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# TRANSFER OF TECHNOLOGY IN THE ARAB STEEL INDUSTRY

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# TRANSFER OF TECHNOLOGY IN THE ARAB STEEL INDUSTRY

The purpose of this paper is to present:

a- Briefly the arab steel industry
b- The technology acquired through the different processes
c- The development of associated industries as technology transferring industries
d- The manpower training
e- The engineering services needs
f- The policy implications for the technology transfer.

In order to discuss these aspects, it was necessary to introduce the general implications for steel and economic development. The presentation will be limited to the alloted 15 minutes. Great care has been given to the figures in this paper, some people will be startled by the implications of the development of the steel industry in the Arab world. For example, following the Lima conference, in 1975, industrial development targets were set for LCD'd by the year 2000. Industrial production in the Third World should account for 25% of world industrial production as compated to 7%, these targets can be translated to steel production. Installed steel production capacities should increase from 750 MT in 1975 to 1750 MT in 2000. This increase should be divided as follows:

Industrial world.................................650 MT + 500 MT
Third world.......................................100 MT + 500 MT
(of which Arab world).............................1,2 + 120 MT

These projections show that in 25 years the production capacity for steel will increase by 75% for industrialized countries that of LDC's will be multiplied by 6 and that of Arab countries by 100. The figures call for some remarks.

1- The staggering investment required 120 billion dollars for the Arab world, counting an average of 1000 dollars per ton at 1975 prices.
2- The manpower training requirement is even more staggering than the investment, an average of 10% of the cost of the project as compared to 2% in industrial countries.

3- The engineering work services required an average of 20% of the cost of the project as compared 6% in industrial countries.

4- The kind of technology to be utilised in the Arab world is paramount: are these countries going to form a receptive and innovative environment conducive to the development and transfer of technology or be producers of semi finished products for exports and therefore widening the technological gap?

## STEEL AND ECONOMIC DEVELOPMENT

The remarkable industrial growth witnessed in modern times would have been impossible without massive production of steel and its fabrication into thousands of different types of tools, structures and other useful products. In fact, steel has become synonymous with economic progress as it used in all fields of modern industrial activities. Therefore, it is now widely recognized the world over that steel plants are not mere "status symbols" but vital instruments of industrial development. This growing awareness has been reflected in the growth of the national steel production in many Arab countries.

### Role of heavy industries in economic development:

In a development country, the transformation of a traditional agricultural or petroleum mining economy into a modern industrial economy is beset with two major types of constraints that arise out either bottle-necks of consumer goods or bottle-necks of investment goods.

Balanced industrial growth has been achieved in industrialized countries by minimising these bottle-necks and ensuring appropriate balance between the light manufacturing industries. This balance has been struck in industrialized countries where the contribution of heavy industries in the total value added by the industrial sector is in the range of 58 per cent to 66 per cent [1]. This could be considered as goal setting indicator for developing countries while framing their programmes of industrialisation. The trend of industrial production in the developing countries

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[1] Structure of manufacturing output by major industrial groups in developed economies for the year 1958 statistical yearbook United Nations, 1963.

and regions during the period 1955 to 1969 also underlines the fact that it is easier for developing economies to achieve a break-through in the industrial sector in heavy industries as compared to light industries. While the output of light industries during this 14 years period nearly doubled in developing countries, the output of heavy industries nearly trebled in the Latin American countries and quadrupled in the Asian countries (Japan excluded). This trend evidently emphasizes the need to set up a heavy manufacturing industry in developing countries to accelerate industrialisation.

## Why steel industry?

Any country willing to meet its steel requirements has two options either to produce steel locally or to import steel spending foreign exchange, although really speaking no country can become truly self-sufficient in steel. This is because it may not be economically viable to produce within a country all the categories of steel required due to restraints imposed by inadequate demand and economies of scale. However, if the benefits accruing to the economy from the national steel industry outweigh the cost of imports of steel the installation of steel plants can be justified. In the following paragraphs an attempt is made to analyse the benefits of steel industry on the overall pattern of growth in the economy. As the installation of heavy industries calls for massive investment the role played by the steel industry vis-a-vis other heavy industries needs to be examined from various angles that promote investment and technology transfer. For this purpose, other heavy industries considered are petro-chemicals, chemicals, petroleum products, rubber products, etc.

## Backward and forward linkage effect

The efficiency of heavy industry catalysing the industrial growth can be best measured in terms of its inter-industry linkages. A pioneering study carried out in mid 50's on the inter-industry linkage in four developed countries namely USA, Italy, Japan and Norway by Chenery and Watabane had established that iron and steel industry has the highest combined backward and forward linkage score amongst industries as shown in Table 1.

TABLE 1

COMPARISON OF LINKAGES IN FOUR SELECTED COUNTRIES

| Sector | Backward Linkage (1) | Forward Linkage (2) | Combined Linkage Score |
|---|---|---|---|
| Iron and Steel | 66 | 78 | 144 |
| Non-ferrous metals | 61 | 81 | 142 |
| Paper and paper products | 57 | 78 | 135 |
| Petroleum products | 65 | 68 | 133 |
| Coal products | 63 | 67 | 130 |
| Chemicals | 60 | 69 | 129 |
| Textiles | 67 | 57 | 124 |
| Rubber products | 51 | 48 | 99 |
| Printing and publishing | 49 | 46 | 95 |

Feasibility of linkage effects in developing countries

Though this effect has been achieved in developed countries its attainment in developing countries would depend on the prospects of overcoming the constraints of market size, technology and resources. For example, though petroleum and natural gas mining is found to have forward linkage effect as high as 97% in developed economies several developing countries exporting crude oil are net importers of petroleum products.

Notes : (1) Percentage ratio of inter-industry purchase to total production by the industry.

(2) Percentage ratio of inter-industry sales to total production.

Sources : H.B. Chenery and T. Watanabe. International comparisons of the structure of production, Econometrica, Vol 26 (pp. 487 - 587).

In certain industries the incremental investment required for processing a basic product into intermediate products is disproportionately high as compared to the initial investment required for the production of the basic product itself, also the further investment transformation of the intermediate products into finished ones is still higher. This characteristic combined with the fact that the small size of the market becomes a deterrent in achieving forward effects in developing countries.

Though the steel industry is also subject to similar limitations for certain products the incremental investment and the scale of operation become crucial for the production of hot rolled strip. Once this stage is crossed, the importance of large scale operation diminishes progressively as illustrated by a typical pattern of economic capacities for the production of intermediate and finished products as shown below:

| PRODUCT | APPROXIMATE ANNUAL ECONOMIC CAPACITY |
|---|---|
| Wide hot strip | 1.000.000 tons |
| Cold rolled strip | 200.000 tons |
| Galvanised roofing sheets[1] | 50.000 tons |
| Domestic refrigerators[2] | 20.000 units |

Residentiary linkage

The capacity of a community to purchase goods and services is governed by the "value added" by the activities in various sectors of the economy (in the form of salaries and wages, rents, interests, insurance premium profits, etc).

Where goods are imported the capacity gets diverted to foreign markets to the extent of the "value added" component of the imported goods. Such leakeage of the purchasing capacity in the form of imports inhibits industrialisation in developing economies by restricting the volume of demand for national industrial products; this either retards development of local industries or leads to establishment of units of uneconomical size.

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Notes : [1] Continuous galvanising lines
[2] Approximately equivalent to 2.000 tons.

As opposed to this, establishment of national industrial units of optimum sizes generates benefits in the form of residentiary linkage due to retention of the "value added" component of the product within the country.

Utilisation of natural resources

The natural resources of a country remain either partly or fully unutilised in the absence of industry that can put them to use. The Arab countries for example have major raw materials namely iron ore, natural gas, limestone, dolomite and manganese required for the development of iron steel industry. However, many of the natural resources in these countries have either remained unutilised or are exploited for exports in crude form as bulk of their steel requirements continue to be exported. Some of these raw materials such as iron ore and dolomite have little alternative use except for the iron and steel industry.

The maximum national benefits from the raw materials such as natural gas and limestone having alternative uses can be derived by their utilisation in the fields having strong development linkage potential as is the case in the iron and steel industry.

Some of the Arab countries like Mauritania, Morocco, Algeria, Tunisia and Egypt have reserves of suitable grades of iron ore. In a few other Arab countries occurences of iron ore have been reported which currently are under investigation. Though a beginning of the integrated steel industry has been made in Algeria, Tunisia and Egypt the ore rich Arab countries namely Mauritania, Morocco, Tunisia and Algeria exported about 100, 90, 80 and 70 percent of their total ore production to the outside world in 1973. Mauritania alone exported more than 12 million tons of ores in this year. Morocco also exported 200.000 tons of manganese ore in 1972.

The major uses of natural gas are:

i - energy for power generation and

ii- raw material for chemical manufacture.

The maximum national benefit of this abundant resource in the Arab countries can be derived by its application in those fields where the cost of its substitutes is the highest, and where its use has the potential of generating a strong development linkage.

A study of incidence of energy cost in some selected industries shows that the incidence of energy cost is the highest in the iron and steel making and accounts for about 23 per cent of the total cost as shown in Table 2:

TABLE 2

RATIO OF ENERGY COST IN THE TOTAL PRODUCTION COST IN SELECTED INDUSTRIES

| Industry | Ratio of energy cost in production cost | Industry | Ratio of energy cost in produc. cost |
|---|---|---|---|
| Iron steel metals | 23,29 (1) | Vehicles | 3,28 |
| Ceramics | 16,98 | Foodstuff | 2,64 |
| Building materials | 14,46 | Wood industry | 1,50 |
| Furniture production | 12,16 | Textiles | 1,34 |
| Mining quarries | 5,17 | Leather industries | 0,78 |
| Chemicals | 4,39 | Clothing | 0,50 |
| Engineering transformation of metals | 3,39 | Average | 6,42 (2) |

In iron and steel industry, energy costs are high mainly due to the high consumption of coke when iron is produced through the blast furnace route. With the development of direct reduction technology iron and steel production can be based on natural gas. It will, therefore, be seen that use of natural gas for the iron and steel plant cannot only ensure utilisation of local natural resources, but also result in an attractive economics.

