
- creation of a minimum industrial complex as a prerequisite for a stable development with relatively high rates of growth and specialization in capital goods industry;
- predominantly export oriented industrial development incl. capital goods accompanied by emergence of industrial centres (enclaves) in the country's economy; industrial centres for capital goods production will stimulate the development of different country areas, small units, accelerate training, technical education, research.

During the initial stage of development, production could be oriented to satisfying local needs while soon after the orientation should be to the establishment of intensive connections with other countries. Such principles as graduality, selectivity and phase by phase development of capital goods industry should be widely used. Particular attention should be given to the:

- orientation towards groups of products which use local raw materials and semi-finished products or components;
- initial orientation towards groups of products with low technological complexity which constitute the foundation of the future production of more complex products incl. initial assembly and gradual local production;
- avoiding small series and special orders the production of which would require a significant engineering potential;
- broad application of foreign experiences in order to increase qualification of labour;
- development of production structures based on a long term international co-operation, specialization and stable needs.

Part of the production exceeding the domestic market is not always easy to export without co-ordination and co-operation agreements and international contracts. In this respect the principles of the international economic and scientific co-operation applied within the COMECON countries may be of interest to developing countries as well as the favourable experiences e.g. of Bulgaria in developing capital goods industry in this framework.

The liquidation of economic backwardness and the development of modern industrial sectors such as the capital goods industry would be impossible without the State and its decisive role. State action may take various forms:

- establishment of a clear long-term economic, industrial and sectoral policies;
- promotion of planning and plan implementation mechanism;
- establishment and development of research, engineering and standardization services;
- establishemnt of credit and financing institutions for promotion of local industry;
- in conformity with the long-term industrial policy and goals create/improve technical education and training facilities;
- creation of a State sector in production, technological infrastructure, foreign trade, banking and credit activities,
- establishment and development of institutions to expand production co-operation as well as regional educational and training programmes with other countries in order to speed up creation of capital goods industries;
- utilization and promotion of appropriate indigenous technologies and in co-operation with other governments gradual transformation of existing selected technological institutions into regional centres.

A. ACTION PROPOSED FOR THE DEVELOPING COUNTRIES

- To set up a strong central planning organization for preparation of capital goods production programme and manpower training plans, etc.;
- To adopt a uniformity of approach with regard to financial incentives for attracting foreign investment and evolving a common policy;
- To determine a clear cut policy on foreign investment and avoidance of restrictive practices and on standard contractual terms with regard to payment for royalty, development of indigenous expertise, performance guarantees, etc.

B. ACTION PROPOSED FOR THE DEVELOPED COUNTRIES

- To assume direct obligation and responsibility on behalf of their enterprises for the contractual terms and performance of the project;
- To provide backing to the performance guarantee given by the enterprise;
- To consider establishment of an investment consortium with its enterprises for supporting guarantees for the project covering not only the performance of the plant in terms of its output and quality but also for consumption of the input materials, training of personnel, developmental damage, etc;
- To consider increasing aid and concessional credits to the developing countries with larger amounts being in an untied form;
- To concentrate on assisting the small and medium scale industries to participate in capital goods production programmes in the developing countries;
- To formulate special financial incentive schemes for encouraging small and medium scale enterprises from their countries to invest in the developing countries. This could also cover those industries which want to move to the developing countries as a part of the re-deployment programme of the developed country;

- To establish a special fund for subsidizing the interest on loan which the developing country may have to obtain from commercial sources;
- To give special facilities for development of infrastructure in the developing countries;
- To consider relaxation of the trade barriers which would also facilitate repayment of loan by the developing countries through a barter like arrangement;
- The developed countries should view the entire scheme of assistance to the developing countries in the light of 'mutuality of interest' and encourage actively the redeployment of their industries and the restructuring of world capital goods industry.

C. ACTION BY UNIDO

To assist developing countries, UNIDO has organized and is going to reinforce a capital goods development programme in all three main regions. Assistance to developing countries will be expanded and centred on:

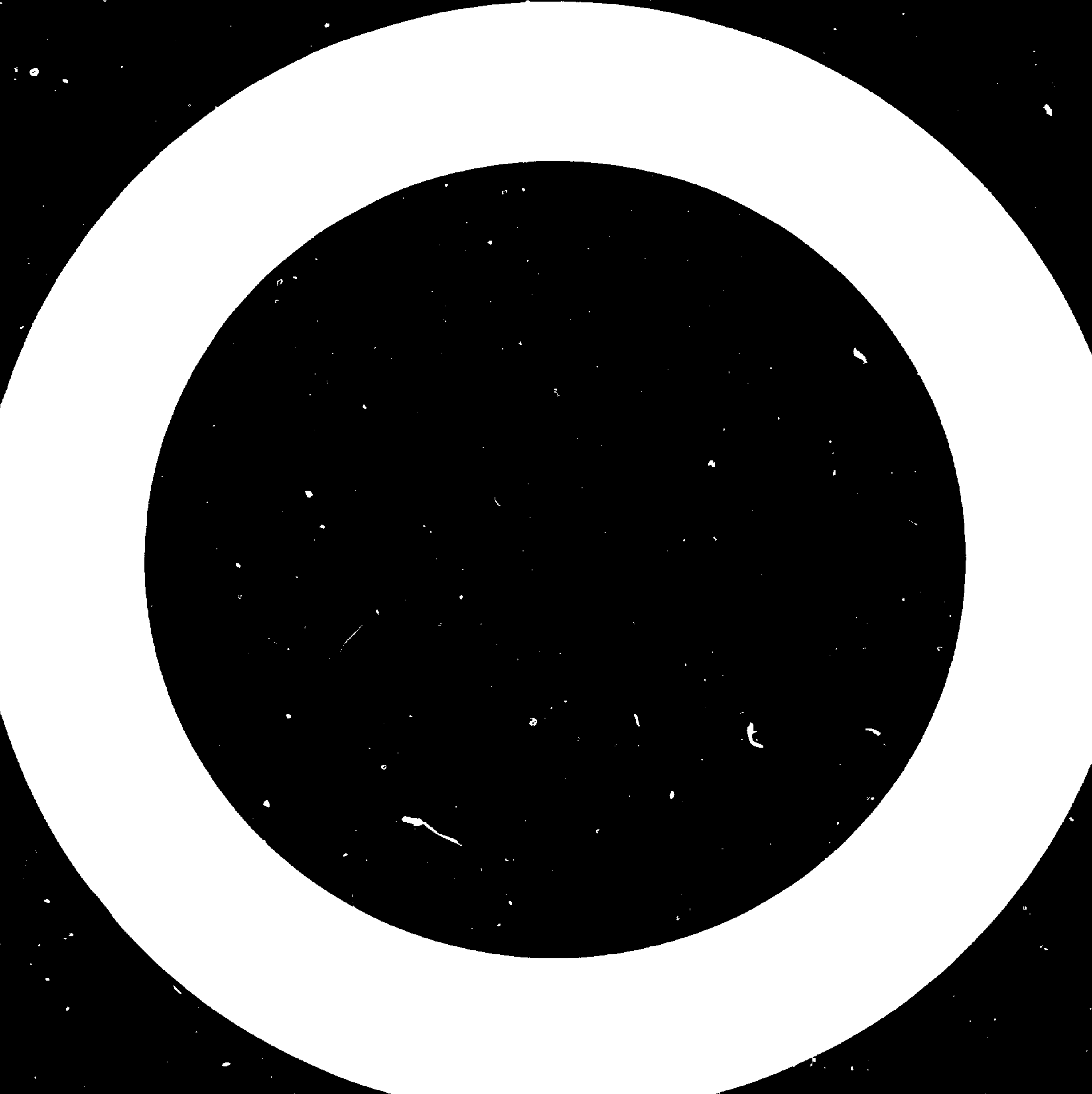
- research and formulation of national and regional development strategies in capital goods sector;
- project identification, sectoral planning and plan implementation including pilot project establishment and management;
- identifying potentials for regional and inter-regional co-operation among developing countries;
- promoting local research, design capacities and industrial information systems;
- training, improvement of capacity utilization, promotion of a repair and maintenance network.

