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08399

Distr.
LIMITED
ID/WG.282/20
28 Sept. 1978
ENGLISH

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

INTERNATIONAL FORUM ON APPROPRIATE INDUSTRIAL TECHNOLOGY

New Delhi/Anand, India 20–30 November 1978

WORKING GROUP No.1

APPROPRIATE TECHNOLOGY FOR HEAVY INDUSTRIES

BASIC MATERIALS INDUSTRIES:
ASPECTS OF TECHNOLOGY CHOICE AND INDUSTRIAL LOCATION

Background Paper

id 78-5852

BASIC MATERIALS INDUSTRIES: ASPECTS OF TECHNOLOGY CHOICE AND INDUSTRIAL LOCATION

by

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CONTENTS

I. INTRODUCTION

1. The choice of process-technology is a key-factor in the development of basic materials industries. It is a decision crucially determining the viability of the undertaking and requires considerable preparatory analysis. To the general economy, a viable basic materials industry can have very significant impacts; advantages derivable from improved utilization of natural resources, a strengthening of the industrial structure and enhanced capability to meet domestic and export demands. Its modus operandi is a direct linkage to raw materials sources. These would be various types of resource-deposits, imported materials, scrap, useable waste or a combination of these sources. From these material-linkages through processing, possibly in various stages, an effective supply structure is to be developed to meet the materials demanded domestically and abroad. To the effectiveness of aforementioned structure optimal location of the processing plants is essential; with resource-oriented and user-oriented locations as two extreme ends in the range of locational options. Developments over time may cause a shift in the optimum points of the structure. These shifts may arise from economic changes, such as improved levels of industrialization or international trade-developments, or from the depletion of resources at particular locations. A major factor of influence is also technological development. Technology is in its nature a development force emitting dynamic innovative capabilities. In basic materials industries, these capabilities are applied and structured, as indicated above, to the generation and production of industrial materials. Within this field, various streams can be distinguished, such as basic metals, silicates and other non-metallic minerals and synthetic materials. Cross-sectorial developments as well as evolutions within a particular stream take place constantly. New materials are developed and new processing methods render older ones less effective. It is from this dynamic potential, that a correct technological choice is to be made. Economic implications are in most

instances of a major order of significance, and preclude therefore often a trial-and-learning-by-error approach. On the other hand extensive documented experiences are available and methodologies have emerged through which, in the context of a given situation, the required insight can be gained regarding the range of available technological options, their economic implications and the extent of the uncertainties, which will have to be taken into account.

2. In the developing countries, the establishment of basic materials industries is a process which interacts closely with general development. Such interactions take place also in other types of industries, but it is, for reasons described above, very much more pronounced in the basic materials sector. In the following text special reference is made to the interaction of technology-choice with the locational pattern of basic materials industries :

- in the first place, it concerns the choice of a primary technology stream amongst a number of interactive technological patterns;
- subsequently, the development of an optimal technological structure within a particular sector is described;
- in a following chapter, the choice at plantlevel amongst alternative technological options is considered.

Reference is made to various sectors of current interest to UNIDO in advancing technological progress in developing countries in the context of a broadbased industrialization and balanced socio-economic development approach. These general development aspects constitute the main theme for the concluding chapter.

II. CHOICE OF TECHNOLOGY IN THE CONTEXT OF INTERACTIVE TECHNOLOGY PATTERNS

3. Interactive technology patterns are a common occurrence in industries, whose processes effect fundamental changes in the physical substance of the materials. Chemical industries are such a sector. Consequently,

the production of various chemical-based products may result ancillary to different types of chemical technology developments. Polyvinylchloride (pvc) is such an example. It is produced as a product developed from the petro-chemical industry. On the other hand, it may also result ancillary to a chlorine-based industry deriving its raw materials from the production of salt. For a developing light industry, pvc is a basic material of great significance and versatility. Household articles, toys and food packaging as well as piping and roofing materials are typical for the wide range of light industry.items producible from pvc. A similar reasoning holds true for other products, such as insecticides which are also derivable from chlorine and hence from salt. As salt is, moreover a basic human food requirement, it may be of particular relevance to examine the applications and developments of salt-based industries in some more detail.

4. Salt is found as a natural deposit and is also derived from seawater. The latter is particularly referred to. The oldest method of recovering salt from seawater is through solar evaporation, a method which is widely applied in the developing countries. Direct evaporation methods applying thermo-compression systems are in use in countries where the weather conditions are less suitable for production at solar fields.

5. In the last two decades electrodialysis has been applied to desalinate seawater. Rather than separating the water from the salt, electrodialysis removes the salt from the water , the brine[1)]

[1)] Brine = Saline water with solute loads of more than 35,000 mg/l, whereas non-saline (sweet) water would contain less than 1,000 mg/l. (ref. US Geological Survey - Classification of Saline Water).

thus obtained is further processed to salt, and also directly, further into caustic soda. In such further processing chlorine becomes available, which requires treatment (e.g. into liquid chlorine), and is useable as basic material for a series of other products (insecticides, bleaching agents, etc.) including vinylchloride and polyvinylchloride (pvc).

6. Vinylchloride is producible by chlorification of ethylene or acetylene. Some ethylene-based processes also use acetylene as supplementary basic material. Hydrocarbons are the basis for both materials; and pvc production is seen generally as an element in the downstream processes related to petroleum refineries. However, acetylene is also producible from other materials, e.g. calcium carbide, (among others obtainable from limestone and coke). Availability of the aforementioned basic material resources would in relation to a certain demand situation be factors determining the optimal route for the manufacture of pvc materials.

7. In addition to caustic soda (= sodium hydroxide), soda-ash (= sodium carbonate) is a main salt-derivative. Caustic soda has a diversified usage in the chemical and other process industries, such as rayon and cellulose, pulp and paper, textiles, soap and detergents. Common routes of production are the causticization of soda-ash with lime and, as mentioned, the electrolytic production from common salt. For the manufacture of soda-ash, which has in itself a variety of end usages, (e.g. glass and bauxite industries), salt and limestone are basic materials. The aforementioned inter-relationships influence significantly the locational considerations, i.e. in general the plant facilities require an optimal proximity to both salt and limestone deposits.