Notes : (1) Mainly coke blast furnace
(2) Including a number of small scale industries.

Source : Institut National de la Statistique et des Etudes Economiques, Paris No. Fevrier 1954.

## INVESTMENT CONSIDERATIONS

Major considerations that need to be examined before investment in an industrial sector are:

I- market for products

II- pace of technological changes

III- probable penalty for capacity underutilisation.

Of the different heavy industries, steel industry is one of the few industries whose products are required for investment as well as consumption. The steel enters the consumption sector in the form of durable goods. Among the four categories of consumption namely durables, semidurables, nondurables and services the item of durables is known to have the highest income elastisity. Steel also enters the process of capital investment in a bigger way than many other industries; the share of machinery and equipment in the capital formation increases from a level as low as 12 per cent to about 56 per cent to 58 per cent in highly industrialised countries. It will thus be seen that the market for steel in the Arab countries will expend the investment as well as consumption sector with progressive industrialisation.

### Pace of technological development

The risk of the selected process and plant equipment becoming technologically obsolete during a short period need to be carefully weighed in the background of pace of technological changes taking place elsewhere in the world while taking investment decisions. It is for this reason that chemical and petro -chemical industries normally are based on calculation of pay back period of a short time of 8 to 10 years. A majority of innovations in the field steel technology during the last decade have been mainly in respect of the scale of operations. Hence unlike some other heavy industries, the risk of technological obsolescence in the steel plant could be considered minimum.

### Social benefits

As developing countries depend on imports of equipment machinery and know-how services on developed countries a large part of expenditure on investment is traded off and to that extent the developing countries are deprived of the possible social benefits of investment. It therefore follows, that the industrial investment which utilises more of local resources and local talents for equipment supplies and construction would yield greater to the investor country in the form of distribution of salaries, wages utilisation of local materials and its multiplier effects on the whole economy. Steel industry permits larger and more progressive localisation of investments resources than many other industries where rapid technological change increase dependence on foreign agencies. Establishment of local steel industry therefore bestow higher social benefits than most other heavy industries.

Future demand of steel in individual countries

The level and pattern of steel consumption of a country at any point of time is dependent on its industrial economic and technological environments. The projections of future demand of steel have therefore to take all these factors into account and should therefore form a subject of detailed analysis for each individual country depending on the historic data available and the type of economy, future steel demands for individual countries are to be projected adopting various techniques like sectoral analysis, regressions analysis, extra-polation of past trend, etc. The projection of steel demand in the Arab countries has been made on the basis of the steel intensity method which would indicate the order of demand expected in these countries.

Steel intensity method

"Steel intensity" is the ratio of steel consumption to GDP expressed in terms of kilogrammes of steel consumption per thousand dollars of GDP and thus a measure of the state of industrial development of the country's economy. Conversely, if the growth rates of GDP and steel intensity of a country could be forecast these could be used to estimate the future steel consumption level. An analysis of steel intensity variation per capita income for 24 different countries has revealed a distinct relationship between these two variables and generalised steel intensity curve is found to have three distinct zones. The first zone at lower level of per capita income corresponds to steep rise in steel consumption for a small increment of income, while in the second zone where the per capita income is more than US dollars 1000, the steel intensity value slowly rise to a peak and decline thereafter. In the third zone where per capita income exceeds US dollars 3000, the steel intensity becomes almost stable showing very little fall in steel intensity value with progressive increase of per capita income.

On the basis of the available data on the national economies of Arab countries and other selected countries, the future demand of steel has been projected. The methodology adopted for projecting the steel demand is as follows:

1- From a study the past growth rate of GDP the possible future growth rates of GDP are projected and the GDP values for 1975, 1980 and 1985 are estimated for individual countries. (at 1972 prices).
2- On the basis of the past trend in the growth rate of population the figures of population for 1975-1980 and 1985 have been estimated for individual countries.
3- On the basis of the past steel intensities of the individual countries the possible steel intensities for the future years have been assumed.
4- The future steel demand for the individual countries has been derived on the basis of the projected per capita GDP and assumed steel intensities.

It is necessary to examine the past trend in variation of steel intensity with per capita GDP to estimate future level of steel intensity for the countries in Arab world. The past data for per capita GDP and steel intensity are given in Table 3 and 4.

Higher investments required in developing countries

The investments required for the installation of iron and steel plants per unit of output in developing countries are substantially higher than those in developed countries for various reasons explained below.

Equipment

I- Lower rating of equipment productivity arising out of a combination of several adverse factors so common in the developing countries such as inferior quality and preparation of raw materials, inconsistencies in the quality of the continuous supply of raw materials, lower levels of skills, low labour productivity, management deficiencies in operation and maintenance, higher downtime, non-availability of spares, etc...

II- Need for greater backward integration of production facilities for example,
   a- installation of captive coke ovens,
   b- captive power generation stations, and
   c- scrap preparation equipment for purchased scrap.