List of documents used as inputs for the preparation of the Global Study

	Document Number	Languages
1. Capital Goods in the Developing Countries	ID/WC.324/3	E, F, S
Consultants' Inputs:		
Institute for Economic Research and Development Planning University of Social Sciences, Grenoble		
2. The Actors in the Capital Goods Industry		E, F
3. Typology of the Developing Countries		E, F
4. The Typology of Capital Goods		E, F
5. The Satisfaction of Basic Needs and the Production of Capital Goods in the Developing Countries		E, F
6. Transfer of Technology and Engineering in the Capital Goods Industry		E, F
7. Automated Capital Goods: - The actors - Their impact on the production conditions		E, F
8. Capital Goods for the Production and Distribution of Electrical Energy		E, F
9. Strategies for Entry Into the Production of Capital Goods for Electrical Energy		E, F
10. Iron and Steel Making Equipment in the Developing Countries		E, F
11. Capital Goods for the Iron and Steel Industry. The Case of Mini Steel Plants		E, F
12. Capital Goods for the Petrochemicals and Fertilizers Industries in the Developing Countries		E, F
INITEC Associated with Tecniberia, Madrid, Spain		
13. Study on the Analysis of Capital Goods for the Construction and Public Works Industry		E, S,

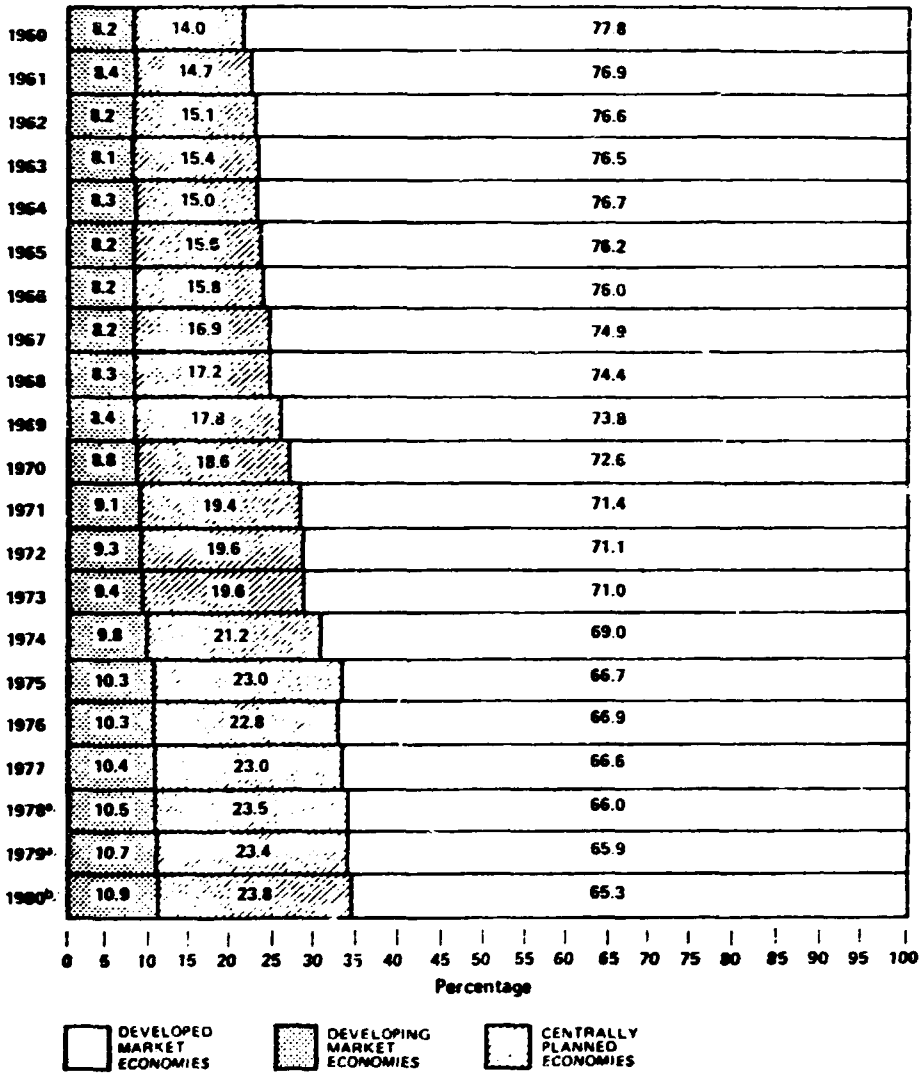
		Document Number	Languages
	ICME Business Consultants, Zurich, Switzerland		
14.	Capital Goods Common to all Branches of Industry, Excluding Machine Tools and Electric Power Generation and Distribution Equipment Worked out by UNIDO Consultants: Mario Samame Boggio with the Assistance of Alberto Ferreyros		E
15.	Study on Capital Goods for the Mining Sector in the Andean Region INITEC, Madrid, Spain		E, S
16.	An Analysis of Machinery for the Food-Processing Industry Prepared by the Research Institute of Engineering Technology and Economy Prague, Czechoslovakia		E, S
17.	Study on the Capital Goods Industry "Machine-Tools Industry" Summary Country Studies prepared by Metra/Seis		E
18.	Study of the Development and Growth of the Capital Goods Industry in Spain - Summary and Conclusions Prepared by UNIDO Consultant: Cristian Gillen	ID/WG.324/2	E, S, F
19.	The Production of Capital Goods in Developing Countries at an Intermediate State of Development: The cases of Guatemala and Peru Prepared by Institute of Economics, Bulgarian Academy of Sciences	ID/WG.324/7	E, S, F
20.	Development of the Capital Goods Industry in Bulgaria Summary and Conclusions Prepared by PROMASZ (Bureau of Studies and Projects' Development of Engineering Industry) Warsaw	ID/WG.324/8	E, S, F
21.	Development of the Capital Goods Industry in Poland	ID/WG.324/12	E

		Document Number	Languages
22.	Technology in the Service of Development /Prepared in co-operation with UNIDO Consultant F. Vidossich/	ID/WG.324/4	E, F, S
23.	Some Aspects of Transfer of Technology and Engineering in the Capital Goods Industry /Prepared in co-operation with Institute for Economic Research and Development Planning University of Social Sciences, Grenoble/	ID/WG.324/4Add.1	E, F, S
24.	Technical Annex /Prepared in co-operation with UNIDO Consultant F. Vidossich/	ID/WG.324/4Add.2	E, F, S
	Prepared by UNIDO Consultant: L. Wasilewski, Poland		
25.	Types of Technologies in the Service of the Capital Goods Industry's Development	ID/WG.324/10	E, F, S
	Prepared by UNIDO Consultant: A. Benbouali, Algeria		
26.	Long-term Contractual Arrangements for the Setting up of the Capital Goods in the Iron and Steel Industry	ID/WG.324/6	E, F
27.	Concepts and Proposals Concerning New Contractual Arrangements for Setting up of Capital Goods Industry	ID/WG.324/1	E, F
28.	Development of capital goods industry in China - country study prepared by Li Yong-Xin, The First Ministry of Machine Building, China, March 1981		E
29.	Prepared by UNIDO Consultant: Viliam Cerniansky with the assistance of N. Ordnung and M. Lexa Some Aspects of the International Economic Co-operation between CMEA and Developing Countries in the Field of Capital Goods Industries		E



ANNEX

Table 1. *Share in world manufacturing value added by economic grouping at constant prices, 1960-1980*



Source: UNIDO data base. Information, at constant prices, supplied by the United Nations Office of Development Research and Policy Analysis, the United Nations Statistical Office and the United Nations *Monthly Bulletin of Statistics*, November 1980, with estimates by the UNIDO secretariat.

[a] Preliminary figure.

[b] Estimate.

Note: The percentages shown here differ slightly from previous shares published by UNIDO because the United Nations has shifted the base year for all constant price data from 1970 to 1975. This is a standard procedure, undertaken periodically to adjust for changes over time in the relative importance of the various components of economic activity within each country. The resulting changes shown here also reflect different rates of inflation in countries (which, in turn, alter the country's weight in calculation of the new base year values) and different consequences resulting from the devaluation of the United States dollar between 1970 and 1975, as well as statistical biases normally associated with any such adjustment. In comparison with previous values estimated in 1970 dollars, the new shares are slightly higher for developed market economies, slightly lower for centrally planned economies and marginally higher for developing countries. Figures exclude China. Other conceptual issues are referred to elsewhere. See *World Industry Since 1960: Progress and Prospects* (United Nations publication, Sales No. E.79.II.B.3), pp 33-34. Totals may not add precisely because of rounding.