8. In a developed industrial structure the end-product usages are to a large extent determinable. The forecast of these demands would be a major premise from which the economic plant-size can be estimated. In countries with a nascent industry a different approach is often desirable. The interactions at different levels between alternate streams of technology preclude the establishment of a pre-determined fixed pattern of development. The effect of new technological discoveries are in this connection also to be taken into consideration. Needed is an overall framework in which a forward diversification strategy is outlined and which would comprise an appraisal of natural

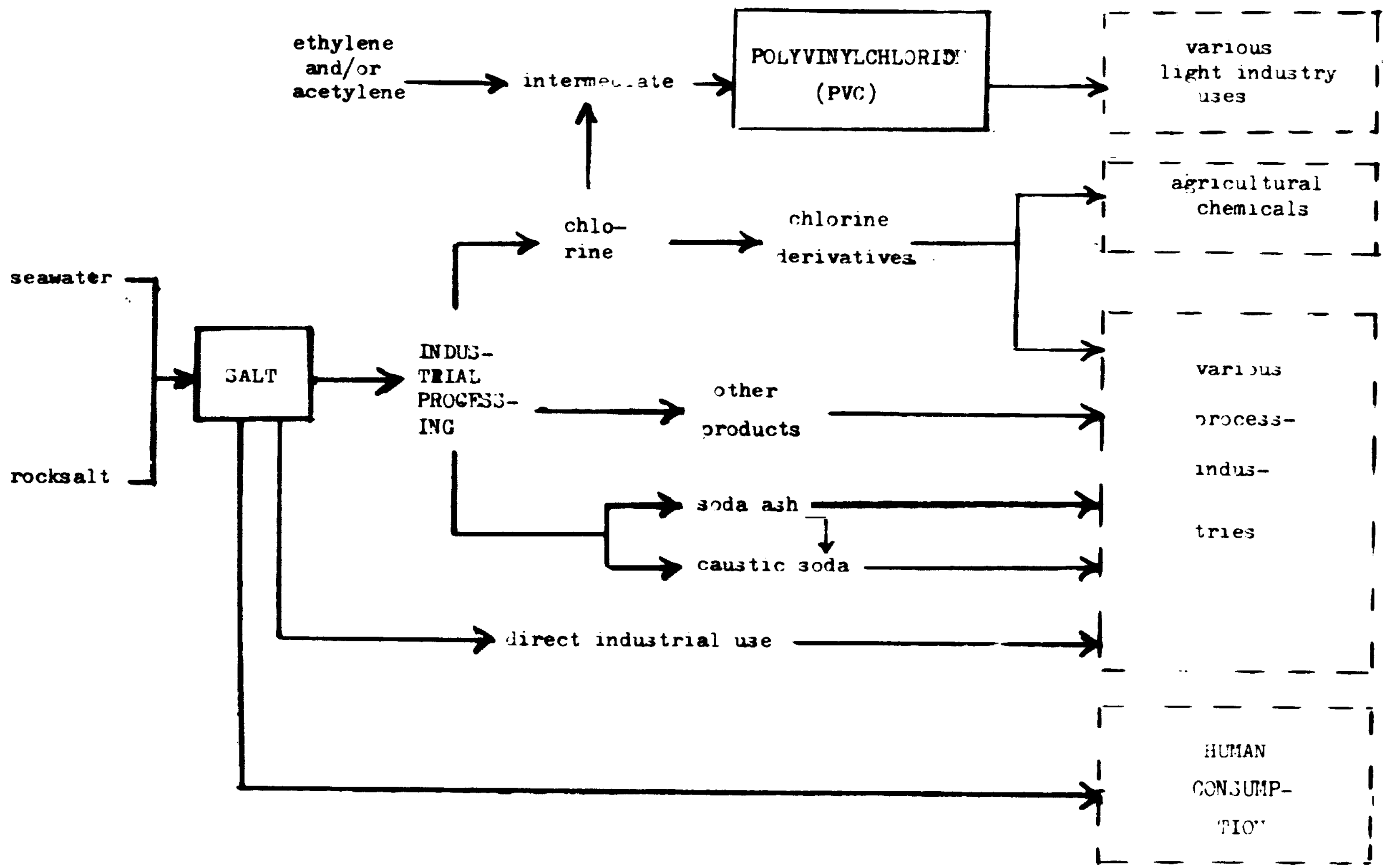

Figure I

Flowchart of salt, salt-derivatives and Polyvinyl chloride (PVC)

resource availabilities, an elaboration of inter-related streams of technological processes and a projection of end-product requirement patterns. This framework is to evolve parallel with developments attained. A primary form could directly be related to basic requirements. In the example described, this would concern the production of salt for human consumption, coupled with the immediate requirements of a nascent industry, e.g. the pvc requirements for light industry, chlorine derivatives for agricultural chemicals, and the soda-ash, caustic soda and related chemicals for various industry sectors (pulp and paper, textiles, soap and detergents, glass or alumina production). From the interaction which these end-usage sectors will pose on the various elements of the framework, growth points will arise which will have to be considered on their own merits. The maturing of such growth points to economically viable units would be signals at which relevant plant-establishments should be considered. Generally, a range of economically justified options exist. Rapid overall growth patterns would be inducive to choices favouring larger units amongst the range of economically viable options. A strong dynamism (horizontally) discernable amongst alternative technological streams would on the other hand warrant caution. It may be a positive trend, but may also point towards certain weaknesses and possibilities for technological obsolescence of certain processes, a situation which would tend to direct the preferred choice amongst the smaller units in the range of economically viable options.

9. As industrialization progresses, the above described interactions between a forward diversification from natural resources and a backward extending demand from light industries become more complex. As indicated, the technology development framework will have to evolve correspoadingly. Progressively also, more selective approaches will have to be adopted.