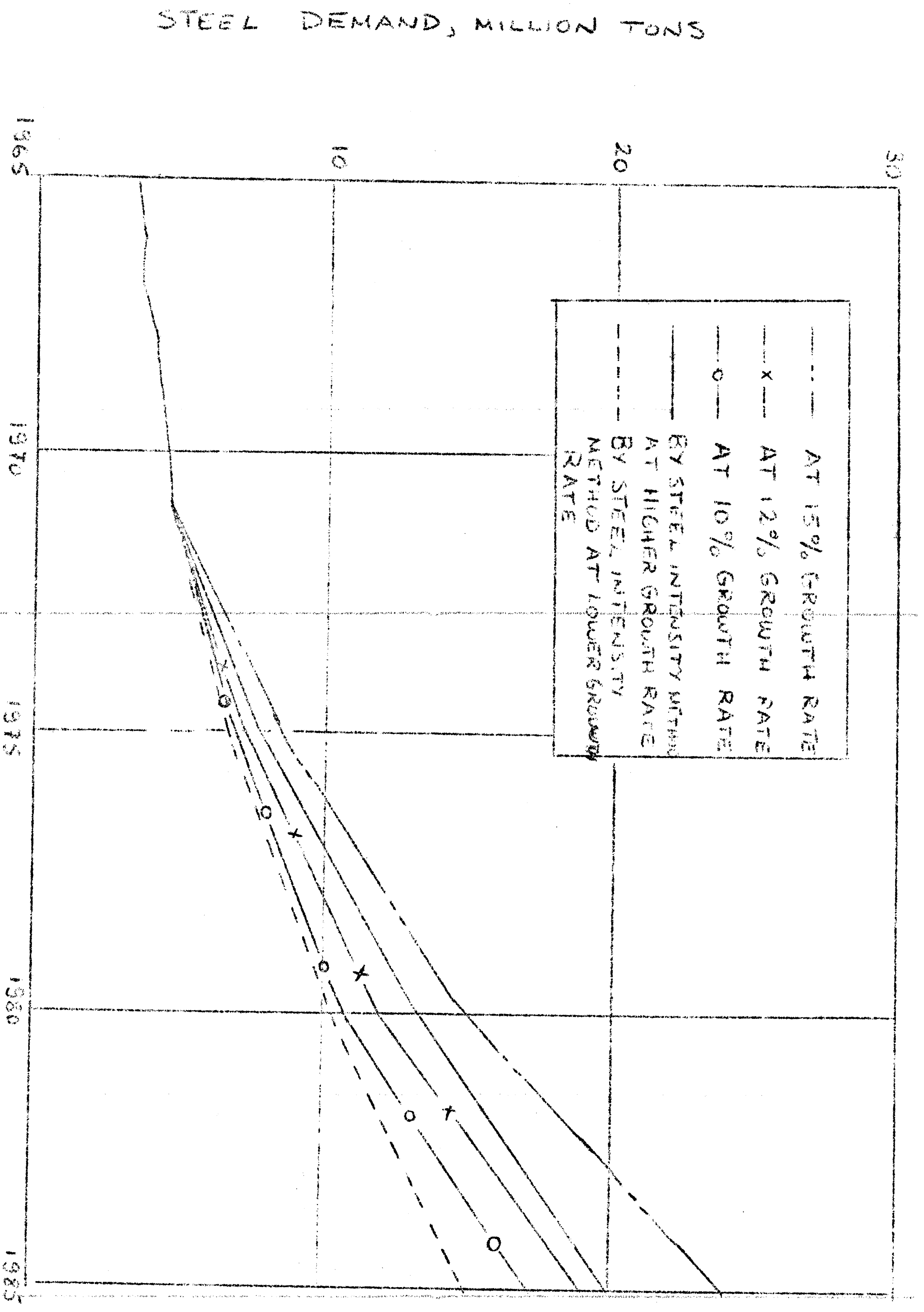


FIG. 1 – PROJECTED STEEL DEMANDS FOR ARAB WORLD

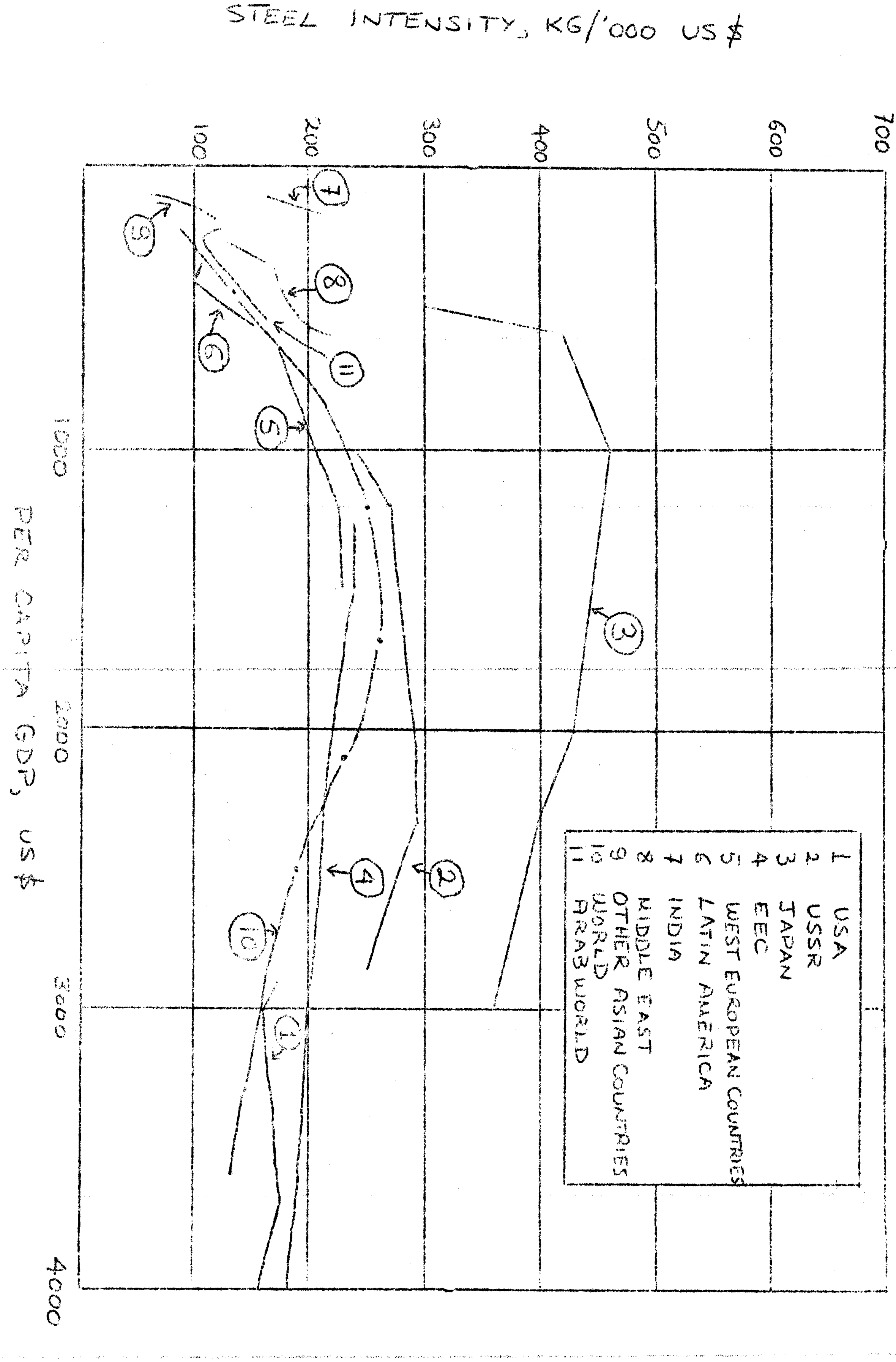


FIG. 2 STEEL INTENSITY CURVES OF SELECTED COUNTRIES AND REGIONS

TABLE 3

PER CAPITA GDP OF ARAB COUNTRIES[1]

(US $ at const. 1963 prices)

| COUNTRY | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 |
|---|---|---|---|---|---|---|---|---|
| Morocco | 187 | 168 | 144 | 168 | 190 | 208 | 209 | 219 |
| Algeria | 250 | 220 | 212 | 205 | 211 | 206 | 210 | 208 |
| Tunisia | 228 | 186 | 223 | 212 | 211 | 226 | 235 | 257 |
| Libya | 455 | 562 | 920 | 1100 | 1272 | 1770 | 1840 | 1855 |
| Egypt | 157 | 165 | 138 | 167 | 161 | 167 | 172 | 168 |
| Lebanon | 552 | 374 | 476 | 478 | 466 | 515 | 520 | 538 |
| Syria | 198 | 185 | 222 | 208 | 212 | 213 | 238 | 269 |
| Saudi Arabia | 300 | 318 | 347 | 378 | 413 | 444 | 475 | 416 |
| Sudan | 109 | 112 | 102 | 102 | 107 | 112 | 116 | 98 |
| Iraq | 291 | 264 | 303 | 298 | 304 | 328 | 339 | 370 |
| Kuwait | 4780 | 4420 | 3460 | 3680 | 3600 | 3880 | 3880 | 3640 |

Notes : (1) Mauritania , Jordan, Yemen (North and South and Gulf Emirates are excluded as their GDP values are not available).

Source : Statistical Year Book UNO issues.

TABLE 4

STEEL INTENSITIES OF INDIVIDUAL COUNTRIES

(Kg per thousand US$)

| COUNTRY | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 |
|---|---|---|---|---|---|---|---|---|
| Morocco | 72 | 88 | 92 | 93 | 93 | 83 | 100 | 100 |
| Algeria | 80 | 110 | 108 | 78 | 82 | 173 | 240 | 245 |
| Tunisia | 95 | 133 | 150 | 132 | 152 | 117 | 143 | 132 |
| Libya | 236 | 300 | 142 | 129 | 160 | 172 | 190 | 75 |
| Egypt | 101 | 146 | 195 | 163 | 152 | 126 | 126 | 164 |
| Lebanon | 217 | 282 | 232 | 526 | 1196 | 200 | 205 | 184 |
| Syria | 100 | 164 | 81 | 194 | 147 | 146 | 195 | 205 |
| Saudi Arabia | 60 | 74 | 145 | 95 | 55 | 94 | 70 | 77 |
| Sudan | 72 | 72 | 41 | 49 | 79 | 57 | 45 | 69 |
| Iraq | 36 | 98 | 93 | 153 | 95 | 149 | 82 | 132 |
| Kuwait | 59 | 60 | 108 | 86 | 149 | 80 | 78 | 50 |

The steel intensity of the Arab world as whole has been derived from the data of individual countries and is given in Table 5. This table also indicates the per capita GDP at constant 1963 prices which has been estimated as the statistical average of the per capita GDP of individual countries.

TABLE 5

STEEL INTENSITY OF ARAB WORLD FROM 1963 TO 1970

| Year | Per Capita Steel Consumption (Kg) | Per Capita GDP (US $) | Steel Intensity (Kg per cent $) |
|---|---|---|---|
| 1963 | 19 | 227 | 94 |
| 1964 | 25 | 216 | 127 |
| 1965 | 29 | 198 | 128 |
| 1966 | 31 | 212 | 227 |
| 1967 | 31 | 220 | 118 |
| 1968 | 34 | 241 | 126 |
| 1969 | 35 | 250 | 123 |
| 1970 | 34 | 250 | 126 |

Note: Excludes Mauritania, Jordan, Yemen.

TABLE 6

PROJECTED CRUDE STEEL DEMAND IN ARAB COUNTRIES
(Thousand Tons)

| Country | 1975 Case I[1] | 1975 Case II[2] | 1980 Case I | 1980 Case II | 1985 Case I | 1985 Case II |
|---|---|---|---|---|---|---|
| Mauritania[3] | 10 | 11 | 14 | 16 | 19 | 25 |
| Morocco | 590 | 675 | 1,080 | 1,450 | 2,024 | 2,620 |
| Algeria | 950 | 1,260 | 1,180 | 1,820 | 1,570 | 2,380 |
| Tunisia | 262 | 302 | 418 | 552 | 765 | 1,000 |
| Libya | 625 | 710 | 1,050 | 1,320 | 1,600 | 1,120 |
| Egypt | 1,300 | 1,500 | 1,650 | 2,200 | 2,130 | 3,250 |
| Syria | 470 | 490 | 750 | 870 | 1,220 | 1,460 |
| Lebanon | 490 | 505 | 725 | 870 | 1,050 | 1,390 |
| Jordan[3] | 100 | 110 | 160 | 210 | 270 | 390 |
| Iraq | 672 | 740 | 998 | 1,300 | 1,330 | 1,720 |
| Kuwait | 342 | 382 | 560 | 680 | 800 | 1,000 |
| Emirates[3] | 370 | 415 | 450 | 550 | 500 | 600 |
| Saudi Arabia | 445 | 485 | 750 | 900 | 1,130 | 1,450 |
| Sudan | 144 | 152 | 206 | 240 | 300 | 400 |
| Yemen(N&S)[3] | 63 | 68 | 89 | 94 | 126 | 167 |
| TOTAL crude steel | 6,833 | 7,805 | 10,180 | 13,072 | 14,750 | 19,972 |
| SAY | 6,800 | 7,800 | 10,200 | 13,100 | 14,800 | 20,000 |
| TOTAL finished steel[4] | 5,500 | 6,300 | 8,200 | 10,600 | 12,000 | 16,200 |
| TOTAL liquid[5] | 7,250 | 8,300 | 10,800 | 14,000 | 15,800 | 21,000 |

Notes: (1) Case 1 Corresponds to lower growth rate by GDP.

(2) Case II Corresponds to higher growth rate of GDP.

(3) In case of Jordan, the steel demand is estimated on the basis of past trends of consumption, the demands for Mauritania and Yemen have been estimated by analogy with Sudan and that of Emirates by analogy with Kuwait.

(4) On the basis of 0.81 conversion factor from crude steel to finished steel.

(5) Assuming the crude steel to be concast semis the yield from liquid steel to concast semis is taken as 94 per cent.

III- Need for installation of captive services (often installed by sub-contractors of the steel plan in developed countries) such as:

a- Oxygen plant for oxygen blowing converters,

b- works transport equipment for railways such as locomotives and rolling stock and road transport such as dumpers and trucks,

c- extensive repair and

d- equipment for maintenance such as relining of blast furnaces, refractory relining of steelmelt shop furnaces and ladles, heavy maintenance for rolling mills, etc...