Table 2. Structure of world production by value added (ISIC) 38 by economic groupings and 1975 constant prices[a]

1975 = 100

	1960			1970			1975			1977			1978		
	Million US dollars	Index	Share (%)	Million US dollars	Index	Share (%)	Million US dollars	Index	Share (%)	Million US dollars	Index	Share (%)	Million US dollars	Index	Share (%)
Developed market economies	146,615.2	38	71.4	337,913.2	88	75.8	383,992.3	100.0	67.2	437,751.2	114	66.0	460,790.8	120	65.5
Centrally planned economies	48,524.5	31	23.6	89,735.1	58	20.1	154,715.7	100.0	27.1	185,658.8	120	28.0	201,130.4	130	28.6
Developing market economies	11,384.0	35	5.5	19,113.2	58	4.3	32,953.8	100.0	5.8	36,908.3	112	5.6	39,544.6	120	5.6
of which:															
Asia	2,499.6	29	1.2	5,237.2	60	1.2	8,728.7	100.0	1.5	10,910.9	125	1.7	12,482.0	113	1.8
Latin America	8,724.4	39	4.3	12,871.1	57	2.9	22,580.8	100.0	4.0	23,935.6	106	3.6	25,064.7	111	3.6
Africa[b]	160.0	10	0.1	1,004.9	61	0.2	1,644.3	100.0	0.3	2,061.8	125	0.3	1,997.9	122	0.3
World[c]	205,278.6	36	100.0	445,896.2	78	100.0	571,661.8	100.0	100.0	663,127.7	116	100.0	703,144.0	123	100.0

Source: Base year figures are supplied by the United Nations Statistical Office, New York. All other figures are calculated from indices published in United Nations, Statistical Office, Yearbook of Industrial Statistics, 1978 edition, Vol. I, New York, 1980; and 1972 edition, Vol. I, New York, 1974.

[a] The percentages shown here differ from those published in previous studies since the United Nations has shifted the base year for constant price data to 1975. Previously published data were based on 1963-based data and did not reflect a previous transition of the United Nations to 1970-based data. The present data therefore reflect qualitative changes (largely between 1963-based data and 1970-based data) as well as different rates of inflation in countries (which in turn alter the countries' weight in calculation of new base year values) and different consequences resulting from the devaluation of the United States dollar between 1963 and 1975, including statistical biases normally associated with any such adjustment. In comparison with previously published figures, shares of the developed market economies are higher as are those for developing market economies. Shares for centrally planned economies are correspondingly lower.

[b] Includes developing Oceania which comprised $36.7 million in 1975. The index is derived from the raw figure which is obtained as a residual.

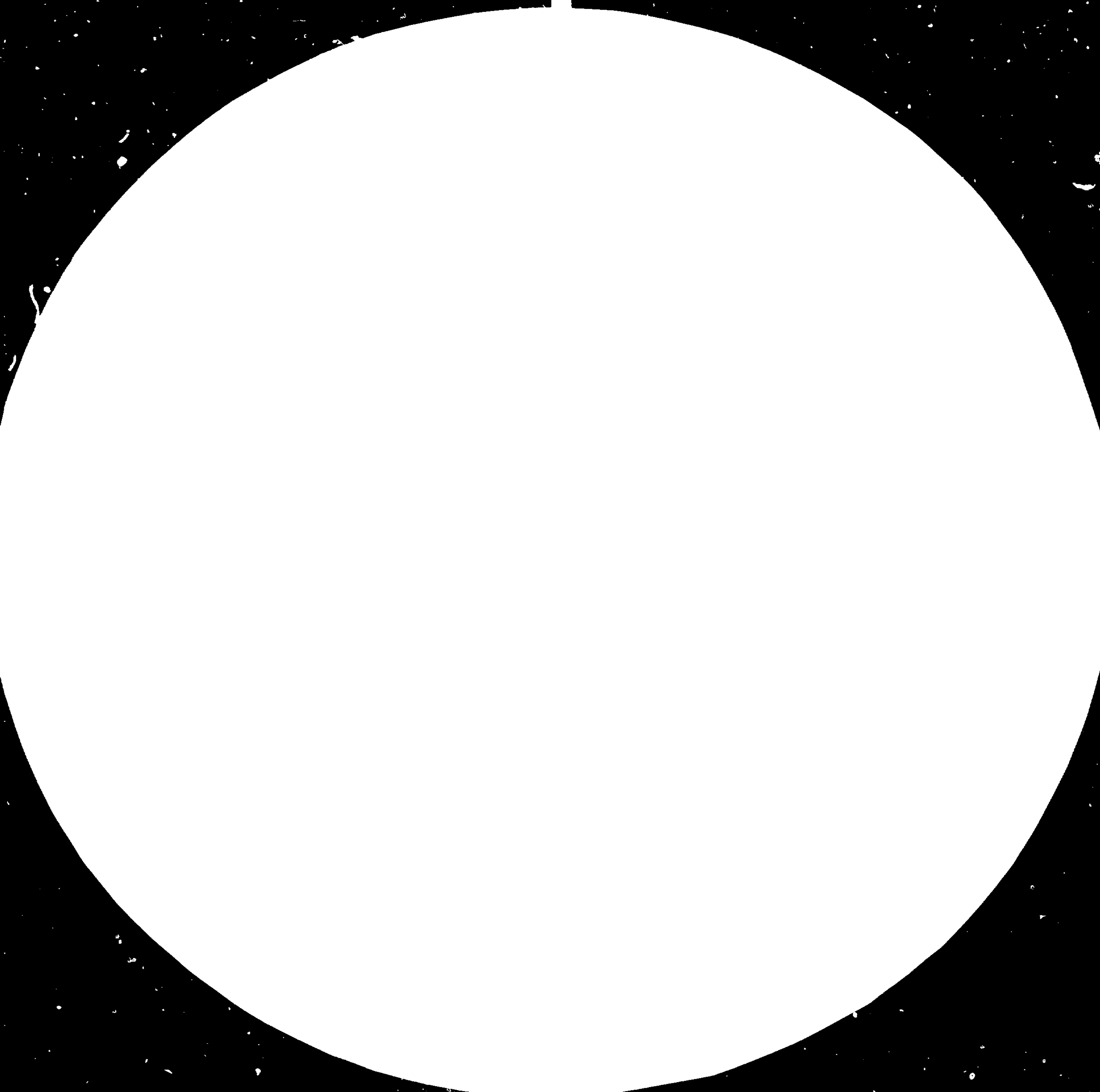
[c] Excludes Albania, China, Viet Nam and the People's Democratic Republic of Korea.

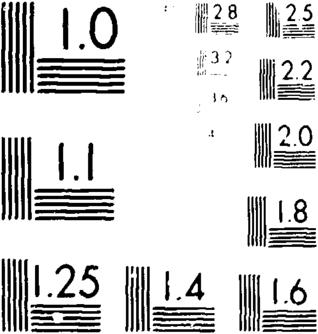
Table 3 WORLD EXPORTS AND IMPORTS OF ENGINEERING PRODUCTS, 1978

(Current prices)

	Exports		Imports	
	10^6 US$	%	10^6 US$	%
Developed market economy countries	324,771	88.2	220,404	59.9
of which: West Germany	66,847	18.2	23,895	6.5
U.S.A.	60,156	16.3	44,871	12.2
Japan	55,511	15.1	4,518	1.2
France	27,822	7.6	19,319	5.3
U.K.	24,432	6.6	17,665	4.8
Italy	18,400	5.0	10,765	2.9
Canada	14,698	4.0	19,233	5.2
Developed planned economy countries	36,410	9.3	37,492	10.1
of which: U.S.S.R.	9,906	2.7	17,491	4.8
Czechoslovakia	5,603	1.5	3,557	1.0
Developing countries	9,385	2.6	110,326	30.0
World total	370,565	100.0	370,565	100.0

Source: Bulletin of Statistics on World Trade Engineering Products, 1978, ECE United Nations, New York 1980





MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Table 4

DEVELOPMENT OF TRADE IN ENGINEERING PRODUCTS BETWEEN ECONOMIC REGIONS
(MILLIONS OF CURRENT US DOLLARS)

To / From	Developed market economy countries		Developed planned economy countries		Developing countries		World	
	1970	1978	1970	1978	1970	1978	1970	1978
Developed market economy countries	57,617.9	211,722.9	2,376.7	12,667.2	18,419.6	100,330.6	78,414.2	324,770.7
Developed planned economy countries	800.1	3,282.5	7,202.7	24,819.6	2,055.7	5,965.6	10,072.2	34,067.7[1]
Developing countries	504.5	5,439.0	7.6	5.6	455.6	4,030.0	967.7	9,384.6
World	58,922.5	220,404.3	9,587.0	37,492.4	20,940.9	110,326.2	89,454.1	368,222.9[1]

[1] **Excludes exports of Romania not distributed by destination of** 2,342.3

Source: **Bulletin of Statistics on World Trade in Engineering Products,** 1978, **ECE, United Nations, New York** 1980.