III. CHOICE OF AN INTRA-SECTORIAL TECHNOLOGY SYSTEM STRUCTURE

10. Linking locations endowed with natural resources and points of entry for imported materials on the one hand and settlement patterns of endusers, domestic and abroad, on the other hand, and developing at optimal localities route industrial processing facilities are key elements in an industrialization strategy. In the context of this paper particular reference is made to aspects relating to the deployment of technology in the context of a forward diversification aiming at optimizing materials utilization through successive processing [1].

11. Assurance of materials supply is an essential prerequisite to industries situated downstream from the material resources. In these downstream industries stock formation, recycling and use of alternate (or substitute) materials are some of the methods by which some contingency can be created against this (vertical) dependency. It remains, however, of primary importance to take at the more upstream situated stages the correct steps. An interplay between various alternate material sources may have to be taken also into account. The example described in an earlier chapter regarding the production of pvc (polyvinylchloride) as a basic plastic material widely used by light industries is an illustration of such a situation and the options for choice amongst alternate routes of technology. Similarly, effective supply of yarn and cloth is a basic requirement for stimulating a dispersed pattern of garment and textile (home) industry activities.

12. In a technical sense the main stream of materials supply distinguishes itself from above-mentioned recycling, which has often a more improvised nature. The main materials stream should preferably be composed of a range of well researched products made available with assured technical specifications. Of equal importance are the pricing conditions and production

1) - For complementary aspects and general approach see "Light Industry Technologies and Rural Development" and "On the Establishment of an Industrial Technology Development Policy", papers by K.H. Yap prepared for UNIDO, Vienna, August 1978 and June 1978, respectively.

costs. A too high price level would immediately effect unfavourably all downstream operations. Nor would it be feasible to sustain a production at costs exceeding the transaction prices. The capital intensity of the basic materials industries would, in such instances, cause an indirect irrational burden on the entire sector and economy. Such a burden would also occur in case of oversizing plant facilities, causing under-utilization of plant capacities, which could extend over relatively long periods of time.

13. In the forward diversification pattern various stages can be distinguished generally. Although interlinked, each stage can often be appraised on its own merits; an appraisal which could be facilitated greatly through the establishment of an overall technological development framework as described in a previous chapter. In order to develop an effective materials supply pattern to subsequent stages of downstream processing, a detailed system structure would have to be evolved. Locations with optimal proximity to material resource deposits are one major premise for such a system pattern. Such optimal locational conditions can relate either to a multi-resource-application pattern (such as salt and limestone in the above described case of soda ash production, or iron and coke for blast furnaces) or to a combination of a local resource with an imported complementary resource, or to a single resource-utilization pattern (e.g. use of natural gas, limestone or silicate deposit). Another locational premise is the settlement pattern of the endusers. These endusers can be industrial units, in case of certain intermediate materials, or individual persons in case of many consumer items. In the latter instance a very diversified endusers pattern is to be taken into account.

14. The development of fertiliser production and distribution is an example of a systemstructure which will have to link up to a very diversified endusers pattern. In the upstream stages of basic materials production, the locational pattern is largely determined by specific resource availabilities (e.g., natural gas, phosphate and potassium deposits), petrochemical complexes and, when imported materials are used,

their entry points. Enduse patterns vary with specific soil conditions, crop types and planting practices. A mixing and blending of the basic ingredients (N, P, and K) near to the endusers would have advantages. Such endusers oriented blending facilities can be envisaged to operate in conjunction with the major production plants of the basic ingredients, or with a central warehousing system when imported basic materials are used[1]. Transportation and storage conditions will have a significant influence on the optimal structure. Unit containerization of bulk transport and standard size bagging for distribution to the farmers would further contribute to a rationalization of the production distribution structure. The above-mentioned combination of centralized processing of chemicals and decentralized fertiliser blending plants is schematically shown in attached diagram.

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1) Reference Paper on Ferlizer Industry prepared for UNIDO by M.C. Verghese describing plant-installations for 30,000 tons per year bulk blending and bagging as "satellite plants" in a national or regional fertiliser industry system. Also reference is made to the application of liquid fertiliser through such satellite plants. Raw materials employed could at these liquid fertiliser satellite plants

1) Nitrogen (N) in the form of anhydrous or aqua ammonia, D.A.P, A.N, urea, etc.
2) Phosphates (P) in the form of phosphoric acid, T.S.P, etc.
3) Potash (K) potassium chloride, sulphate, phosphate or hydroxide.
4) Clay for stabilizing suspension.
5) Water.

yielding the following compositions:

1) N- anhydrous ammonia 82% N
   aqua ammonia 15 - 25% N
   urea 48% N
   ammonium nitrate 30% N
2) P- phosphoric acid 54% P_2O_5
3) K- potassium chloride 62% K_2O
4) N- P_2O_5 - K_2O in different proportions as needed by crops and soils and made up of components which are mutually compatible such as:-