IV- Higher expenses incurred on the erection of machinery and equipment due to high remuneration required to be paid to the personnel deputed by equipment suppliers from developed countries and difficult availability of tools and tackle required for heavy erection.

V- Higher prices paid for imports of equipment.

MARKET CONDITION

VI- Constraints imposed by the smallness of the markets on the aggregate demand which preclude maximisation of economies of scale.

VII- Fragmentation of the market demand into a large assortment of sizes which does not permit maximisation of the batches for rolling schedules in the highly capital intensive rolling mills.

INFRASTRUCTURE DISADVANTAGES

VIII- Constraints imposed by limitations of underdeveloped infrastructure such as the inadequate stiffness of the electricity supply system to sustain high capacity electric arc furnaces of distribution network which may require larger storage facilities in rolling mills.

IX- Larger inventories of initial and capital spares which are required to be maintained since the spare parts are not available at short notice unlike developed countries.

CONSTRUCTION AND GESTATION

X- Longer construction and gestation period due to difficulties in the development of infrastructure, construction facilities, financing, project co-ordination and monitoring etc... which result in high incidence of capitalised interest charges, administration expenses and price escalation in equipment and construction costs.

XI- Higher costs of construction work and structural steelwork due to higher costs of materials (in which a major contributing factor is the incidence of high transport costs), adverse productivity, wage ratio of construction labour and higher costs of construction equipment.

XII- Higher capital outlays on training facilities for creating cadre of trained manpower and on labour welfare amenities.

PRE-OPERATING EXPENSES

XIII- Higher pre-operating expenses

a- on the training of operation and maintenance personnel in operating plants in foreign countries.

b- high salaries of the foreign experts deputed to the plant for providing training facilities.

c- higher remuneration to the foreign experts who assist in trial runs and commissioning of the plant, and

d- salaries disbursed to the trainees during the training period.

e- higher expenses on construction facilities e.g. to meet the power, water and storage facilities required during construction.

HISTORY

Steel industry was created in Arab Countries on purely commercial basis to produce finished products of high demand such as reinforcement bars and welded pipes.

The main raw material for reinforcement bar production was iron and steel scrap, the major part of which was left after the second world war. Plates and strips were the main imported materials for welded pipe manufacture.

Semi-integrated plants were built in different Arab Countries from 1947 onward. Table 7 shows a brief statement of these plants, their location, start-up years, main raw materials, main products and production capacities.

In other countries, rolling mills and pipe mills were built, mainly to produce reinforcement bars and welded pipes from imported billets and strips. Table 8 gives the location of these mills, their start-up years, capacities, main raw materials and finished products.

Later on, some countries started to plan fully integrated steel plants, using their local iron ore in conventional blast furnaces, and importing the required coke or coking coal from other countries outside the Arab world.

Finally, Lybia, Qatar, Abu Dhabi, Iraq started direct reduction plants.

At present, only three integrated plants exist in the Arab world: in Algeria, Tunisia and Egypt.

TABLE 7

SEMI-INTEGRATED STEEL PLANTS IN ARAB COUNTRIES

| Name of Plant | Location | Start-up Year | Main Raw Materials | Main Iron & Steel products | Annual Production Capacity (tons) |
|---|---|---|---|---|---|
| Oran Steel Works | Oran Algeria | 1956 | Scrap | RC bars | 40.000 |
| Delta Steel Mills | mostorod Cairo Egypt | 1947 | Scrap | RC bars<br>cold drawn wire<br>Steel & CI casting | 60.000<br>60.000<br>2.000 |
| National Metal Industries | Alexandria Egypt | 1953 | Scrap | RC bars<br>cold drawn wire<br>wire rope<br>steel rolls<br>steel castings<br>baling hoops | <br>2.000<br>1.500<br>4.000<br>10.000<br>8.000 |

Many of these plants are working below their full capacity, mainly due to lack of raw materials i.e. scrap and/or billets. Furthermore, some plants suffer from unbalance between melting & rolling capacities, where either of both may not be fully utilized. This unbalance is being remedied through projects under study or under execution.

CATEGORYWISE PRODUCTION IN INDIVIDUAL PLANTS

Reinforcement bars and welded pipes were the main products of interest to the Arab Steel Industry at its beginning. Light sections ranged third in production capacity and volume of production.

Installed production capacities of individual plants are given in Table 8.

TABLE 8

PRODUCTION CAPACITIES OF ARAB IRON & STEEL PLANTS

| Plant and Country | Railway track material | Heavy sections | Light sections | Bars and rods | strip | plates | sheets | Steel tubes and Pipes | wire | tinplate | Galvanized Sheets | Iron and Steel Castings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sometal - Morocco | | | | 45 | | | | | | | | |
| El-Hadjar - Algeria | | | 150 | 540 | 300 | (20) 100 | (80) | 120 | | 40 | 40 | |
| Oran Steel works - Algeria | | | | 45 | | | | | | | | |
| Spiral Pipes - Algeria | | | | | | | | 100 | | | | |
| Large Welded Pipes-Algeria | | | | | | | | 18,3 | | | | |
| Small welded pipes-Algeria | | | | | | | | 18,7 | | | | |
| National Iron & Steel-Tunisia | | | 35 | 85 | | | | | | | | |
| Tube Plant - Tunisia | | | | | | | | 7 | | | | |
| Libyan Metallurgical-Libya | | | | 36 | | | | 160 | | | | |
| Egyptian Iron & Steel-Egypt | (25) 125 | (100) | | | 500 | (65) 75 | (10) | | | 45 | 10 | |
| Delta Steel Mills-Egypt | | | | 100 | | | | | 6 | | | 2 |
| Egyptian Copper Works-Egypt | | | | 200 | | | | | 2 | | | 10 |
| National Metal Industries-Egypt | | | | 70 | | | | | | | | |
| El-Nasr Pipe Manuf.-Egypt | | | | | | | | 130 | | | | |
| General Iron & Steel-Syria | | | | 110 | | | | | | | | |
| Lebanon Steel Mills - Lebanon | | | | 220 | | | | | | | | |
| Consolidated Steel - Lebanon | | | | 90 | | | | | | | | |
| National Tubes - Lebanon | | | | | | | | 78 | | | | |
| Tubes de Levant - Lebanon | | | | | | | | 12 | | | | |
| Jordan Iron & Steel-Jordan | | | | 170 | | | | | | | | |
| Jordan Tubes - Jordan | | | | | | | | 30 | | | | |
| Iskandariya Mech. Ind.-Iraq | | | | | | | | | | | | 12 |
| Kuwait Metal Pipes-Kuwait | | | | | | | | 35 | | | | |
| Steel Rolling Mill-Saudi Arabia | | | | 45 | | | | | | | | |
| Sudanese Sheet Metal-Sudan | | | | | | | | | | | 25 | |
| T O T A L | 25 | 100 | 185 | 2356 | 800 | 175 | | 709 | 8 | 85 | 75 | 24 |
| | | | | | 4542 | | | | | | | |

TABLE 9

ROLLING MILLS AND PIPE MILLS IN ARAB COUNTRIES

| Serial No. | Plant | Location | Start-up Year | Main Raw Material | Main iron and Steel Products | Annual Production capacity (tons) |
|---|---|---|---|---|---|---|
| 1 | Sometal | Casablanca, Morocco | 1971 | Billets | R.C.bars,<br>Screws, Bolts and nuts | 45,000<br>5,000 |
| 2 | Welded Pipe Factory | Reghaia, Algeria | 1960 | H.R.Strip | Welded pipes | 37,000 |
| 3 | Pipe Factory | Menzel Bourgiba, Tunisia | 1966 | H.R.Strip | Welded pipes | 7,000 |
| 4 | Libyan metal Industries Co. | Tripoli, Libya | 1965 | Billets | R.C.bars | 36,000 |
| 5 | El-Nasr pipe Manufacturing Co. | Ain-Helwan, Egypt | 1962 | H.R.Strip | welded pipes | 30,000 |
| 6 | General Iron & Steel Co. | Hama, Syria | 1972 | Billets | R.C.bars | 110,000 |
| 7 | National Tube Co. | Beirut, Lebanon | 1957 | H.R.Strip | Welded pipes | 78,000 |
| 8 | Tubes de Levant | Beirut, Lebanon | 1960 | H.R.Strip | Welded pipes | 12,000 |
| 9 | Lebanon Steel Mills | Tripoli, Lebanon | 1963 | Billets | R.C.bars | 240,000 |
| 10 | Consolidated Steel of Lebanon | Aamshit, Lebanon | 1964 | Billets | R.C.bars | 90,000 |
| 11 | Jordan Iron & Steel Co. | Zarka, Jordan | 1967 | Billets | R.C.bars | 170,000 |
| 12 | Jordan Pipe Co. | Zarka, Jordan | 1971 | H.R.Strip | Welded pipes | 30,000 |
| 13 | Iskandariya Mechanical Industries Co. | Iskandariya | 1972 | Pig iron scrap | St & C.I.castings | 12,000 |
| 14 | Kuwait Metal Pipe Industries Co. | Kuwait | 1964 | H.R.Strip | Welded pipes | 35,000 |
| 15 | Iron & Steel Works | Jeddah, Saudi Arabia | 1967 | Billets | R.C.bars | 45,000 |
| 16 | Sudanese Sheet Metal Products Co. | Khartoum, Sudan | 1969 | C.R.Strip | Galvanized Sheets | 25,000 |

TABLE 10

INTEGRATED STEEL PLANTS IN ARAB COUNTRIES

| Plant | El-Hadjar Iron & Steel Complex | National Iron & Steel Company | Egyptian Iron & Steel Company |
|---|---|---|---|
| Location | Annaba, Algeria | Menzel Bourgiba, Tunisia | Helwan, Egypt |
| Start-up year | 1969 | 1966 | 1958 |
| Main equipment | | | |
| Sintering Plant | 1 | 1 | 1 |
| Blast Furnaces | 1 | 1 | 2 |
| L.D. Converters | 2 | 2 | - |
| Thomas Converters | - | - | 4 |
| Electric Furnaces | - | - | 2 |
| Annual Production(+) | | | |
| Sinter | 800,000(77 msq.) | 165,000(22msq.) | 450,000(50msq.) |
| Pig iron | 450,000 | 100,000 | 300,000 |
| Blooms & billets | - | 150,000 | 50,000 |
| Slabs | 530,000 | - | 215,000 |
| Finished products capacities(t/year) | | | |
| Railway track mat. | - | -) | |
| Heavy sections | - | -) | 125,000 |
| Light sections | - | 35,000) | 100,000 |
| Bars & rods | - | 85,000) | |
| Strip ) | - | - | 300,000 |
| Plates) | 400,000 | -) | 75,000 |
| Sheets) | | -) | |
| Welded pipe | 100,000 | - | - |
| Tinplate | - | - | 45,000 |
| Galvanized sheets | - | - | 10,000 |

STEEL TECHNOLOGY

The continuing efforts at improving efficiency and economics of steel plan operations have always been accompanied by significant advances in the technology of Iron & Steel Production.