Table 5

DEVELOPMENT OF TRADE IN ENGINEERING PRODUCTS BETWEEN ECONOMIC REGIONS
(PERCENTAGES)

To	Developed market economy countries		Developed planned economy countries		Developing countries		World	
From	1970	1978	1970	1978	1970	1978	1970	1978
Developed market economy countries	to 73	to 65	to 3	to 4	to 23	to 31	to 100	to 100
	from 98	from 96	from 25	from 34	from 88	from 91	from 88	from 88
Developed planned economy countries	to 8	to 10	to 72	to 73	to 21	to 18	to 100	to 100
	from 1	from 1	from 75	from 66	from 10	from 5	from 11	from 9
Developing countries	to 52	to 57	to 1	to E	to 47	to 43	to 100	to 100
	from 1	from 2	from E	from E	from 2	from 4	from 1	from 3
World	to 66	to 59	to 11	to 10	to 23	to 30	to 100	to 100
	from 100	from 100	from 100	from 100	from 100	from 100	from 100	from 100

Source: Bulletin of Statistics on World Trade in Engineering Products, 1978, ECE, United Nations, New York 1980.

Table 6

Countries having an embryonic capital goods industry
Classification by absolute and relative number of employees(1)

Country	Class 382		Class 38		Manpower in Class 38 as % of Class 3
	Manpower (10^3)	Ranking	Manpower (10^3)	Ranking	
India	279	1	1,266	1	22.7
Brazil	153	2	518	2	24.2
Argentina	?	3	399	3	20.9
South Korea	47.7	4	295.3	4	21.1
Turkey	41.8	5	156	5	22.1
Colombia	15.8	6	79	10	17
Malaysia	14.6	7	70	11	23.6
Chile	14.2	8	60	16	22.4
Singapore	13.7	9	97	8	50
Egypt	12.4	10	83	9	12.7
Philippines	12.0	11	65.4	13	12
Hong Kong	11.9	12	159.9	6	22.9
Pakistan	10.5	13	54.5	17	11.9
Indonesia	8.8	14	61.6	14	8.4
Peru	8.7	15	40	18	15.3
Iran	8.2	16	68.5	12	16.0
Venezuela	7.6	17	61.5	15	18.5
Sri Lanka	6.2	18	21.0	20	17.9
Thailand	6.9	19	39.55	19	12.6
Mexico	6.0	20	105.55	7	?
Iraq	5.75	21	20.0	21	15.2
	Other countries for which 38/3 > 10%				
Kuwait	1.3	24	4.5		16.7
Zambia	1.0	25	8.5		17
Mauritius	0.7	26	4.1		15.3
Kenya	0.5	27	26.3		25
Nigeria	0.4	28	20		11.5

Source: Yearbook of industrial statistics 1974-1975, except Argentina

Table 7

Imports, Production, Consumption of engineering products(1) (Class 38) - Estimate for 1977 (China excluded)

	Hypothesis		Imports		Consumption			Production(2)	
	P/C	I/C	10^6 US$	%	10^6 US$	%	per cap. consumption $	10^6 US$	%
India	0.85	0.15	1,350	1.5	9,000	5.7	14	7,650	11.1
Countries having an industrial base	0.65	0.35	22,900	26.0	65,500	41.7	141	42,600	61.8
Countries with an industrial base in the course of formation	0.30	0.70	24,900	28.2	35,600	22.7	131	10,700	15.5
Countries producing raw materials	0.20	0.80	31,680	35.8	39,000	24.8	108	7,320	10.7
Agricultural countries	0.08	0.92	7,470	8.5	8,100	3.1	12	630	0.9
TOTAL	0.44	0.56	88,300	100	157,200	100	75	68,900	100

(1) Engineering industries

(2) Production data do not correspond with information contained in table 2 due to different methodology.

Table 8 - UNIDO Model - EVOLUTION OF THE MACRO-ECONOMIC MAGNITUDES

Hypothesis 1

	Developed countries			Developing countries		
	1970 (US$b)	Annual rate of increase as %	2000 (US$b)	1970 (US$b)	Annual rate of increase as %	2000 (US$b)
Gross domestic product (GDP)	2,723.09	4.0	8,831.77	363.01	8.0	3,690.64
Manufacturing output	1,465.86	4.3	5,247.64	96.58	9.6	1,531.12
Manufacturing (added value)	586.35	3.9	1,835.83	42.38	9.3	612.21

Hypothesis 2

	1970 (US$b)	Annual rate of increase as %	2000 (US$b)	1970 (US$b)	Annual rate of increase as %	2000 (US$b)
Gross domestic product (GDP)	2,723.09	2.6	5,934.00	363.01	6.5	2,420.42
Manufacturing output	1,465.86	2.9	3,409.83	96.58	8.2	1,020.87
Manufacturing (added value)	586.35	2.5	1,224.83	42.38	7.8	408.32

Table 9

DEVELOPMENT OF PRODUCTION, NET EXPORTS AND REQUIREMENTS FOR MECHANICAL MACHINERY, ELECTRICAL MACHINERY AND INSTRUMENTATION

Hypothesis 1: Rate of growth of the GDP in the developed countries of 4%

	Developed countries				Developing countries			
	1970 (US$b)	2000 (US$b)	Factor of increase	Annual rate of growth	1970 (US$b)	2000 (US$b)	Factor of increase	Annual rate of growth
Production (output)	274.70	1,068.07	3.88	4.6	8.80	215.40	24.5	11.2
Net exports	10.60	168.31	16	9.6	- 10.80	- 173.34	16	9.6
Consumption (requirements)	264.10	899.76	3.40	4.2	19.60	388.74	19.8	10.5

Hypothesis 2: Rate of growth of the GDP in the developed countries of 2.6%

	Developed countries				Developing countries			
	1970 (US$b)	2000 (US$b)	Factor of increase	Annual rate of growth	1970 (US$b)	2000 (US$b)	Factor of increase	Annual rate of growth
Production (output)	274.70	712.71	2.59	3.2	8.80	144.86	16.4	9.8
Net exports	10.60	111.6	10.5	8.2	- 10.80	- 118.36	10.5	8.2
Consumption (requirements)	264.10	601.11	2.27	2.8	19.60	+ 263.22	13.40	9.0

Table 10 - Definition of the scenarios(1) (2)

Relations between the developed countries	Joint management				Partial fragmentation between the poles
Internal dynamics of the developed societies	Consensus leading to high rates of growth	Rapid changes in values and moderate growth	Conflicts between social groups and moderate growth		
Development in relative productivities North-South relations between the DC	Convergence			Divergence	
Major increase in North-South economic trading	A	B1	B2	B3	
Accentuation of divisions between the North and the South				C	
Fragmentation of the South by regions and in liaison with the developed countries					D

(1) The fourth dimension concerning the internal dynamic of the various groups of the developing societies has been essentially taken into account at the level of the regional analyses incorporated in the scenarios.

(2) In order to avoid repeating the letters the scenarios are sometimes given the following names in the text:

A : high growth scenario
B1: new growth scenario
B2: convergent moderate growth scenario
B3: divergent moderate growth scenario
C : North-South rupture scenario
D : protectionist scenario

Despite their use these code names do not summarize the hypotheses on which the scenarios are based in a satisfactory manner.

