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CREATION AND TRANSFER OF METALLURGICAL KNOW - HOW[1]

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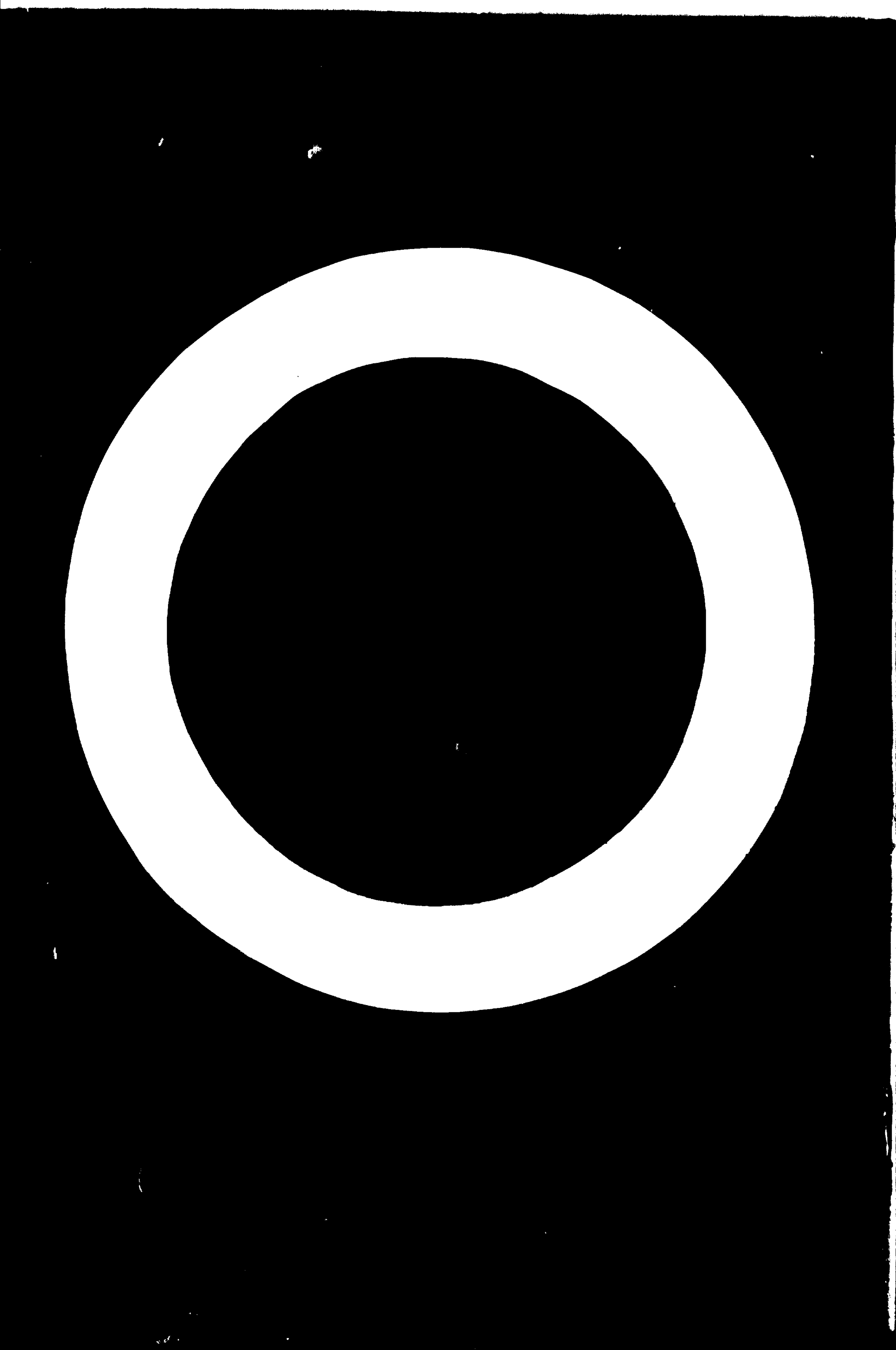