Ratios of N:P:K	N:P:K
1:1:1	15:15:15
1:2:1	7:14:7
1:2:3	4:8:12
1:3:1	6:18:6

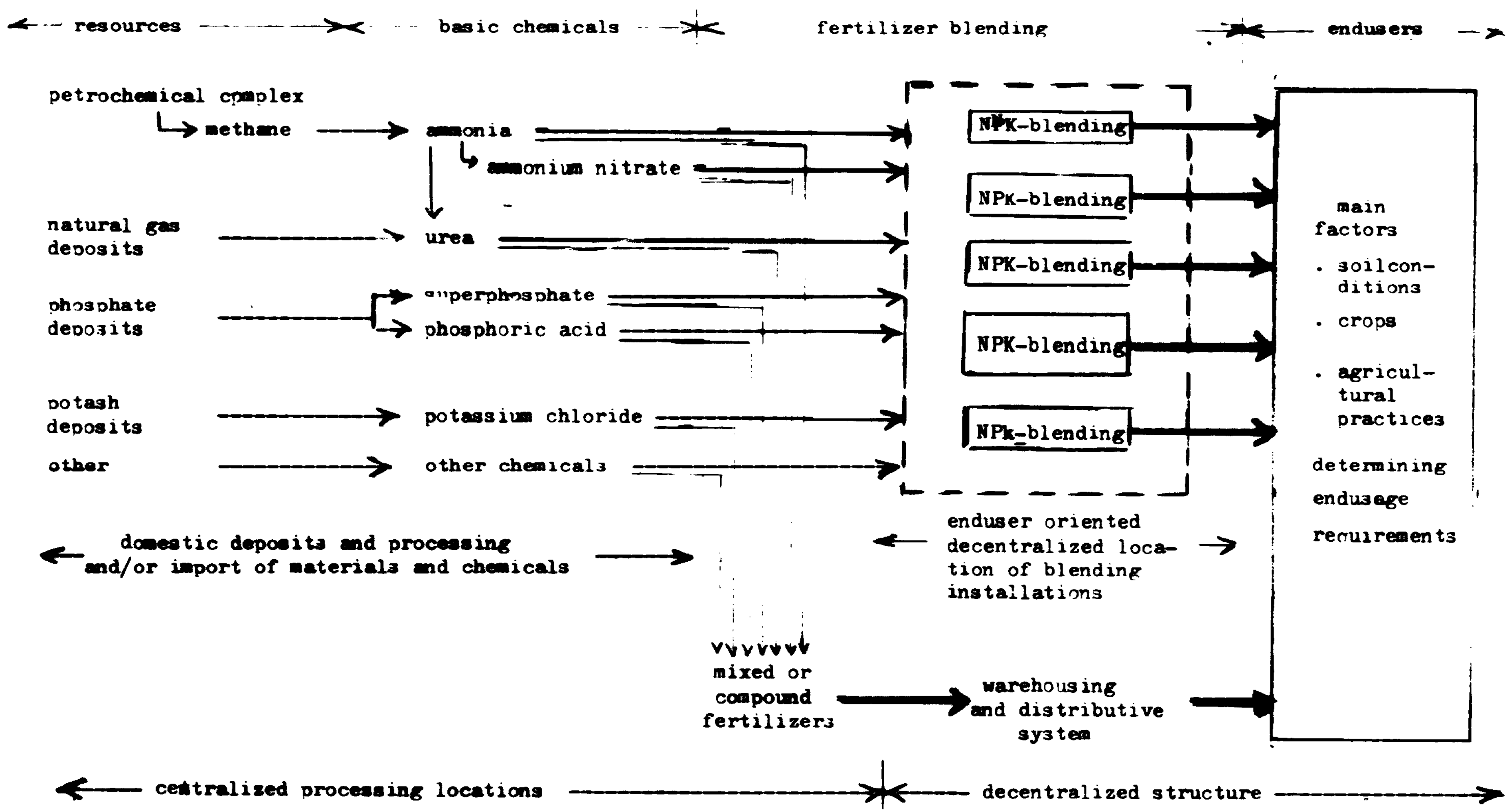

Fig.II FERTILIZER PRODUCTION AND DISTRIBUTION

- Centralization and Decentralization in the Sector Systemstructure -

15. Various types of intrasectorial systemstructures can be envisaged. The systemstructures will also evolve with time, as higher levels of development are reached, or new technologies are introduced and applied, which require different patterns of specialization and/or operating scales. The development of operating scales do not always tend towards larger sizes. The breakthroughs in electronic-miniaturization in the last decade[1]) are a striking example of a turn-around towards smaller units in a computer development trend, which had seemed a mere decade or two ago to be headed towards ever bigger entities. In the systemstructure therefore, appropriate allowance needs to be made for systemflexibility. Mandatory incorporation of quality assurance requirements will also exert influence on the systemstructure, as, for instance, discernible in the drugs and pharmaceutical industry, in which bulk-, batch- and small-dosage-formulation-activities are interwoven in an intricate pattern. The interdependence with the transportation infrastructure has been referred to already as a main factor. It is particularly dominant, for instance, in the construction and building materials sector. In this sector various types of materials-streams (clay-, cement-, wood-, metal- and synthetic materials) interplay in the construction process, which itself shifts from location to location. Generally, clay-, cement- and wood-based materials are derivable from resources, situated dispersedly in a particular country. These resources will be utilized more and more in an industrialized manner as higher development levels are attained. A subsector in which this tendency is particularly pronounced is the cement industry. Through a process-innovation, vertical kiln processes have found application[2]) in the last two decades, deploying economic capacities an order of five to ten smaller than the conventional horizontal rotary kiln processes. These smaller scale processes have obvious advantages in utilizing dispersedly situated limestone deposits to supply cement for local construction activities. The action-

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1) Transistors virtually replaced vacuumtubes around 1960. Subsequently multiple function elements developed, notably the integrated circuit (1965/68) and large scale integration (1970/72); between parentheses the periods of introduction of applications at a noticeable scale.

2) several hundred vertical kiln processes are at present in operation in the industrialized as well as developing countries.

radius of these smaller plants will depend evidently on topographic conditions, the volume and rate of construction-activity and the comparative needs for cement vis-à-vis other types of building materials. These factors will determine largely the degree in which smaller local-supply-oriented and larger general-distribution-oriented plants will have to be incorporated in the total intra-sectorial systemstructure.

IV. CHOICE OF TECHNOLOGY AT PLANT-LEVEL

16. Removal of impurities from the raw materials is the first processing step of ore-oriented industries. After such ore-benefication various stages of further processing follow, resulting in a variety of semifinished products serving as basic materials to other industries. These processing patterns are typical to iron as well as other metallurgical industries processing a variety of metal ores, such as bauxite, copper, tin, manganese, nickel, chromium and titanium, for general industrial as well as special purpose applications. Furthermore, through alloying new materials are obtainable, which could substitute one another to a certain degree. Due to the internationally rather uneven geographic distribution of ore-resources, materials-substitution has been early recognized therefore as a major area in which applied technological research can contribute significantly to redressing structural balance of trade problems. Within a given technological stream, also in the basic metals sector, a range of structural options as referred to in a previous chapter will apply. On these options the technology-choice at plant-level bears direct influence. As an illustration, the choice between various alternative routes in iron and steelmaking technology [1]) will in the following text be explored in some further detail.