Iron Ore Preparation
-beneficiation
-sizing
-blending
-sintering
-pelletizing

Beneficiation of iron ores is being practiced in some Arab countries. In other countries investigations have been and are being carried out to determine the most economic method of ore beneficiation. Sintering of iron ore is being practiced in Egypt, Algeria and Tunisia; a pelletizing plant in Morocco produces 800.000 T/y of pellets.

Iron making
-furnace size (1.000 ton/day in the 1940's. Over 10.000 T/today).
-electric smelting: generally adopted at locations where cheap and abundant electric power is available.
-the installed capacity for power generation in the Arab countries is estimated at 8.200 MW of which about half is in Egypt. This capacity is below the capacity used for the Italian Steel Industry.

Direct Reduction
-a number of direct reduction plants for production of sponge Iron are being installed in the Arab countries (Algeria, Libya, Iraq, Abu Dhabi, Qatar). Which utilise natural gas a reductant.
-the non-availability of coking coal in the Arab countries and the abundant availability of natural gas indicate the possibility of greater use of direct reduction processes. There are in all a total of 7 blast furnaces operating in the Arab countries.

Steel making.

LD process
Oxygen bottom blown process
Electric steelmaking.

In the next two decades, the oxygen converter and the electric furnace may be the only two principal steelmaking processes in most countries. In Arab countries such a two process situation is logical, because they are not burdened with the heritage of open hearth or Bessemer facilities. The oxygen converter could be used for producing steel from hot metal while the arc furnaces would be generally used for smaller scale operation, using scrap and sponge Iron as metallic charge.

Iron & Steel making routes and Plant sizes

The selection of production process is dependant on the capacity and product-mix of the plant, the commercial availability of the process for a particular plant, size, quality and cost of available raw materials and the energy situation which vary widely from country to country, as well as from location to location within the same country. Therefore, the plant size and the process to be adopted are to be determined for each project individually, after making necessary studies.

In order to indicate the methodology of process evaluation, hypothetical cases have been considered, based on stated assumptions. For the purpose of this evaluation, since the rolling and finishing facilities of a steel plant are not influenced by the raw material and energy situation, the evaluation up to the stage of liquid steel production is considered adequate.

Iron and steelmaking routes

Combining the three ironmaking processes - blast furnace (BF), electric smelting (ESF) and direct reduction (DR) - and the two alternative steelmaking processes namely basic oxygen steelmaking process (BOS) and the electric furnace steelmaking process (EF), the following three alternative iron and steelmaking routes are in operation in the Arab world.

Route 1 : DR-EF: sponge iron production in direct reduction process and steel in electric arc furnace using sponge iron and steel scrap.

Route 2 : ESF - BOS: production of hot metal in electric smelting furnace and steel in basic oxygen converters.

Route 3 : BF - BOS : production of hot metal in blast furnace and steel in basic oxygen converters.

HOW TO BRIDGE THE GAP?

The available resources of natural gas and other liquid hydrocarbons inspired several Arab countries, to plan their future steel industries on the basis of routes other than the blast furnace. These countries reported till now are: Algeria, Tunisia, Libya, Egypt, Iraq, Kuwait, Qatar, Abu Dhabi, and Saudi Arabia. Direct reduction seems to be the process that has become a focus of attention. Most of the studies and plans are based on the importation of high grade pellets, but the end objectives of the projects differ from one country to another. If it is finally decided to bridge the gap through direct reduction processes, many economical and technical prerequisites should be carefully considered particularly, those which are related to:

-the choice of the type of the process and the capacity that best suits the local conditions;
-the use of the pre-reduced material;
-the future developments affecting direct reduction, and
-future supply and prices of raw materials, such as fuel and energy.

THE DIFFICULT QUESTION OF CHOICE:

There are many processes for direct reduction, which can be classified into two main types namely:

-processes with solid reductants,
-processes with gaseous reductants.

The conditions prevailing in the Arab countries seem to be in favour of gaseous direct reduction processes, which can be classified in the three types namely:

-shaft furnace processes: Midrex - Armco - Purofer;
-static bed processes: HYL
-fluidized bed processes: FIOR - HIB

Which process of these is the best remains an unanswerable question unless detailed feasibility studies based on reliable information are carried out. Besides, one of the most important factors which signify reliability is the experience gained through the application of the process in question on an industrial scale for a reasonably long period, without serious problems. Such precautions will guarantee that Arab countries would not become a field of experimentation. Anyhow, defining the project objective helps much in answering the question of choice. The question of project objectives involves many aspects such as:

-producing sponge iron at lowest cost.
-producing steel at lowest cost.
-utilizing only available materials.
-locating the direct reduction plant near an existing plant if any to utilize existing infrastructure and services.

SITUATION IN THE EIGHTEES

In view of the available information on foreseen capacities of direct reduction plants in Arab countries, it seems that the sponge iron production may reach some 10-15 million tons in the eighties. Here two important questions arise: the first one concerns whether these capacities will be realized and the second is whether the produced sponge iron shall be totally devoted to the Arab industrial development.

It is obvious that even with these probable sponge iron capacities in addition to the existing plants and their current expansions, and on condition that all the production shall be used within the Arab World there will be still a short fall in steel that permits further capacities to be developed.

This dilemma requires deep and thoughtful studying on the part of Arab planners and those concerned with the development of the iron steel industry to define the best orientation of steel development.

Such orientation should not be bordered by the eighties but must cross the eighties over to the year 2000.

Forecasting of Steel demand in the year 2000

| Year | Rate of Growth 7% | | Rate of Growth 10% | |
|---|---|---|---|---|
| | Raw Steel | Finished Steel | Raw Steel | Finished Steel |
| 1990 | 38,73 | 31,36 | 44,48 | 36,01 |
| 1995 | 61,43 | 49,74 | 81,03 | 65,60 |
| 2000 | 97,49 | 84,70 | 147,65 | 119,52 |

Per Capita Demand of Steel
Kg

| Year | Rate of Growth 7% | | Rate of Growth 10% | |
|---|---|---|---|---|
| | Raw Steel | Finished Steel | Raw Steel | Finished Steel |
| 1990 | 173,3 | 140,3 | 199,0 | 161,1 |
| 1995 | 242,9 | 196,7 | 320,4 | 259,4 |
| 2000 | 340,7 | 275,9 | 516,0 | 417,7 |

DEVELOPMENT OF ASSOCIATED INDUSTRIES

Steel, by reason of its low cost and high degree of versatility as engineering material, provides the take off point for numerous metal based and engineering industries. At the same time the exacting technology of making shaping and treating of steel necessitates various in the form of raw materials, consumables spare parts and other materials for repairs and maintenance requiring development diverse industries ranging from mining to manufacturing sectors.

BACKWARD AND FORWARD LINKAGE IN INDUSTRY

The prospects and potential of transformation of any economy through the establishment of an industry depend on the linkage of that industry to other industries due to its high combined backward and forward linkage, the establishment of a steel industry stimulates high growth of steel consuming industries using its outputs and feeder industries supplying the imputs.

Lists of typical feeder steel consuming and by product industries that grow around the nucleus of a steel plant are presented in tables 11, 12 and 13 respectively. Also along with steel industry, alloy steel plants iron and steel foundries and forge plants can be started as parallel industries.

## TABLE 11

## TYPICAL FEEDER INDUSTRIES

**Metallic Materials**

1. mining of ores
2. Ore benefication
3. Agglomeration processes such as sintering and pelletisation
4. Ferro-alloys
5. Sponge iron
6. Scrap processing

**Non-Metallic Materials**

1. mining of coal, Flux and refractory raw materials
2. Coal washeries
3. Benefication

**Consumable materials**

1. Graphite electrodes electrode paste
2. Pickling acids.

**Repair & maintenance materials**

1. Rolling mill rolls
2. Welding electrodes
3. Iron, Steel & non-ferrous castings.
4. Forged & fabricated components
5. Machined component
6. Refractories.