I. <u>INTRODUCTION</u>

We still know remarkably little about the international transfer of metallurgical "know-how" and much less still about the status of development and creation of the metallurgical know-how in the developing world. There are several ways through which technical knowledge and metallurgical know-how find their way from the advanced to the developing countries but the overriding and often unanswered questions are whether and to what extent such "transfer of metallurgical know-how" does take place, at what cost and speed and if the cost of this transfer is <u>qualitatively</u> and <u>quantitatively</u> commensurate with the actual results achieved. There is no unified way to adjudge these results qualitatively and still much less quantitatively. There can be no uniform or rigid pattern for the transfer of technology from the developed to developing countries since conditions differ in the developing countries and each country has to decide its own policies and modes of the transfer of metallurgical know-how and technology. In the course of the next decade, developing countries will have to invest an estimated $20 billion (including infrastructure investment) for the development of their metallurgical industries. Most of this investment will correspond to plant installations and related facilities. A sizeable portion of the investment, perhaps one-fourth, will correspond to the acquisition of direct and indirect "know-how". Since many developing countries (for example: Argentina, Brazil, India, Mexico, etc.) feel that they cannot continue to depend primarily on imported equipment and technical "know-how", on a commercial basis, UNIDO plans to assist in the establishment of local sources and systems for know-how creation and transfer. This would ensure that a substantial amount of the total investments required is applied locally in the acquisition of services (planning, engineering, design, research and development) or of equipment. In other instances, the need for autochtonous metallurgical "know-how" arises from special conditions, as when the national economy depends markedly on certain metallurgical products (for example: Bolivia, Chile, Democratic Republic of the Congo, Malaysia, Zambia). Still in other cases (many countries in Latin America, Asia and Africa could be listed as examples) it is the need to maintain or accelerate a process of industrialization which requires ready availability of local expertise for planning, design and operation of plant installations, adaptive research and development, etc. The problem is directly related to the development of a sound metallurgical industry, essential for sustained economic growth.

Some of the developing countries (Brazil and India, for example) have established nuclei of metallurgical know-how, technical consultancy services, research and development but these need expansion, diversification and specialization in certain specific areas and advanced fields. In most other developing countries such nuclei have yet to be established on an effective basis. The methods of transfer of technology between one advanced country to the other and from advanced countries to the developing countries vary widely depending upon the economic and political conditions of the countries involved. One of the ways the transfer of technology takes place from a foreign enterprise to its branch or its subsidiary firm in the developing country is often based on direct foreign investment as an adjunct to the transfer of technology; some developing countries donot favour the latter since they donot actively or financially participate in such enterprises and often have little management or policy control over the foreign enterprises' operations.

The transfer of technology in another form is based on licensing the use of a process by a foreign firm to the indigenous producer in a developing country. This mode of technology transfer does not provide full safeguards that the specialized process will not be utilized by a third party in the same developing country or even in another country. For the licensee, it means a continuous payment of royalties.

Another method often used is the "turn-key" package deal in which the foreign firm or a consortium of foreign firms undertakes to set up the entire plant and related ancillary units and also is supposed to give performance guarantees over a certain period for integrated plant's operations based on specific norms of productivity, production costs and quality of the product-mix. However, in actual practice these guarantee clauses hedged as these often unobtrusively are by so many subtle and undiscernable clauses, not unoften fail to provide the required safeguards thereby entailing to the developing country additional financial expenditure. The "turn-key" and package deals are considered by many to be not wholly satisfactory in the long run or in their ultimate analysis tending as these do to repetitive import of technology and at times continuous dependance by the developing countries on foreign technology.

Cost of know-how transfer

Despite some attempts to assess the cost of transfer of technology between various countries, no uniform mode of such assessment has been formulated for compilation of the requisite data. It has been stated[1/] that during 1964 the total flow of payments in the transfer of technology, excluding wholly socialist countries, has been of the order of one billion[2/] dollars. The United States of America accounted for twelve per cent of the payments and about 57 per cent of the receipts. Industrialised countries of western Europe had a share of about 61 per cent of the payments and about 41 per cent of the receipts. All these countries, including Japan, Canada, Australia, the socialist countries and all the developing countries (except for intra-trade amongst socialist countries and their transactions with developing countries) accounted for 27 per cent of payments and two per cent of receipts; Japan alone accounted for 13 per cent payments and one per cent of receipts. All the developing countries together had a share of less than ten per cent of payments and almost negligible proportion of receipts; this is attributed to the inability of the developing countries to offer cross-licensing and barter deals in know-how in developed countries.

What is metallurgical "know-how"

Metallurgical "know-how" cannot be concretely or objectively defined in quantitative terms. The "know-how" itself may comprise the process

1/ Oldam C.H.G., Freeman C. and Turkcan E., "Trends and Problems in World Trade and Development", UNCTAD Second Session, TD/28/Supplement February, 1968.

2/ 1 billion = 1,000 million

and production technology, flowsheets, detailed designs and engineering, complex formulae, products and raw materials' specifications, performance charts and quality criteria, plant and equipment detailed specifications, operational manuals, transfer of technical skill and expertise, training of local personnel, maintenance and trouble shooting facilities, etc. Metallurgical "know-how" spectrum is wide indeed. In its broadest sense, it may also comprise marketing data and projections, sales-management concepts and financial controls within the plant. Know-how is what may be termed as the "intellectual property" the modus-operandi of whose transfer, contents and quality in specific terms depend upon the "modus-vivendi" arrived at between the licensor and the licensee. There are no universal yardsticks to measure or quantitatively assess the "know-how" pool available for transfer or for home use.