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1) Acknowledgement is made to the co-operation of Dr B.R. Nijhawan, Unido, for informations and counsel provided.

17. The proven method for the last centuries of reducing iron ore is through the blast-furnace process, utilizing coke as the main reductant. The molten iron is converted into steel through oxygen converters which have for the last two decades become the main equipment in steel making. The ingots thus produced are further processed in the rolling mill complex for various semi-finished products of a flat shape or a non-flat shape. A direct material stream from steel making to rolling mills can also be effectuated through continuous casting. Above described type of integrated iron and steel plant may range in capacity from a few hundred thousand tons up to 10 million tons per year or more. Currently, for a steelplant of one million tons, the total investment would be in the order of US $ 800 million and would provide employment for about 6,000 persons. It is evident that for any economy such an investment will require careful choice of location, choice of process and technology, choice of the types of end products, rolling mill and ancillary equipment required. The process of choice and establishment often covers a period of several years up to a decade or more. Availability of iron ore resources, availability of good coking coal, the incorporation of new developments such as continuous casting facilities, and the utilization of possible by-products are other factors of consideration. Starting up and operational aspects would also have to be considered in the course of outlining a strategy for establishing such an iron and steel plant. For instance, this establishment could be undertaken step by step, commencing with rolling mill facilities and gradually incorporating the up-stream facilities. Also immediately an integrated approach could be adopted, starting with ore benefication, blast furnace and further down-stream processes.

18. On the other end of the spectrum of technology options for producing iron and steel is the utilization of scrap, pig iron and/or sponge iron for production of steel by electric smelting. The capacities may range in size from 20,000 tons per year upwards.

Capital investments for a 100 thousand tons plant would be in the order of US $ 25 million and employ 800 persons. These figures indicate in comparison with the blast furnace somewhat more favourable investment ratios, both for capacity as well as the number of persons employed. The versatility of the plants is, however, more limited and mainly oriented towards non-flat products. Furthermore, operations may be prone to sensitivity in the scrap metal supply situation, both quantitatively and price wise.

19. Other technological approaches have emerged in the last two decades, although their developments have been based on concepts of a much older date. The first main development concerns the use of other fuels than coke. Useful experiences have, for instance, been acquired in the forest rich countries (e.g. Brazil) by utilizing charcoal as the main reductant for the blast furnace process. Another direction of technology development is aimed at attempting to eliminate the blast furnace altogether. These latter developments are the direct reduction processes in which gas or coal remove the oxygen from the iron oxides of the ore. Ores of a relatively high grade are needed, e.g. Fe-content of 60 to 65%. The direct reduction will result in a beneficiated iron ore product, the so-called sponge iron and which may, for instance have a Fe-content of 87%. The sponge iron is subsequently smelted by electrical arc-furnaces into steel. This development has a history of over 50 years, starting with early experiences in Sweden. These indicated that the direct reduction process should from an economic point of view be followed directly by a further processing into steel. The Bessemer steel-making process which was, at that time most widely used, was less suitable for this purpose. In the post-war period use of the electric arc furnace became more widely applied and in the period 1950 - 1975 about one hundred different schemes for direct reduction of iron ore coupled with electric arc furnaces were examined. This development resulted in a number of experiences from actual implementation in the last decade. In early 1978 about 11 million tons of direct reduction process capacity were installed, of which about 40% came on stream in 1977. A further

expansion is anticipated possibly to a quintupling of the above mentioned figures in the late 80's. The capacities range from 150 thousand to 1.5 million per year. A 500 thousand ton integrated plant utilizing the direct reduction process would require, for instance, an investment in the order of US $ 250 million and would employ 3,000 persons.

20. The range in steelmaking technologies described above would include the following five alternatives[1]):

(a) The use of blast furnaces with coke as main reductant and oxygen converters supplying molten steel to the rolling mill complex. This process would be applicable in locations with access to large markets and relatively high levels of industrialization.

(b) Application of a charcoal blast furnace coupled with oxygen converters to supply the molten steel. This would be particularly applicable in locations with abundant forestry resources.

(c) Use of an electric reduction process and oxygen converters to supply the molten steel. This process would be particularly suitable for locations with abundant electricity at low cost, and limited access to good coking coal.

(d) Applying a direct reduction process coupled with electric arc furnaces to supply the molten steel. Gas based direct reduction processes would be particularly advantageous for countries rich in oil and natural gas resources.

(e) Scrap based electrical furnaces to supply the molten steel to rolling mills. This process would meet early development requirements in various countries. The dependence on scrap-availability would be reduced when pellets would be obtainable more widely; a development which could for instance result from a wider application of the direct reduction process.

[1]) Listed are technologies on which adequate experiences have been acquired. Various new processes are under development such as powder-injection-processes utilizing iron ore fines.

TYPE	DESCRIPTION OF STEEL PLANT CONFIGURATION	CAPACITY RANGES ('000 t/year)
(a)	coke / ore — BF — LD — ingot / CC — rolling mill — flats and non-flats	300 - 10 000
(b)	charcoal / ore — charcoal BF — LD — ingot / CC — rolling mill — flats and non-flats	150 - 400
(c)	non-coking coal / ore — electric reduction furnace — LD — ingot / CC — rolling mill — flats and non-flats	150 - 1 000
(d)	gas (or coal) / high grade ore — DR — electric arc furnace — ingot / CC — rolling mill — flats and non-flats	150 - 1 500
(e)	Scrap / sponge iron / cold pig iron — electric furnace — ingot / CC — rolling mill — mainly non-flats	20 - 400

Source : Unido

Notes : BF = blast furnace
CC = continuous casting
DR = direction reduction process
LD = LD-type oxygen converter

Figure III - IRON AND STEEL INDUSTRY - SOME TECHNOLOGICAL ALTERNATIVES

The above descriptions indicate that ore resources, availability of suitable reductants, energy and markets would be key factors in the choice of the technology to be adopted.