## TABLE 12

## TYPICAL INDUSTRIES CONSUMING STEEL PLANT PRODUCTS

| Semis | Finished Products: Non-Flat | Finished Products: Flat |
|---|---|---|
| A-TONNAGE STEELS | | |
| 1. Rerolling mills | 1. Fabricated structural steel work | 1. Welded pipes & tubes |
| 2. Wire drawing | 2. Fasteners like nuts, bolts, rivets and washers. | 2. Steel furniture |
| 3. Seamless tube | 3. Wire mesh, ropes & other wire products | 3. Expanded metal |
| 4. Cold-drawn bars | 4. Forgings. | 4. Tanks & storage vessels |
| 5. Forgings | 5. Agricultural implements | 5. Gas cylinders |
| | 6. Link chains | 6. Drums & containers |
| | | 7. Builders' hardware |
| | | 8. Enamelware |
| | | 9. Profile section |
| | | 10. Equipment for chemical plant & refineries |
| | | 11. Welded steel sections |
| | | 12. Cans & crown corks |

## TABLE 12

### TYPICAL INDUSTRIES CONSUMING STEEL PLAN PRODUCTS (cont'd)

| Semis | Finished Products Non-Flat | Flat |
|---|---|---|
| B- ALLOY TOOL & SPECIAL STEELS | | |
| 1. Cold-drawn bars | 1. Roller chains | 1. Welded pipes & tubes |
| 2. Seamless tubes | 2. High tensile & precision fasteners | 2. Stainless steel utensils |
| | 3. Forgings | 3. Hachksaw & bandsaw blades |
| | 4. Metal-cutting & forming tools | 4. Razor blades |
| | 5. Hand tools | 5. Equipment for chemical plants & refineries |
| | 6. Automobile spare parts e.g. springs | 6. Roller chains |
| | 7. Link chains | 7. Leaf springs |
| | 8. Cutlery & surgical instruments. | |

## TABLE 13

### TYPICAL BY-PRODUCT BASED INDUSTRIES

| Metallic by-product | Non-Metallic by-product |
|---|---|
| 1. Scrap re-rolling | 1. Blast furnace slag cement |
| 2. Scrap recovery from slag | 2. Fertilizer from high-phosphorus steel making slag |
| 3. Iron-based pigments from ferrous oxide by-product from pickling line | 3. Coke oven by-product-gas & tar recovery, tar distillation, nitrogenous fertilizer production supplemented by nitrogen supply from the oxygen plant.(1) |
| | 4. Recovery of benzene, toluene, xylene etc. (1) |

Note: (1) These units are integral with coke oven plants which in turn generally form a part of integrated steel plants.

## TRAINING AND EMPLOYMENT PROBLEMS IN THE ARAB STEEL INDUSTRY

The ratio of invested capital for the creation of one job in the steel industry is one of the highest compared to other industries, like the textile or chemical industry for instance. It is estimated that in developing countries, invested capital exceeds one billion dollars in order to build an integrated steel plant with an annual capacity of 1 million tons, and 10,000 new jobs approximately. This means that the capital invested for the creation of one single new job amounts to about 100,000 dollars which represents one of the highest ratios in any of the various known industries.

More important still is the fact that when establishing a steel plant, an acceleration effect is created insofar as new jobs are generated in the industries directly or indirectly connected with the steel industry. A survey carried out by the American Iron and Steel Institute reveals that for every job created in the steel industry, eight new jobs (15 in the developing countries) are created in other industries which would not have existed if the steel industry did not supply these other industries with steel.

### A NECESSITY: THE HUMAN CAPITAL

The essential problem of Arab countries is not one of financial or material resources, but rather the crucial problem of human resources taken in its real sense; the "human capital".

It is becoming increasingly obvious nowadays that the problem of economic development is closely linked to that of manpower training, in fact, it cannot be dissociated from it, to such an extent that manpower training has become the main corollary of real progress.

Scientific and technological progress has reached such a peak in the highly industrialized countries, that the gap between training and refresher courses is narrowing daily, and the notion of permanent training is no longer a fashionable expression, but rather a scientific economic, and social necessity.

Thus, many among the developing countries had not immediately grasped the fact that one of the major setbacks to their economic development lays precisely in the lack of qualified personnel at all levels, and they consequently underestimated this important aspect in their plans of industrial development.

Insofar as the Arab countries are concerned, the scourge of undertraining has not spared them at all, since in fact, it constitutes one of the basic features of under-development. Hence the firm determination of most of these countries to industrialize their economy, namely, by creating a steel industry; yet this determination has come up against the problem of shortage of qualified personnel.

ASSESSING THE MANPOWER REQUIREMENTS FOR AN IRON & STEEL PLANT

The iron and steel industry requires a substantial number of qualified and specialized staff.

- senior management staff
- engineers
- technical staff and foremen
- qualified and specialized labour.

Yet, most developing countries suffer from lack of the necessary qualified personnel, required to work in the planning, the conception, the implementation, the running and the management of these new industrial units.

Any industrial planning, therefore, should necessarily imply a sound planning for manpower requirements. This, in turn, implies training plans which should be started even before the construction of the new industrial units taking into account the factors of "time needed for construction and training".

The number of personnel in the integrated steel plant of "Menzel Bourguiba" Tunisia, was in the year 1969 about 1,300 of which there were 25 engineers, 100 administrative personnel, 50 foremen and a great number of qualified workers (the total number of personnel is now about 1,800).

Following is the number of personnel working in the Helwan integrated steel plant since the year 1962:

| Fiscal year | Steel production per year | Personnel | Productivity T/M/Y | Increase % |
|---|---|---|---|---|
| 1962-1963 | 139,591 | 7,208 | 18,86 | - |
| 1963-1964 | 144,033 | 8,708 | 16,54 | - 12,3 |
| 1964-1965 | 137,930 | 8,766 | 15,74 | - 4,8 |
| 1965-1966 | 131,483 | 8,562 | 15,36 | - 2,4 |
| 1966-1967 | 148,963 | 8,283 | 17,98 | + 17,1 |
| 1967-1968 | 181,920 | 8,438 | 21,56 | + 19,9 |
| 1968-1969 | 189,343 | 8,521 | 22,22 | + 31 |
| 1969-1970 | 231,827 | 10,052 | 23,06 | + 3,8 |

CATEGORYWISE DISTRIBUTION OF HADJAR PERSONNEL
(ALGERIA) (Capacity 400,000 tons)

| Personnel categories | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 |
|---|---|---|---|---|---|---|---|
| Engineers & other cadres | 130 | 203 | 210 | 182 | 224 | 231 | 378 |
| Foremen & Technicians | 453 | 504 | 580 | 729 | 660 | 802 | 981 |
| Qualified Workers | 1,042 | 1,285 | 1,585 | | | | 3,291 |
| Unskilled Workers | 1,415 | 2,006 | 2,245 | | | | 4,397 |
| Administrative Personnel | 699 | 860 | 935 | | | | |
| TOTAL | 3,739 | 4,860 | 5,564 | 6,413 | 7,621 | 8,815 | 11,315 |

The various examples mentioned are of course not comparable with plants in developed countries but when considering the production figures we notice the difference in the number of personnel between the plants. Those differences are due to:

- Plants equipment
- Capacities of the various units
- Production categories
- Automation grades
- The existence of infrastructure to execute the necessary repairs, maintenance, production of coke and energy, mining units and preparation of raw materials.

The examples presented show that the manpower requirements of the iron and steel plants in developing countries are much higher than the similar ones in industrial countries. This is mainly due to two reasons:

- the shortage of facilities of external services, the plants are obliged to create their own service centres to be able to cover their own demand.

- The productivity level is relatively low because of the short experience of those countries in the iron and steel sector.

It is here worth mentioning that the requirements of the Bhilai plant in India for example. See Table No. 14, which has about 25,000 workers for the production of 2,5 million tons is much higher than similar Italian plants - Toronto Italsider has 4,500 persons for the production of 2,5 million tons - This is due to the two factors mentioned hereabove.

TABLE 14

ESTIMATION OF PERSONNEL REQUIREMENT FOR NEW STEEL PROJECTS IN INDIA

I- VISAPHAPTNAM STEEL PLANT: PRODUCTION CAPACITY / 2,64 M/T

| Section | Cadres | Highly Qualified | Qualified | Semi Qualified | Unskilled Workers | Total | Total |
|---|---|---|---|---|---|---|---|
| A-Production personnel Technical staff | 215 | 535 | 2,550 | 370 | 790 | 4,245 | 4,460 |
| Pers.maintenance at the level of department | 100 | 225 | 1,270 | 430 | 300 | 2,225 | 2,325 |
| Centralised maintenance & general services | 480 | 1,350 | 3,825 | 780 | 1,390 | 7,345 | 7,825 |
| Office pers.(plant) | - | - | - | - | - | 455 | 455 |
| Total | 795 | 2,110 | 7,645 | 1,580 | 2,480 | 14,270 | 15,065 |
| B-General Administration | 130 | - | - | - | - | 1,605 | 1,735 |
| Total | 925 | | | | | 15,875 | 16,800 |

II- VIJAYANAGAR STEEL PLANT 2,64 M/T
PRODUCTION CAPACITY 2,64 MILLION TONS

| Section | Cadres | Highly Qualified | Qualified | Semi Qualified | Unskilled Workers | Total | Total |
|---|---|---|---|---|---|---|---|
| A-Production personnel Technical Staff | 220 | 565 | 2,475 | 475 | 660 | 4,175 | 4,395 |
| Pers.maintenance at the level of department | 100 | 210 | 1,255 | 425 | 280 | 2,170 | 2,270 |
| Centralised maintenance & general services | 495 | 1,440 | 4,130 | 825 | 1,465 | 7,860 | 8,355 |
| Office pers.(plant) | | | | | | 470 | 470 |
| Total | 815 | 2,215 | 7,860 | 1,725 | 2,405 | 14,675 | 15,490 |
| B-General Administration | 130 | - | - | - | - | 1,605 | 1,735 |
| Total | 945 | | | | | 16,280 | 17, 225 |

| Societies | Year | Production of steel in millions | Number of Employees |
|---|---|---|---|
| Fuji Iron Steel Company Ltd. | 1968 | 11,624 | 34,295 |
| Kawasaki Steel Corporation | 1968 | 7,457 | 35,367 |
| Kobe Steel Ltd. | 1968 | 3,746 | 30,470 |
| Nippon Kohan Kasahiri Kaldha | 1968 | 8,716 | 41,166 |
| Sumitomo Metal Industries Ltd. | 1968 | 8,524 | 28,407 |
| Yazata Iron Steel Co. Ltd. | 1968 | 12,776 | 45,791 |
| Toronto Italsider, Italy | 1966 | 2,500 | 4,620 |
| Bhilai Steel Plant, India | 1972 | 2,500 | 25,451 |

ESTIMATIONS OF MANPOWER NORMS FOR ARAB COUNTRIES

We're going to present an approximation for the manpower norms that are necessary when establishing new iron and steel plants in Arab countries.