Transfer of metallurgical "know-how"?

It would be useful to identify the topics and problems confronting the transfer of metallurgical know-how in developing countries in the background of:

a) An assessment of the problems and needs of developing countries regarding "know-how" for: Planning and design of metallurgical plants; design of metallurgical equipment; development (improvement or adaptation) of metallurgical processes; development of metallurgical products; increasing production; productivity and quality in metallurgical industries;

b) An analysis of the mechanisms and practical ways to stimulate the establishment of the capability needed in the developing countries;

c) Establishment in developing countries, of local engineering and technical consultancy services, of metallurgical plant and equipment design units and of applied metallurgical research and development centres in metallurgical processes and materials, in conjunction with the intensification of the transfer of metallurgical "know-how" from the advanced countries.

d) Problems confronting developing countries in establishing technical consultancy services for metallurgical industries; critical analyses of possible practical recommendations, ways and means to transfer the metallurgical "know-how" from developed to the developing countries and regions.

e) Evaluation of the services of international technical consultants in the establishment of metallurgical industries in developing countries; critical analysis and possible recommendations in the interest of developing countries.

f) Scope for the establishment of technical consultancy services for metallurgical industries in developing countries in close linkage and/or partnership basis with metallurgically advanced countries; critical analyses of various factors involved, practical recommendations and formulation of the means to achieve them.

g) The role of research, development work and pilot plants operations including prototype (semi-industrial) metallurgical units, in the creation and transfer of metallurgical "know-how" and production expertise in developing countries and regions.

h) The transfer of technical "know-how" for the iron and steel industries from the developed to developing countries; some case histories and leading examples; practical recommendations and their implementation for developing countries and regions.

i) Technical consultancy services and creation of technical know-how for non-ferrous metallurgical industries in the developing countries; past experience and future recommendations for practical implementation on a self-sustaining bases.

j) Project engineering, creation and transfer of technical know-how in metal transforming industries to developing countries, including the desigr engineering of rolling mills and metal transforming equipment.

k) Technical consultancy services and development of metallurgical know-how for the beneficiation and processing of raw materials for metallurgical industries in the developing countries and regions.

l) Analyses of the factors inhibiting the creation and transfer of metallurgical know-how in the developing countries; practical recommendations to promote the flow of metallurgical know-how from the developed to developing regions and the rôle of UNIDO therein.

m) Techno-economic studies, pre-investment surveys and appraisals and project engineering of metallurgical industries including capital financing requirements for the developing countries.

n) A study of the regional and interregional approaches to the creation of technical know-how and consultancy services for the metallurgical industries.

o) The design of metallurgical plants and equipment including design of infrastructure facilities and auxiliaries.

p) Developing, improving or adaptation of metallurgical processes, including applied research and development projects, integrated pilot plant designs and installations.

q) Development of new metallic alloys for specific applications, cermets and metal matrix composite metals (fibre solid-state, reinforced metal and non-metallic alloys), powder metallurgy and products.

A metallurgical project has to pass through the following four stages in order to become fully operational:

first stage

a) Identify and formulate the general concept based round the original idea for a country to set up a particular industrial project.

second stage

b) Project studies covering the technical feasibility and economic viability (including pre-investment studies) of the industrial project.

These studies are as crucial as these can be critical for the project and are divided into five steps as shown in the attached Fan Diagram I.

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third stage

c) The third stage will be implemented only if the conclusions relating to the techno-economic assessment of the industrial project vide 1a) and 1b) above are positive and capacity of the industrial sponsors (in the public or private sector)

(Cont'd)

third stage (cont'd)

(to raise the capital funds (including the foreign exchange component) for the industrial project has been established. The third stage thus covers the practical erection and installation of the industrial scale project.

fourth stage

d) The fourth stage comprises the practical starting up operations, commissioning the plant's integrated operations and working up the plant to full performance to inter alia test the plant's capacity to attain the requisite output and produce the required (and guaranteed in some cases) end products and that too in terms of production costs estimated in the detailed project report.

Each of the above four stages can be elaborated in order to conform to specific work bar charts and in particular to time schedules.

The third stage covering the erection and installation of the industrial scale plant should be based on critical path analysis and methodology.

The fourth stage likewise, will need to be critically programmed in advance.

These four stages will have to be fully implemented by all concerned diligently and faithfully.

It is difficult for any one to claim that last words on these complex subjects have been said. The local conditions in a developing country, the status of its general economic growth and industrial development, the management personnel and consultancy services and talent available in the country - all these facters play respectively important roles in metallurgical projects formulation and their practical implementation.