Source: Interfuturs

Table 11 - Development of world industrial production 1970-2000 (scenarios A and B2)

Region	Rate of increase in the world added value 1970-2000						Regional distribution of the industrial added value								
	Production of machinery		Other products		Total		Production of machinery			Other products			Total		
							1970	2000		1970	2000		1970	2000	
	A	B2	A	B2	A	B2		A	B2		A	B2		A	B2
OECD	4.6	3.7	3.9	3.2	4.0	3.4	75.4	61.6	59.4	67.1	49.2	48.6	68.5	51.4	50.5
USA	3.5	2.6	3.0	2.2	3.1	2.3	31.1	18.7	17.0	30.4	17.2	16.4	30.3	17.3	16.5
Canada	4.1	3.2	3.8	2.9	4.0	2.9	2.9	2.2	1.9	2.7	2.0	1.8	2.7	2.0	1.8
Japan	6.3	6.0	6.0	5.6	6.0	5.7	10.6	13.5	15.0	6.5	8.4	9.2	7.1	9.0	10.2
EEC	4.4	3.5	3.7	3.1	3.8	3.2	26.4	22.0	21.0	21.3	14.5	14.8	22.4	15.8	15.9
Other countries	6.4	4.8	5.4	4.4	5.5	4.4	4.5	5.8	4.4	6.5	7.2	6.3	6.2	7.0	6.1
Eastern Europe	6.4	5.6	5.2	4.9	5.4	5.0	17.2	21.8	21.5	19.9	21.0	23.6	19.3	21.0	23.2
China	8.1	8.0	7.3	7.3	7.4	7.3	2.7	4.3	6.3	4.5	8.8	10.2	4.2	3.0	9.6
Third World	9.0	8.3	7.5	6.9	7.6	7.1	4.6	12.3	12.6	8.4	17.2	17.9	7.7	16.4	16.7
Latin America	9.2	8.7	7.9	7.4	8.1	7.6	3.0	8.2	8.9	4.2	9.7	10.0	4.0	9.4	9.9
East and S.E. Asia	8.4	7.8	8.3	7.5	7.2	6.5	1.3	1.7	1.8	1.2	3.1	3.1	2.4	3.0	2.9
South Asia			5.5	4.6				1.2	1.1	1.3	1.5	1.6		1.5	1.5
North Africa/Middle East	10.0	7.5	7.3	6.4	7.5	6.4	0.3	1.1	0.6	0.9	1.9	1.8	0.8	1.7	1.6
Black Africa	5.5	4.6	5.4	4.6	5.4	4.6	0.1	0.1	0.1	0.7	1.0	1.0	0.5	0.8	0.8
World	5.4	4.6	5.0	4.3	5.0	4.4	100	100	100	100	100	100	100	100	100

Source: Interfuturs

Table 12

Development of the structure of trading in the manufacture of machines and other manufactured goods between the market economy developed countries (A), the centrally planned developed countries (B) and the developing countries (C) from 1970 to 2000 in scenarios A and B2

Manufacture of machines

Starting situation

Importing zones

	1970	A	B	C	Total
Exporting zones	A	53.2	5.6	34.4	93.2
	B	1.1	1.0	2.5	4.7
	C	1.6	0	0.4	2.0
	Total	56.0	6.7	37.3	100.0

Other manufactured goods

Importing zones

	1970	A	B	C	Total
Exporting zones	A	51.2	5.1	21.4	77.6
	B	4.6	0.7	2.5	7.8
	C	11.8	1.3	1.4	14.6
	Total	67.5	7.2	25.3	100.0

Scenario A

Importing zones

	2000	A	B	C	Total
Exporting zones	A	41.9	10.1	32.3	84.3
	B	2.8	1.3	5.3	9.4
	C	2.3	0.1	3.8	6.3
	Total	47.0	11.5	41.5	100.0

Importing zones

	2000	A	B	C	Total
Exporting zones	A	40.2	6.2	13.9	60.3
	B	8.1	1.7	6.3	16.1
	C	13.1	4.0	6.5	23.6
	Total	61.4	11.9	26.7	100.0

Scenario B2

Importing zones

	2000	A	B	C	Total
Exporting zones	A	37.0	10.3	35.3	82.6
	B	3.1	1.5	6.9	11.5
	C	3.1	0.1	2.7	5.9
	Total	43.2	12.0	44.8	100.0

Importing zones

	2000	A	B	C	Total
Exporting zones	A	36.2	8.1	13.9	58.2
	B	7.9	1.5	5.6	15.0
	C	14.7	4.7	7.4	26.8
	Total	58.8	14.3	26.9	100.0

Source: Interfuturs

Table 13

Development of trading in capital goods in the market economy countries, 1970-2000

Imports from:

	1970	2000	
		A	B2
Market economy developed countries	95	89	85.5
Planned economy developed countries (inc. China)	2.0	6.0	7.2
Developing countries	3.0	5.0	7.2
Total	100	100	100

Exports to:

	1970	2000	
		A	B2
Market economy developed countries	57.2	49.7	44.8
Planned economy developed countries	6.0	12.0	12.5
Developing countries	36.8	38.3	42.7
Total	100	100	100

Changes in the rate of cover

	1970	2000	
		A	B2
with DC	21.5	14	11.4
with PEDC	5.09	3.6	3.3

Source: Interfuturs

Table 14

Development of trading in capital goods in the planned economy countries (inc. China), 1970-2000

Imports from:

	1970	2000	
		A	B2
Market economy developed countries	83.5	88	86
Planned economy developed countries (inc. China)	16.5	11.3	12.5
Developing countries	0	0.7	1.5
Total	100	100	100

Exports to:

	1970	2000	
		A	B2
Market economy developed countries	24	29.7	26.9
Planned economy developed countries	22	13.8	13.0
Developing countries	54	56.5	60.1
Total	100	100	100

Changes in the rate of cover

	1970	2000	
with MEDC	0.20	0.28	0.30
with PEDC	-	53	69

Source: Interfuturs

Table 15

Development of trading (Class 7) in the developing countries, 1970-2000

Imports from:

	1970	2000	
		A	B2
Market economy developed countries	92	78	78.7
Planned economy developed countries (inc. China)	6.7	12.8	15.3
Developing countries	1.3	9.2	6.0
Total	100	100	100

Exports to:

	1970	2000	
		A	B2
Market economy developed countries	80	36.5	52.6
Planned economy developed countries (inc. China)	0	1.5	1.7
Developing countries	20	62.0	45.7
Total	100	100	100

Changes in the rate of cover

	1970	2000	
		A	B2
Overall	0.05	0.15	0.13
with the OECD countries		0.07	0.09
with the PEDC		0.02	0.02

Source: Interfuturs

Table 16 - ALTERNATIVE 1 (China excluded) - The poorest countries do not improve their position

	1977					Annual rate of increase over the period		2000				
	CONSUMPTION		PRODUCTION		$\frac{P}{C}$	C	P	CONSUMPTION		PRODUCTION		$\frac{P}{C}$
	10^6 US$	%	10^6 US$	%				10^6 US$	%	10^6 US$	%	
INDIA	9,000	5.7	7,650	11.1	0.85	8.9	9.2	63,956	5.6	57,913	9.8	0.90
Countries having a major industrial base	65,500	41.7	42,600	61.8	0.65	8.9	9.5	465.460	40.9	343,506	58	0.74
Countries with an industrial base in course of formation	35,600	22.7	10,700	15.5	0.30	9.8	11.5	305,705	26.8	130,829	22	0.43
Countries producing raw materials	39,000	24.8	7,320	10.7	0.20	8.5	9.2	254,652	22.4	55,415	9.3	0.21
Agricultural countries	8,100	5.1	630	0.9	0.08	8	8	47,558	4.2	3,699	0.8	0.08
TOTAL	157,200	100	68,900	100	0.44	9.0	9.8	1,137,331	100	591,362	100	0.52

Table17 - ALTERNATIVE 2 (China excluded) - The poorest countries improve their position

	1 9 7 7	ANNUAL RATE OF INCREASE OVER THE PERIOD		2 0 0 0				
		C	P	CONSUMPTION		PRODUCTION		P / C
				10^6 US$	%	10^6 US$	%	
INDIA	AS FOR ALTERNATIVE I	8	8	52,843	4.6	44,915	7.5	0.85
Countries having an industrial base		8.5	9.1	427,686	37.5	320,764	53.6	0.75
Countries with an industrial base in course of formation		9.5	11.4	287,061	25.2	129,177	21.6	0.45
Countries producing raw materials		9	11.2	283,054	24.8	84,916	14.2	0.30
Agricultural countries		11	15.6	89,312	7.8	17,862	3	0.20
TOTAL		9	9.8	1,139,956	100	597,635	100	0.52

Table 18 Structure of the total complexity by levels,blocks and subblocks

Level of complexity	Software	Hardware =	Central production unit	Semi-finished inputs +	Services =	Technical infrastructure	Components	Total Complexity
	A1 +	A2 =	A	B1 +	B2 =	B	C	A + B + C
1	8.65	11.44	20.10	0.51	2.96	3.48	1.69	25.27
2	12.45	17.83	30.29	2.25	5.59	7.85	5.00	43.14
3	19.92	23.16	43.08	7.78	11.10	18.89	17.38	79.35
4	29.16	28.39	57.55	14.24	16.98	31.22	41.18	129.95
5	54.50	33.89	88.40	27.15	29.04	56.19	88.23	232.82
6	122.54	50.57	173.11	49.92	44.27	94.20	229.92	497.23