21. For <u>countries possessing ore deposits</u> the economic benefits of above described ore-benefication and subsequent processing accrue in the first place from the value added. A processing of ore into pig iron ingots and various types of flat and non-flat products would already yield an added value of 10 - 20 times. These values will be extended further when various types of engineering products are produced.

22. As apparent from the foregoing analysis, specific resource endowments will be main factors in selecting the technology to be applied. A clear trend is however discernable in the above described ore-based processes towards lower ranges of optimal plant-capacities; thus yielding a higher degree of flexibility and improved possibilities for situating first stage processing operations near to the ore deposits. The choice and application of the Mexican developed Hyl direct reduction process [1]) in Indonesia is an example of an <u>interregional transfer of technology</u>, amongst developing countries. Mature process-experience and simplicity of operation were also selection-criteria in addition to market aspects and availability of ore and gas resources. Availability of forestry resources and limitation in coal-supply have led in Brazil to the development of charcoal blast furnaces. A similar resource-situation is confronted, for instance, by some countries in the West-African sub-region [2]) and also in the countries with iron ore deposits in the south-eastern subregion of Africa.

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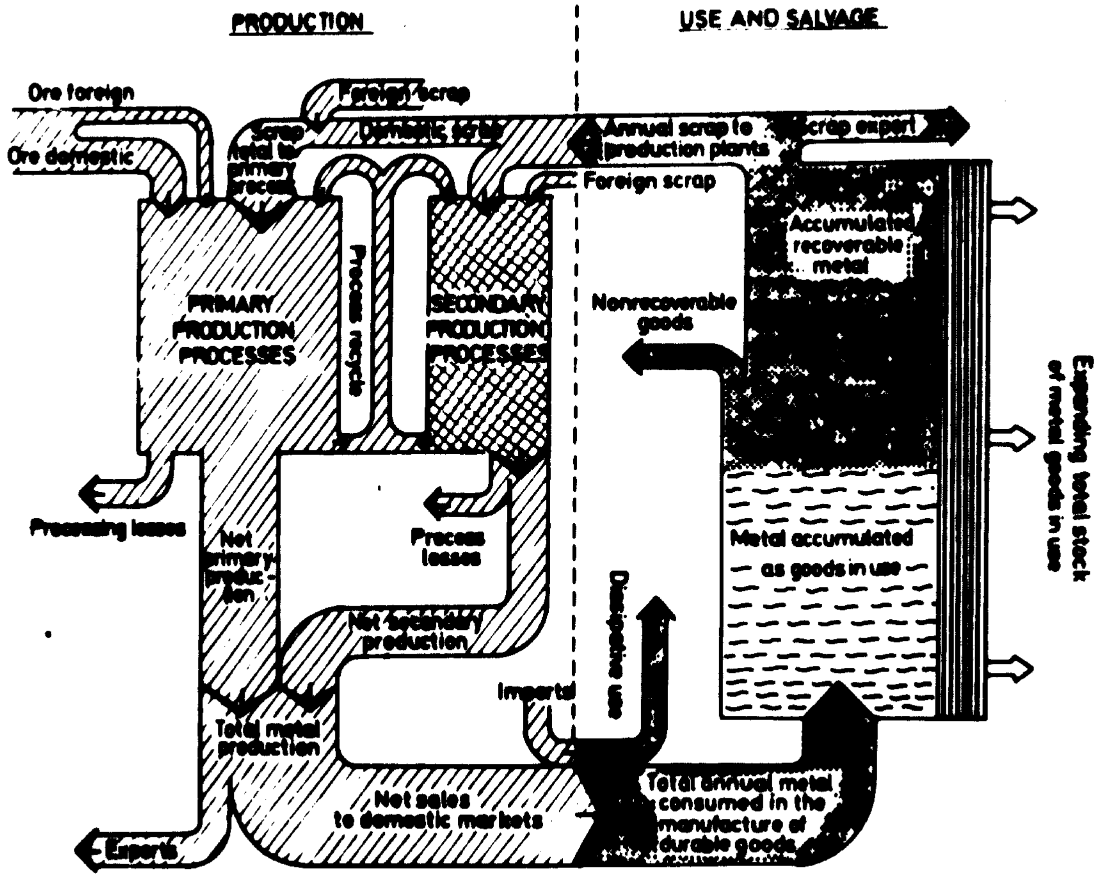
[1]) HyL stands for Hojalata y Lamina the mexican company fist applying (1957) direct reduction of iron-ore to sponge-iron utilizing gas as reductant. The HyL process has also been used in Brazil. The Indonesian plant is the first application in the Asian region.

[2]) Mining production of iron ore in the W-African region amounts currently to over 45 million tons per year exported (source: Metal Bulletin - 1977)

23. Availability of such a basic material as iron and steel is a factor of significance to any economy, also those which do not possess natural-resource endownments. Scrap utilization combined with imported sponge and/or pig-iron would in these instances be a basis to make a certain beginning. Such facilities would also apply to countries (or areas within larger countries) where infrastructural and/or external transport facilities require a maximum use of recycling to ensure a materials supply situation optimally supporting other sectors of industry. The facilities utilizing salvage materials have also a function complementary to the basic production facilities, once the latter have been established. This interreplationships is illustrated in the figure below.

Fig. IV METAL PRODUCTION, USE AND SALVAGE CYCLE



Source : UNIDO publication ID/51, Utilization of non-ferrous scrap metal. Report of an expert group meeting on non-ferrous scrap metal.(Sales No.: 70.II.B.30)

V. SUMMARY AND GENERAL DEVELOPMENT ASPECTS

24. In the preceding text reference was made to salt, hydrocarbons, various nonmetallic minerals and metal ores as some of the natural resources on which basic materials industries can be established[1]. Primary aims in developing these basic materials industries are the augmentation of domestically added value and the strengthening of the materials supply to light industries and other downstream situated activities. Out of the materials basis a forward diversification pattern will enfold, from which new development opportunities will arise. Availability and application of suitable process-technologies are at the core of these developments.