The structural analysis of the manpower in integrated Arab steel plants shows the following results, if we consider the conditions in these countries.

| NORMS OF MANPOWER FOR ARAB COUNTRIES | | |
|---|---|---|
| Categories | Ratio to global staff | Average |
| Engineers, other cadres | 2 - 4% | 3 % |
| Foremen, technicians | 4 -11% | 7,5% |
| Qualified workers | 32% | 32 % |
| Unskilled workers | 38 -54% | 46 % |
| Administrative personnel | 8 -15% | 11,5% |

MANPOWER NORMS FOR STEEL PLANTS

| Categories | % | Capacity | 300,000T/an | | | 500,000 T/an | | |
|---|---|---|---|---|---|---|---|---|
| | | T/M/Y | 50 | 75 | 100 | 50 | 75 | 100 |
| Engineers, cadres | 3 | | 180 | 120 | 90 | 300 | 200 | 150 |
| Foremen, Technicians | 7-5 | | 450 | 300 | 225 | 750 | 500 | 375 |
| Qualified Workers | 32 | | 1920 | 1280 | 960 | 3200 | 2133 | 1600 |
| Semi-qualified workers & unskilled work | 46 | | 2768 | 1840 | 1380 | 4600 | 3067 | 2300 |
| Employees | 11,5 | | 690 | 460 | 345 | 1150 | 777 | 575 |
| Total Staff | 100 | | 6000 | 4000 | 3000 | 10000 | 6667 | 5000 |

From this approximated percentage as regard, the manpower norms in Arab countries we can proceed with presenting rough figures for manpower requirements which take production capacity and productivity in consideration. It is to be noted in the first place, that notwithstanding the increase in the productive energies, the increases in the need for highly qualified personnel seems neither logical nor realistic. As an example, we may take the case of a one million ton producing factory as against that of one that produces twice this amount. This should mean that the ordinary estimates of skilled workers will, in the case of the new Arab iron and steel projects be greater and that this will, in all cases necessitate accordingly top priority, to the training of these individuals who are being equipped for this new factory, notwithstanding that this kind of training will entail a comparatively high expenditure. Notwithstanding that the employment and training problems do, of course have their own nature incident to the position of each country, yet it may be generally possible to look into three kinds of countries, at the same time taking into consideration the level of their development in relation to the iron and steel industry.

A- Those countries that are industrially highly advanced and that have all the necessary training machinery.

B- Those that are less industrially developed and whose training machinery hardly meet all the demands put forward by the acceleration of industrial training and in particular by iron and steel training.

C- Those countries in which the technical training machinery are at a very backward level and in which there is not any iron and steel industry. Hence it is possible to assess the training problems particularly apparent in the countries falling under paragraphs (B) and (C) these countries which as yet have no iron and steel industry are consequently devoid of any training machinery in this field. Hence the need arises for these countries should they decide to set up an iron and steel industry, to give particular attention to the training problems and to promote the training among projects to be carried out.

The initiation for iron and steel industry would necessitate not only the training of the staff required for the start of work in the factory but, what is still much more imperative, the mapping out of a training scheme for all categories of workers, on the basis of the designed regulatory managerial schemes and after taking into consideration the various aspects of the factory's units and products.

A) TRAINING OF TECHNICAL STAFF

The need arises for training not only engineers, but other employees, supervisors, and qualified technicians who will be required to pursue and become familiar with the diverse construction works. These could be trained in the industrialized countries within category (A), or, in some cases, within category (B). Recourse may be had to pursuing a joint training method (in accordance with the level of experience and specialisation), via securing the fundamental training in the category (B) countries and later sending the trainees to complete their training for a shorter period, in the industrial countries.

B) TRAINING OF ADMINISTRATIVE AND MANAGERIAL EMPLOYEES

This segment of the personnel should be ready to work when the factory starts work, whilst the higher employees, the category engineers carrying out the designing and which also comprises, highly advances economists, must participate in the technical studies and implementation and with some specialised information about planning and regulations. This group could be provided with the basic theoretical training in the country itself in view of the fact that all the developing countries generally have educational establishments that conduct training in the various economic financial, legal and other fields.

The need still arises for providing specialised complementary training to this group either in the categories (A) and (B) country as already mentioned in regard to the technical employees, must be followed.

C) TRAINING OF SKILLED AND SPECIALISED WORKERS

This group comprises the largest number although this type of training is comparatively of the lowest category, the attention granted to the training of skilled and specialised workers should be permanent in view of the leading role that they play in running the factory. The training of this group can be done in the (B) category of countries.

Some Arab countries like Algeria, Tunisia and Egypt do have iron and steel industries. Moreover, Algeria and Egypt do have specialised training machinery. Hence cooperation among the Arab States could be useful to those deciding to set up an iron and steel industry.

## TABLE 15

### MANPOWER NORMS FOR STEEL PLANTS DEPENDING ON CAPACITY

| Categories | Cap T/Man | 300,000 T/Y 50 | 300,000 T/Y 75 | 300,000 T/Y 100 | 500,000 T/Y 50 | 500,000 T/Y 75 | 500,000 T/Y 100 | 1,000,000 T/Y 50 | 1,000,000 T/Y 75 | 1,000,000 T/Y 100 | 2,000,000 T/Y 50 | 2,000,000 T/Y 75 | 2,000,000 T/Y 100 | 3,000,000 T/Y 50 | 3,000,000 T/Y 75 | 3,000,000 T/Y 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Engineers & cadres | 3 | 180 | 120 | 90 | 300 | 200 | 150 | 600 | 400 | 300 | 1,200 | 800 | 800 | 1,800 | 1,200 | 900 |
| Foreman & technicians | 7,5 | 450 | 300 | 225 | 750 | 500 | 375 | 1,500 | 1,000 | 750 | 3,000 | 2,000 | 1,500 | 4,500 | 3,000 | 2,250 |
| Qualified workers | 32 | 1,920 | 1,280 | 960 | 3,200 | 2,133 | 1,600 | 6,400 | 4,267 | 3,200 | 12,800 | 8,734 | 6,400 | 19,200 | 12,800 | 9,600 |
| Semi-qualified workers & non-qualified | 46 | 2,768 | 1,840 | 1,380 | 4,600 | 3,067 | 2,300 | 9,200 | 6,134 | 4,600 | 18,400 | 12,268 | 9,200 | 27,600 | 18,400 | 13,800 |
| Employees for Administration | 11,5 | 690 | 460 | 345 | 1,150 | 777 | 575 | 2,300 | 1,554 | 1,150 | 4,600 | 3,180 | 2,300 | 6,900 | 4,600 | 3,450 |
| Total Staff | 100 | 6,000 | 4,000 | 3,000 | 10,000 | 6,667 | 5,000 | 20,000 | 13,334 | 10,000 | 40,000 | 26,668 | 20,000 | 60,000 | 40,000 | 30,000 |

THE ENGINEERING SERVICES NEEDS

Arab countries invest lots of efforts and resources in developing their industries, and not enough on engineering services, that is in creating their own organizations. The problem involved here is the planning, designing, implementing and operating of the project. The solution usually applied is to give it to a foreign engineering firm; in the hope that through the adaptation to the particular condition of the country there will be some transfer of technology.

This transfer occurs marginally at different stages from economics studies to "the turnkeys" or "product in hands" projects. It can safely be summarized as follows:

1- Importation of foreign technologies

2- Setting up of capacities for reproduction.

These different activities require the organization of consulting offices related to the production of consumer goods.

The adaptation of imported technologies to the circumstances of the national economy implies the creation of national capacities of conception. This means of engineering offices and more precisely of general engineering.

The last stage in this process of transfer is the development of new technologies which entails the creation of means of research and development connected with the passing stage from general engineering to that of process engineering.

The capacity of Arab industries in the field of heavy equipment is very limited to satisfy a part of the massive orders induced by the considerable investments which are offered by the various Arab governments. Between the invester and the supplier of equipments the intermediary engineering is paramount.

Every engineering enterprise is connected in the production of equipment. It naturally proposes the machinery and apparatus with which it is most familiar. It has no interest in looking towards local industry unless it is to fill some gaps in its orders.

In sofar as steel technology is concerned, Arab countries are dependent on foreign companies; therefore, the implications of such a liaison, engineering to supplier to invester are vital in terms of technological choices. The engineering firm is more concerned with the promotion of the foreign equipment than with local one.

The real transfer of technology takes place in metal transformation and machine manufacturing. The forward-backward linkages mentioned above need no elaboration.

The investment in Arab steel industry are so important that some decision-makers are hesitant. The investment required per ton of steel is around 1000 (infrastructure included). As compared to 300 in developed countries. This difference resides in the difficulty of environment. Among the factors included in this difference are the high cost of engineering and erection. The amount of these factors is around 30% of the cost of the project.

The table below gives a list of the three integrated steel plants in Egypt, Algeria and Tunisia with the approximate cost of engineering.

| | Annual Production Capacity T | Cost of Construc. /Ton | % cost of Engineering | Cost of Engineering Erection |
|---|---|---|---|---|
| EGYPT: NSC Phase I | 250,000 | 300 | 25 | 18,750,000 |
| Phase II | 1,250,000 | 500 | 30 | 187,500,000 |
| ALGERIA: Phase I | 400,000 | 500 | 30 | 70,000,000 |
| Phase II | 1,800,000 | 500 | 35 | 245,000,000 |
| TUNISIA: Menzel Bourguiba | 95,000 | 400 | 30 | 11,400,000 |
| TOTAL | 3,725,000 | | | 532,650,000 |

The steel consumption of the Arab countries should reach 15 M/T by 1980 (94 Kg. per capita) and 25 M/T by 1985 (120 Kg. per capita).