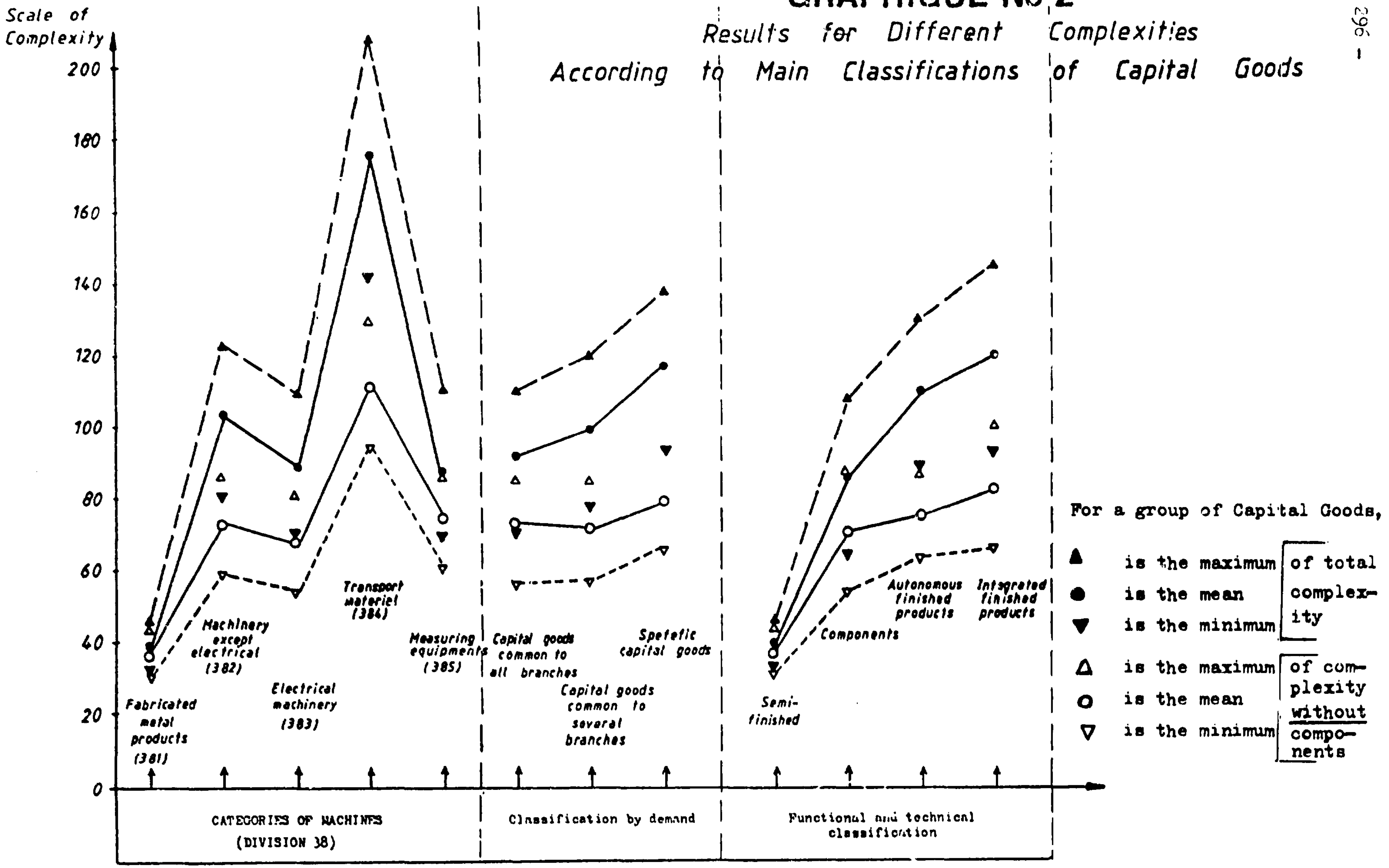
Table 19 **Breakdown of Division 38 (ISIC) by principal groups and by complexity levels**

Complexity level	Capital goods (all)	Simple metal products	Non-electrical machines	Electr. machines and equipment	Transport equipment	Industr.control and measuring equipment	Semi-finished product	Parts and sub-assemblies	Autonomous machines and equipment	Equipm. integrated into a "complicated" process	Goods common to all the branches	Goods common to several branches	Specialized goods
		381	382	383	384	385	A	B	C	D	BC TB	BC	BS
I (0 to 30)	3,5% (11)	30.0	1.9	0	0	0	33.3	3.8	3.7	0	0	5.5	3.8
II (30 to 55)	14,1% (45)	56.5	12.0	16.7	4.8	0	66.7	17.3	13.7	6.8	20.3	5.5	15.8
III (55 to 100)	40,6% (129)	13.0	42.1	58.3	23.8	84.6	0	50.0	41.1	29.5	50.7	47.2	32.3
IV (100 to 180)	32,7% (104)	0	38.4	25.0	31.0	15.4	0	28.8	29.7	56.8	21.7	35.2	36.7
V (180 to 320)	7,9% (25)	0	5.6	0	31.0	0	0	0	10.0	6.8	7.2	6.6	8.9
VI more than 320	1,3%	0		0	9.5	0	0	0	1.8	0	0	0	2.5
Total	100,0%	100% (23)	100% (216)	100% (24)	100% (42)	100% (13)	100% (3)	100% (52)	100% (219)	100% (44)	100% (69)	100% (91)	100% (158)

( ) number of products analysed

GRAPHIQUE No 2

Results for Different Complexities According to Main Classifications of Capital Goods