25. The technology-choice is to be made in a dynamic longer term context. Some main factors of influence are : usage-, international trade-, production-specialization- and resource-availability patterns. In turn, these factors are influenced, and sometimes in a primary manner brought about by technological development. In the choice of technology existing technologies, possible adaptation of such technologies as well as innovations and possible emergence of new technologies will have to be taken into account comprehensively.

26. To illustrate the abovementioned influences various examples were considered in some detail. The development of polyvinylchloride (pvc) is an example of an usage-oriented innovation, which has upstream consequences for the establishment of a basic materials industry. Although discovered as a material in the first half of the 19th century [2] the application of pvc was only recognized a century later; it gained application during the warperiod as a substitute material and became a widely used industrial material in postwar years. An example interrelated with the evolution in the world's geographical distribution of resources is the iron and steel industry. The technology developed

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1)Forestry and agro-resources are another source, referred to in "Light Industry Technologies and Rural Development", paper by K.H. Yap, prepared for UNIDO, August 1978.

2)The formation of polyvinylchloride (pvc) was first observed by Liebig in 1835, and reported by Regnault. Early investigators include Baumann (a.o. determination of the product-density), Ostromuislenski (postulation of the polymerization process) and Klatte (a.o. describing the application as film and fiber). Source: Kirk-Odmer, Encyclopaedia of Cheimical Technology, 2nd edition.

historically from common occurrence of iron ore and coking coal. As described, in recent decades new processes utilizing other materials as ore-reductants, e.g. natural gas, have proven their effectiveness. Moreover, their application indicate a viability at capacity-ranges substantially below the conventional processes. Capital-saving, improved capital-to-employment ratios and also significant reduction of undesirable environmental influences are some other advantages, which have been experienced. In the preceding chapters also other major innovations displaying similar combined advantages have been referred to. These technological innovations are also significant from the viewpoint of rationalizing internationally the basic materials production structure; a rationalization from which, on longer term, benefits could accrue for both developing as well as industrialized countries alike.

27. Major shares of ore-mining productions are currently still exported unprocessed from developing to industrialized countries. For iron-ores this share is about three-quarters, and for bauxite more than ninety percent[1]). For the former, technological developments have advanced in a manner, that in the coming decades a noticeable shift towards a higher share of processed iron products is most likely. Simultaneously, local production will be able to meet to a larger extent than hitherto, domestic iron and steel requirements. On a projected steel consumption in the not too distant future of 170 million tons in the developing countries, aggregate local production is expected to amount to two-thirds, as against a current level of about forty percent[2]). For bauxite and alumimium local processing is limited to a few locations, and a wider development is yet to be evolved. Although aggregate figures for fertilizers would indicate for developing countries a shift towards a higher proportion of production to consumption[3]), a more intricate production distribution pattern will have to be considered. Potash and phosphate deposits are concentrated in relatively few locations. Natural gas and other sources for nitrogenous fertilizers are however widespread. A special dimension is further arising from the emergence in recent years

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1)Ref. annex I - Some background data concerning basic metals industries in developing countries

2)Ref. <u>Draft World-wide Study of the Iron and Steel Industry: 1975-2000</u> (UNIDO document ICIS/25)

3)Ref. Draft World-wide Study of the Fertilizer Industry: 1975-2000 (UNIDO document ICIS/81) of the oilproducing countries as financial powers. A highly specialized network of international supply sources, which will supplement domestic fertilizer production can be anticipated. It is in such a context, that the intra-sectorial systemstructure at national level, described in an earlier chapter, will have to be considered. When limited consumption requirements prevail - due to the size of the country and/or other conditions - a subregional approach to evolve an optimal sectorwise technological systemstructure would be desirable. It is through such sectorstructures that basic materials industries can provide a maximum impact for balanced longterm socio-economic growth[1]).

28. At plantlevel, establishment factors for basic materials industries include - besides technology-choice, and optimal proximity to resource-deposits and market areas - major provision of energy, water and transportation facilities. In urban and developed areas these facilities are largely obtainable through linkups with existing public utilities and transportation structures. In rural, remote and undeveloped areas separate development of these facilities is usually necessary. Often, the optimal locations for basic materials industries coincide with these relatively undeveloped regions. With its establishment an impact will be made on the area of its location, and from a general development point of view, it might be desirable to distinguish several strata in the dimensioning of aforementioned facilities; i.e. to meet the direct process requirements, the plant-organization requirements and the general area and community requirements respectively.

29. The process-requirements are directly related to the technology-choice, and would be an integral part of the plant's techno-economic responsabilities. Plant-organization related requirements are often of a broader nature. It could include a range of diverse facilities, such as housing for plant personnel, educational and medical care facilities for dependents, development of roads and possibly other transportation facilities and other facilities, which - as distinct

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1) In annex II the average annual industrial growth rates in developing countries are summarized for the periods 1960-1977 and 1972-1977. The data illustrate the relative growth impacts of basic metals and heavy industries on the one hand and light industry (with employment and other merits) on the other hand; yielding on balance the overall growth rate for the manufacturing industry.