Several Arab countries will develop their steel capacities which will reach about 15 M/T in 1985.

The installed capacity today is around 5 M/T. This means an increase of 10 M/T at an average cost of 1000 T. It also means that the cost of general engineering will be around 3 billion (at 1977 prices).

These figures indicate clearly the need for institutional framework consulting and engineering organizations to perform the services needed in this sector. The absorptive capacity for technology is evident; what is less evident, less demonstrative is the activities of the national consulting and engineering firms. They do not produce, the development of professionals is taken for granted, and the trends invested in these organizations do not have the expected yield, they mature after long periods of self-definition and self-confidence.

Their need is unquestionable; they are the "technical arm" of the government or the national enterprise. They help in the transfer and assimilation of foreign technology.

## THE POLICY IMPLICATIONS FOR THE TECHNOLOGY TRANSFER

The Arab Iron and Steel Industry is still at the first step of its development. Nevertheless, what is important is that Arab countries are aware of the importance of this industry for their economy.

The purpose in presenting this paper, with a particular emphasis on manpower training and requirements for steel plants and the Engineering Services needs, was to underline the importance of these aspects and to try to pinpoint the policy implications for the technology transfer.

The pace of technological development in the steel industry is such that the risk of technological obsolescence could be considered minimum; It could be said, safely, that the steel industry is one of the few industries where the transfer of technology can occur by imitation, pure and simple. This is not important as far as the processes are concerned.

a- If it is a classical process, that is a blast furnace route, the experience has shown that it works;

b- If it is a direct reduction process, the transfer can occur through the duplication of the plant in the Arab country (ies), but the attention should be drawn to the fact that whichever route is taken, the two basic problems are and will be for a long time.

1- The manpower training

2- The engineering services needs.

The mention of the development of Engineering Industries in this paper was to show the liaison between the initial development of a steel industry and some of its successive stages that will lead to the transfer of technology. We should keep in mind that the real transfer of technology takes place in the transformation of steel because many people seem to have forgotten that steel is an improved raw material.

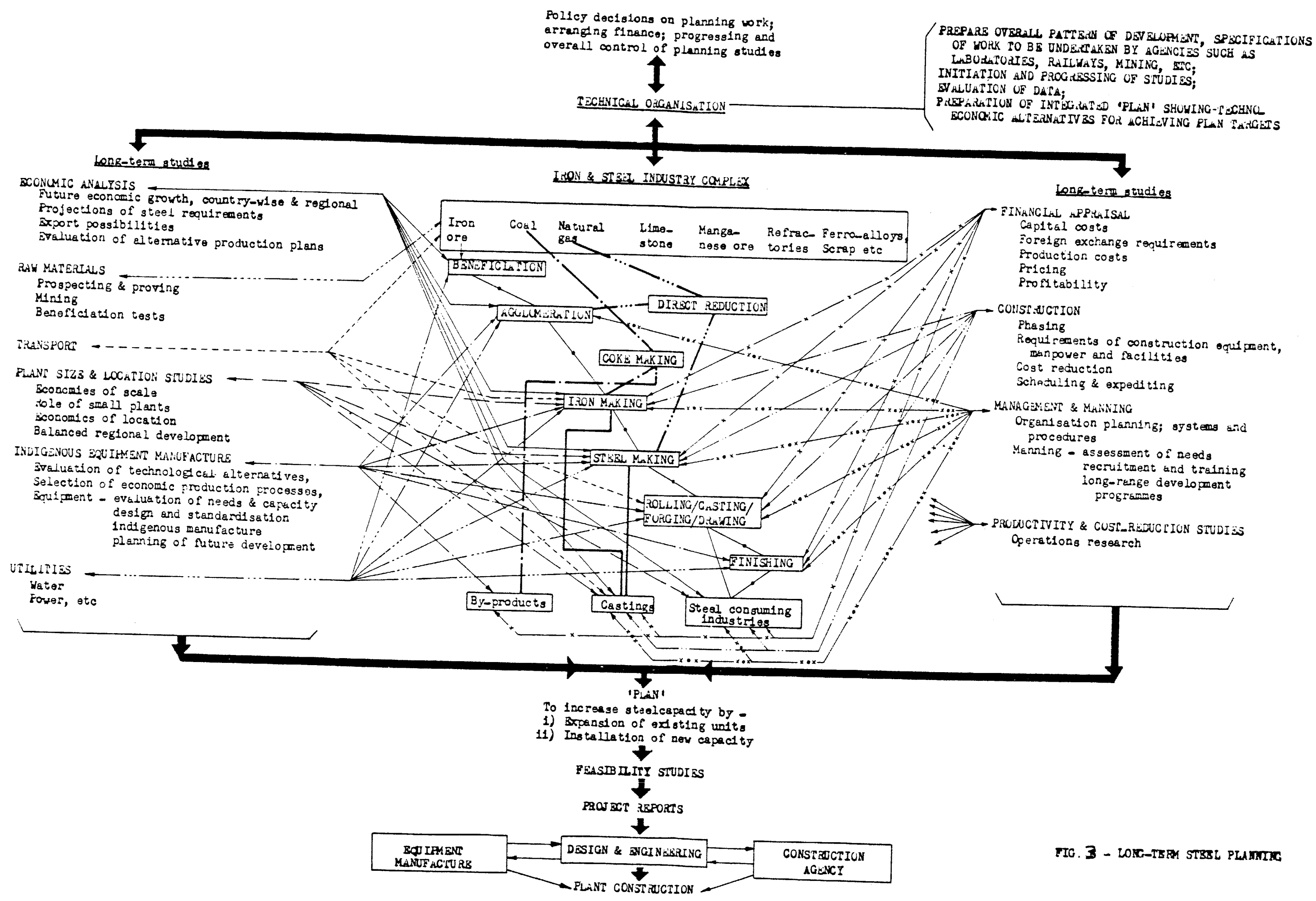


FIG. 3 - LONG-TERM STEEL PLANNING

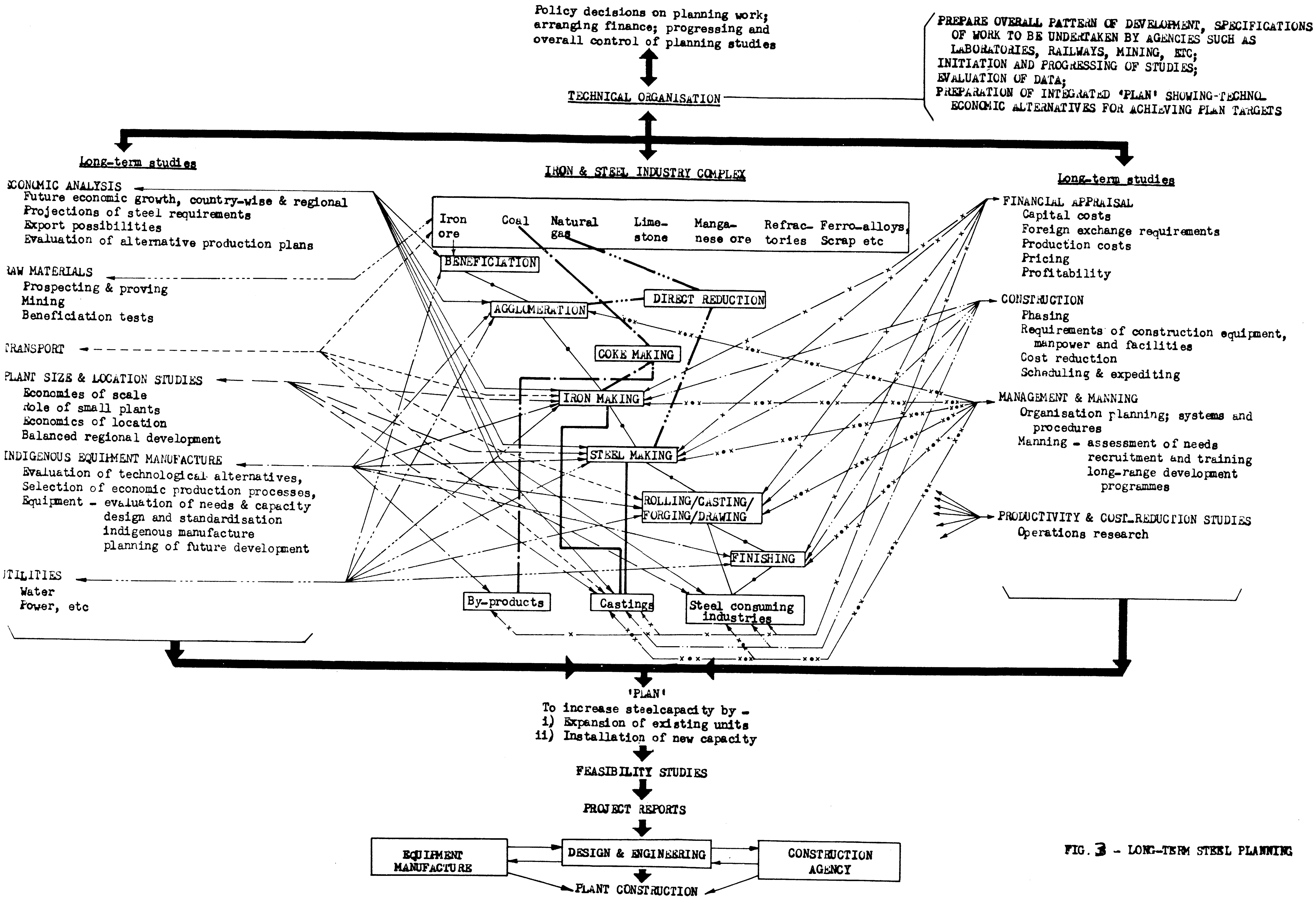


FIG. 3 - LONG-TERM STEEL PLANNING