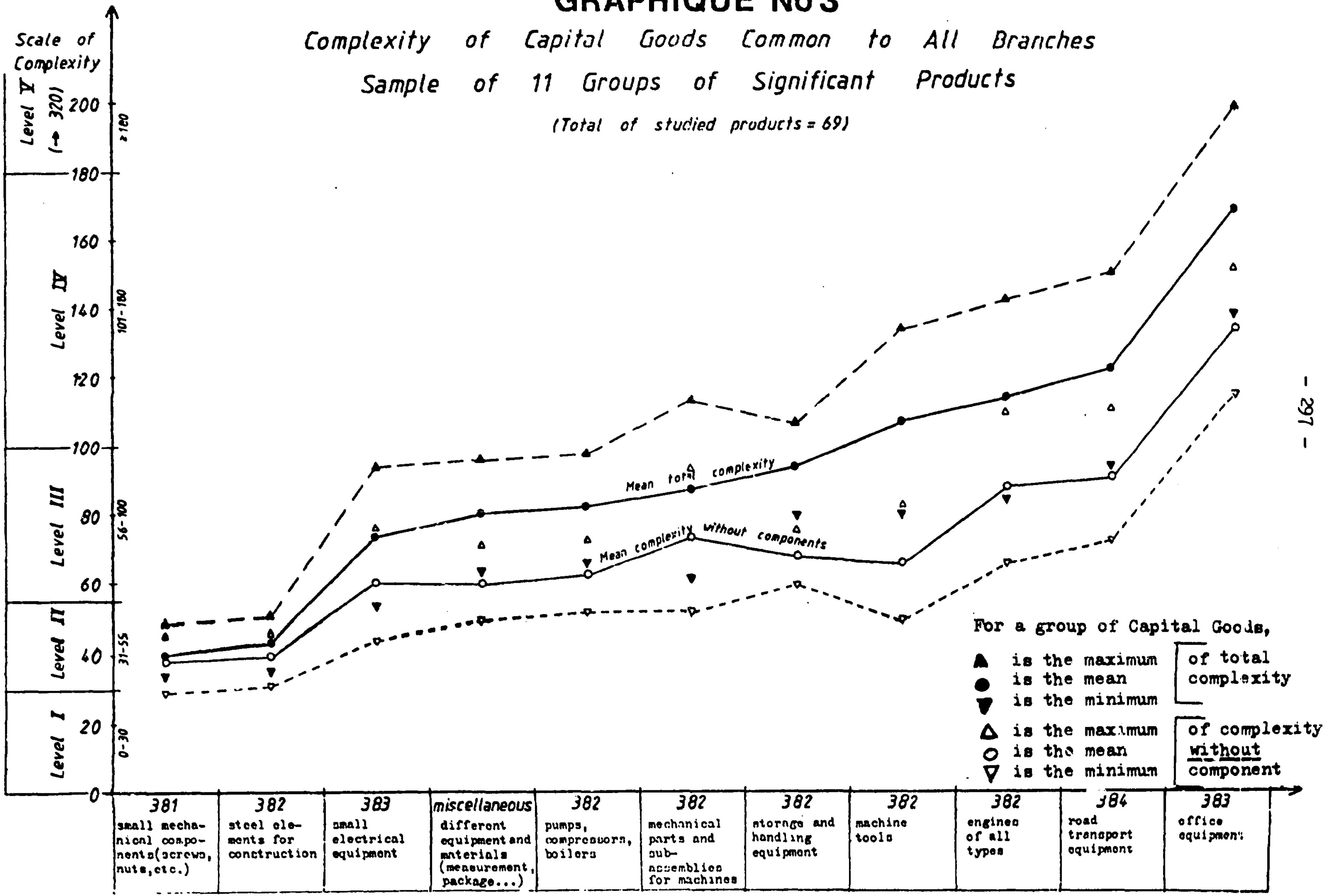


GRAPHIQUE No 3

Complexity of Capital Goods Common to All Branches

Sample of 11 Groups of Significant Products

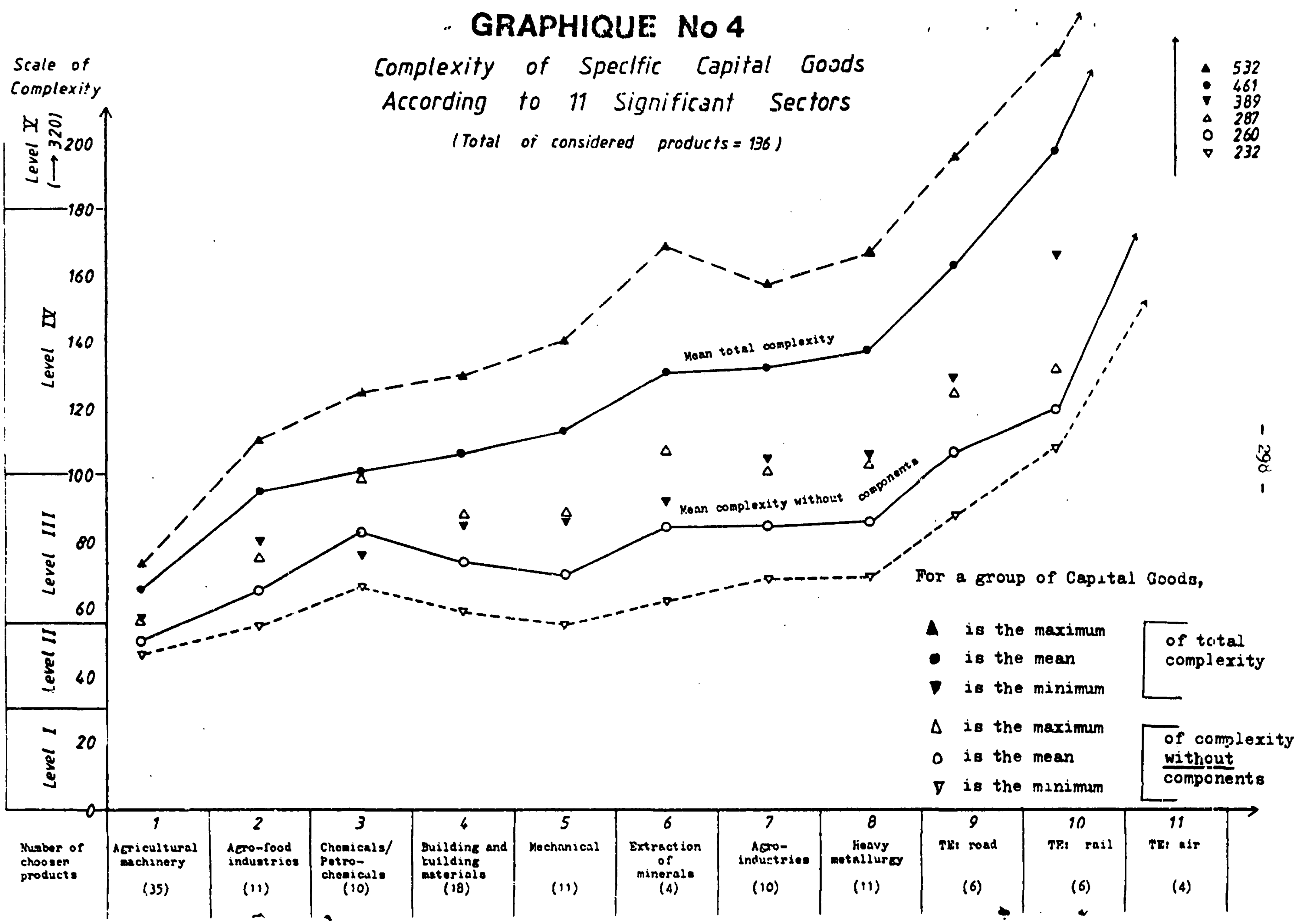
(Total of studied products = 69)



GRAPHIQUE No 4

Complexity of Specific Capital Goods According to 11 Significant Sectors

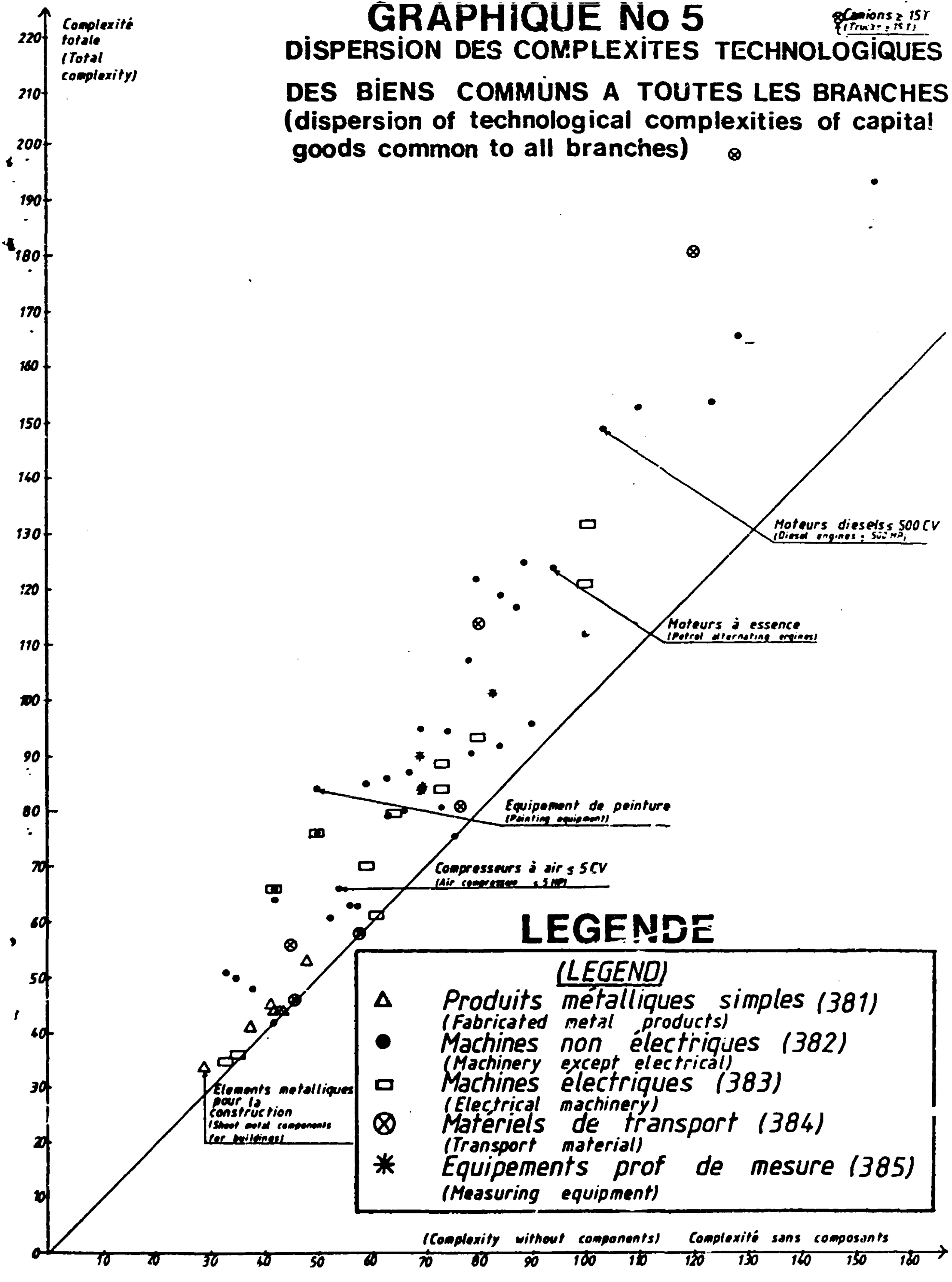
(Total of considered products = 136)