from the broader and primarily community-oriented infrastructure - could be described collectively as the "mezzo-structure" required for the plant's organizational functioning. In remote areas the development of an adequate mezzostructure often requires considerable investments, which from the point of view of the plant processing operations are of a necessary but indirect nature. A fully (also public) company-oriented development would, out of economic necessity, tend towards a rather restricted set-up, and which in its use often tends to create a schism within the area of its establishment. A broader based approach is desirable. Many of the mezzostructure elements, e.g. education, medical care and utilities, can often be extended to serve a larger group of the local population. Such extensions would make also economies of scale possible - e.g. for utility facilities - from which both the plant and the community could benefit equally. In the operational sphere also various linkages with the surroundings are feasible, e.g. for maintenance and repair, for byproductutilization and for supplies. Aforementioned development of mezzostructure and operational linkageas apply also, in a somewhat modified manner, to basic materials industries situated in urban and more developed areas. They gain significantly in importance, however, when the establishment of the undertaking relates to rural, remote or relatively undeveloped areas. Whilst economic viability constitutes the basic core for the direct process operations, it would be desirable to approach the project as a whole not as a single purpose industrial undertaking, but as a primary nucleus for area-as well as sectorwise development. In other words, to consider basic material industries as <u>new central places</u> in a wider framework for spatial and national development.

description	Total Dev. Ctr.		Lat. America		Africa		Asia & Pacif.	
	ctr	volume	ctr	volume	ctr	volume	ctr	volume
Iron and steel industry								
. projected steel consumption 1)		170		73		14		33
. 1974 - steel consumption 2)		74.2		30.6		7.0		36.6
- steel production 2)		36.1		17.7		1.3		17.1
- imports & stock-changes		38.1		12.9		5.7		19.5
. 1976 - iron-ore production (estimated at 100 % Fe-content 3))	22	124	7	71	9	22	6	31
- pigiron produc ion	8	27	4	13.5	1	..	3	13.5
- crude-steel production	9	32.5	6	19.0	..	..	3	13.5
Aluminium industry								
. 1976 - bauxite production (conversed into estimated Al-aequivalent 4))	11	13.9	6	8.8	2	4.2	3	0.9
- aluminium production	4	0.43	2	0.16	1	0.06	1	0.2

Units : ctr = number of countries in 1976-sample
volume = million metric tons per year

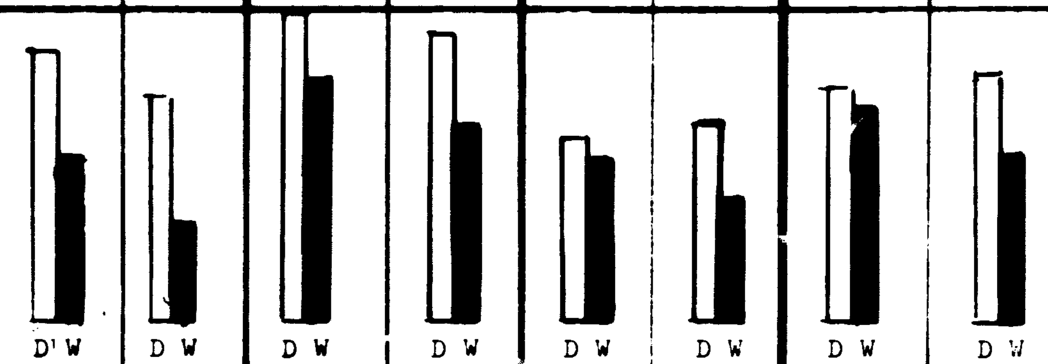
Notes : 1) reference **UNIDO** Draft world-wide study of the iron and steel industry 1975-2000; the projected steel consumption refers to the estimate for 1985; however, in view of the relatively low correlation figures (? varying from 0-57 - 0.71) the projected steel consumption data are to be considered as relating to a situation in the not too distant future, rather than a particular year.

2) **UNIDO** Draft World Wide Study of the Iron and Steel Industry, 1975 - 2000

3) 1976- iron ore production in 22 developing countries, conversed into 100 % Fe-content according to estimated percentages for various oreproducing countries. The figure of 124 million tons (100 % Fe) corresponds with 201.3 million tons gross, which is about 23 % of the total world production of iron ore in 1976 (including centrally planned economy and industrialized market economy countries)- source: U.N. Bureau of Statistics

4) The conversion factor applied assumes a 60 % alumina (Al_2O_3) content and an input of two tons alumina for each ton of aluminium. The volume of 13.9 million tons Al-aequivalent corresponds with 46.5 million tons of bauxite - source of Basic data : U.N. Bureau of Statistics.

Annex I - Some Background Data Basic Metals Industries
(developing countries)

REGION	BASIC METALS		HEAVY INDUSTRY		LIGHT INDUSTRY		TOTAL MFG.IND.	
	60-77	72-77	60-77	72-77	60-77	72-77	60-77	72-77
Total Developing Ctr[1])	7.8	6.4	8.7	8.2	5.1	5.6	6.7	6.9
- Latin America	7.7	5.5	8.5	6.5	4.6	4.0	6.5	5.3
- Dev.c. Asia	9.0	9.4	9.3	11.8	5.5	7.3	7.0	9.2
World [2])	4.7	2.3	7.0	5.5	4.6	3.5	6.1	4.8
Graph of total developing countries (D) and world (W)								

Unit : percentages
Source : U.N. Bureau of Statistics
Notes :
(1) developing market economy countries of Africa, Latin America and Asia
(2) total of market economy and centrally planned countries, industrialized and developing regions, for which data are available.

ANNEX II - AVERAGE ANNUAL GROWTH RATES IN THE PERIODS 1960-1977 AND 1972-1977

Annex III

An Annotation on the Term Basic Materials Industry as used in the Context of this Paper

Basic materials industries constitute part of the group of heavy industry sectors. The latter is classified by the United Nations Department of Economic and Social Affairs as follows :

ISIC No.[1]	Description
341	Manufacture of pulp, paper and paperboard
351	Manufacture of industrial chemicals
352	Manufacture of other chemicals
353	Petroleum refineries
354	Manufacture of miscellaneous products of petrolum and coal
36	Manufacture of non-metallic mineral products
37	Basic metal industries
38	Manufacture of fabricated metal products, machinery and equipment

Within the above ISIC-groups, those industries which are engaged in the production of industrial materials for supply to other industries and to other economic activities are referred to as basic materials industries.

1) ISIC= International Standard Industrial Classification of all economic activities (ref. U.N. Statistical Papers, series M, No.4, rev. 2).

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