GRAPHIQUE No 5

DISPERSION DES COMPLEXITES TECHNOLOGIQUES DES BIENS COMMUNS A TOUTES LES BRANCHES

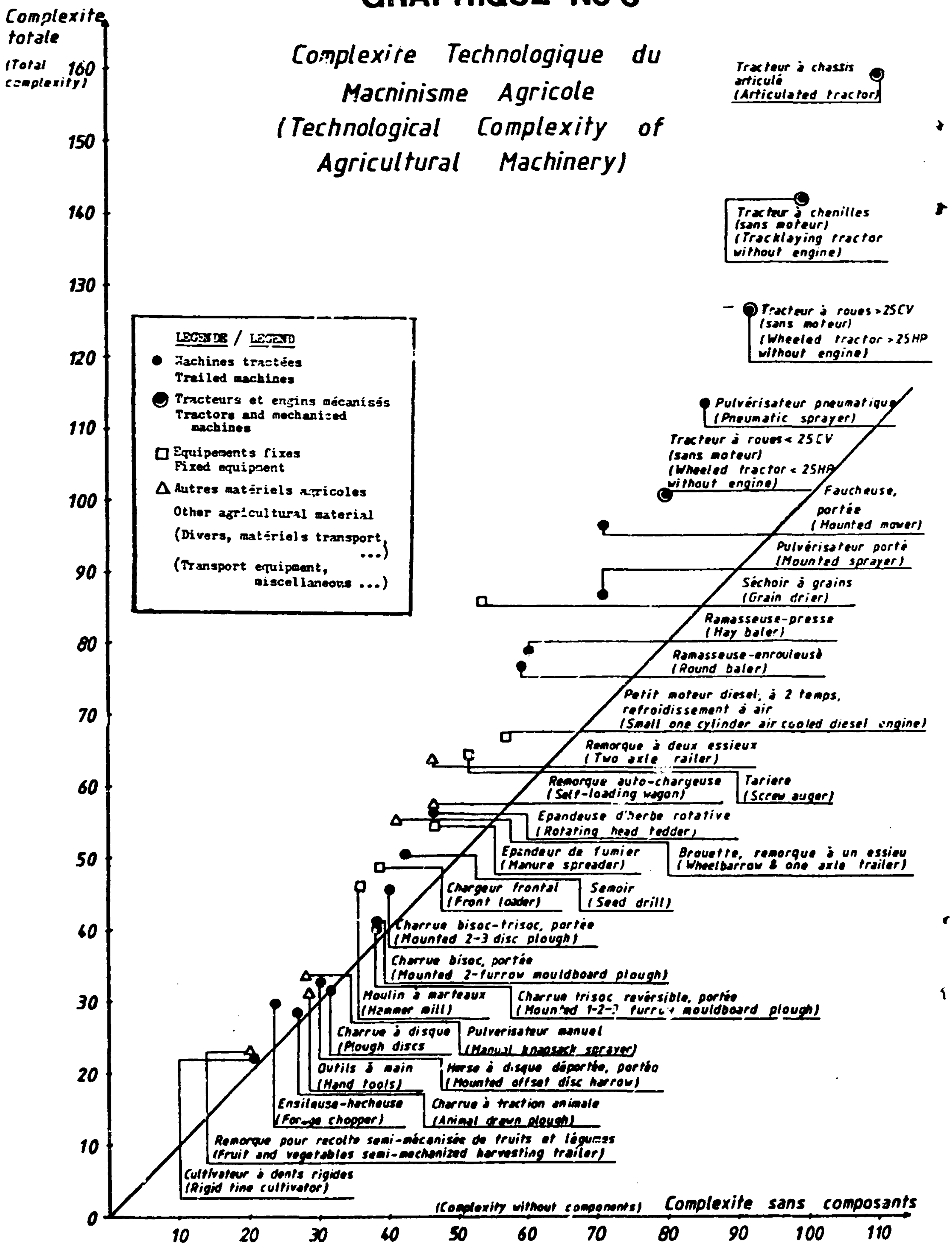
(dispersion of technological complexities of capital goods common to all branches)



GRAPHIQUE No 6

Complexite Technologique du Macninisme Agricole

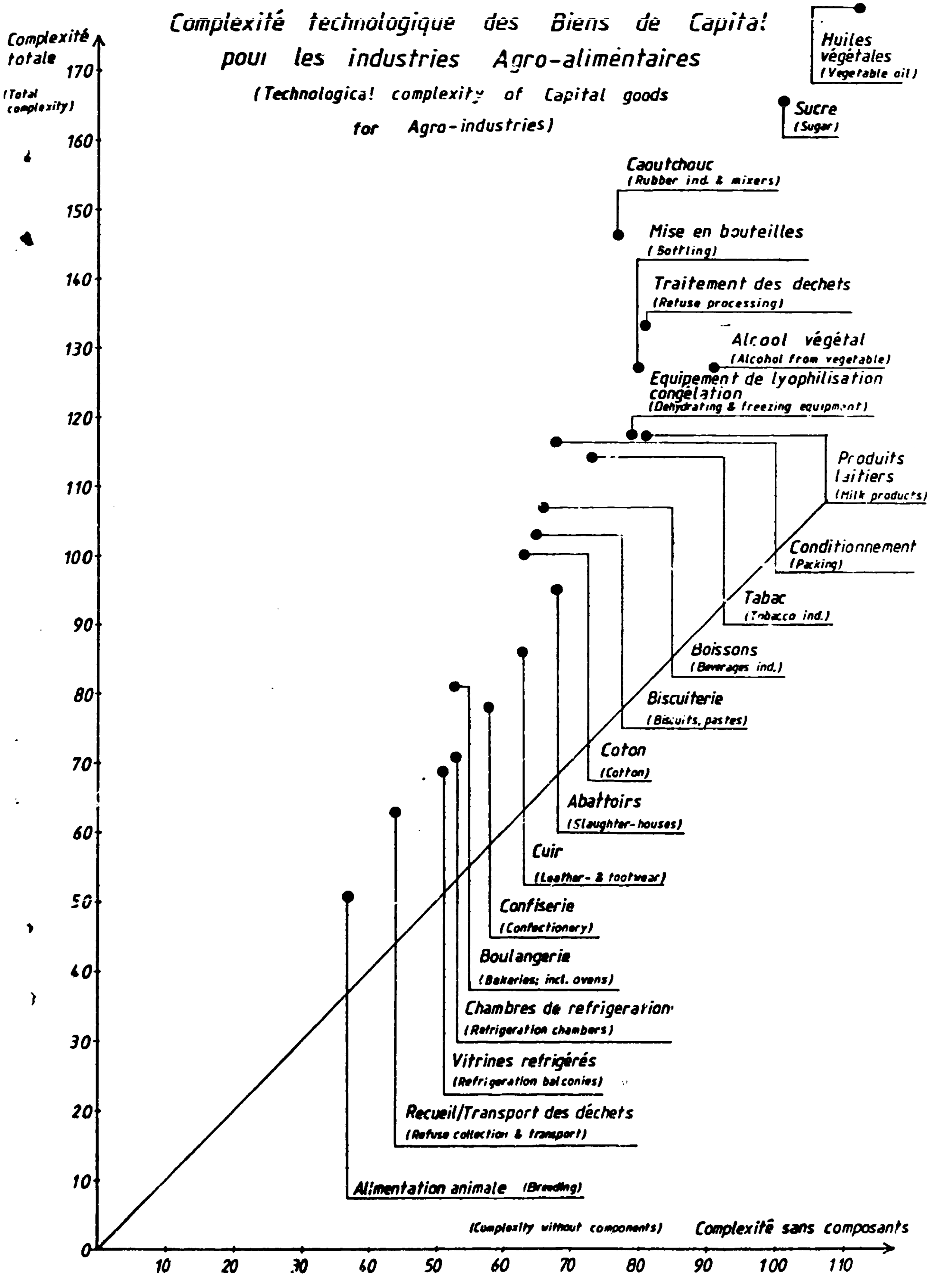
(Technological Complexity of Agricultural Machinery)



GRAPHIQUE No 7

Complexité technologique des Biens de Capital pour les industries Agro-alimentaires

(Technological complexity of Capital goods for Agro-industries)



GRAPHIQUE No 8

Complexite Technologique des Biens de Capital pour L'Industrie de la Construction et des Matériaux de Construction

(Complexity of Equipments for Construction & Building Materials Industry)