Scope and objectives of technical consultancy services in the establishment of an iron and steel industry in developing countries

A. **Feasibility Study**

i) The first and the most important step to take when planting an iron and steel plant is the preparation of a feasibility study. The importance of feasibility studies in developing countries where conditions differ considerably from those met with in developed countries cannot be underestimated. There are, however, cases where the developing countries are additionally faced with lack of certain basic raw materials such as high grade metallurgical coking coal, high quality iron ores, etc.

ii) The object of preparing a feasibility study is related to the fundamental clarification of certain basic techno-economic factors which govern the success or the failure of the entire project. These cover mainly the following parameters:

a) Domestic market requirement and probable export possibilities. Availability of basic and auxiliary raw materials in the country in the background of currently increasing trends to import high grade iron ore where the local iron ore deposits are not sufficient and/or are of poor quality.

b) Capacity of the plant and the nature of multiple product-mix, the plant will be designed to produce.

iii) Choice of technological processes including pre-reduction, electric smelting or blast furnace smelting of iron ores, the size and nature of the rolling mills and auxiliary equipment for metal transformation (rolling, forging, extrusion), continuous casting. Approximations of the capital costs including the foreign exchange component. Approximations of the production cost for each of the constituent product-mix and assessment of profitability of the integrated project.

Résumé of the recommendations and summary of the project and comments on whether or not the project should be implemented.

B. Optimisation studies and final selection and elaboration of the selected scheme of operations including selection of the site, bearing in mind the soil conditions (these will require soil tests and determination of the load bearing capacity of the soil). The location of the plant will be governed inter alia by the status of the transport facilities (for each ton of steel produced, over four tons of the raw materials must be transported to the plant cite). The selected scheme of operations including the choice of technological processes will bear in mind the capacity in the country for the manufacture of steel plant equipment and machinery in order to reduce the foreign exchange component to the minimum possible figure. This optimisation study will load in its ultimate analysis to the preparation of the detailed project report.

C. Detailed project reports will contain the overall plant layout including that of the individual constituent units, the provision of services (gas, water, power, compressed air, etc.); full specifications of the plant equipment and machinery, material balances and plant flowsheets; the capital investment costs the working capital and assess the overall profitability of the integrated project. The detailed project report may refer if required to the possibilities of a turnkey package deal related specifically to a particular country and scope of split-up contracts based on maximum utilisation of the manufacturing capacity for steel plant equipment in the country.

D. One of the lacunae in the detailed project report prepared for the developing countries by technical consultants relates in many cases to the omission of guarantee clauses and guarantees in respect of original capital cost estimates and production cost projections, the performance and capacity of the integrated plant to attain its rated output based on the norms of raw materials already worked out in the detailed project report. The project report will also outline the manpower requirements including the labour force, supervisory staff, business management and administrative personnel, etc. The detailed project report will also comprehensively outline the training programme in the above categories of the manpower requirements for the integrated steel plant. Details will also be furnished of the expatriate expert staff, including the expenses to be repatriated mostly in foreign exchange.

E. Detailed project engineering

The detailed project engineering will provide complete drawings including working drawings, preparation of tender papers based on the specifications contained in the detailed project report, scrutiny and selection of the tenders and appropriate advice to the investors or the Government, as the case may be, before entering into agreement with the selected firm. Considerable caution and alertness are required to ensure that the consulting firm is not involved directly or indirectly with the firms who will be assigned the contracts for the supply of plant e quipment and auxillaries including infrastructure equipment. In the detailed project report and detailed project engineering, the critical path analysis and modern network methodology would be followed.

F. Execution of the project in collaboration with the technical consultants

The actual implementation of the project will require the in-plant training of the plant workers, operational supervisory and management staff in order to fix the operational data to establish actual production norms and yield figures at each successive step. It is possible that the consultants who will undertake these duties would be different from these who had prepared the detailed project report and/or the detailed project engineering. There is considerable merit in having a separate consultant firm during the commissioning, running in and operation of the integrated plant, in order that this consultant can adjudge the technical contents and financial projections contained in the detailed project report prepared by the original technical consultants. Thus, there are three different stages involved in the design of an integrated steel plant. The first stages in the feasibility report and the preoaration of the detailed project report. The second stage covers the preparation of detailed engineering and working drawings for the integrated steel plant and its constituent units (blast furnaces, steelmaking shop, rolling mills, finishing departments, etc.). The third stage is related to the preparation of detailed designs of the plant equipment and relevant drawings and blue prints, such as for the blast furnaces, L.D. oxygen steelmaking units, etc. and their fabrication since none of them can be bought "off the shelf" as if it were. In elaborating the three stages, it is pointed out during the first stage, technical feasibility and economic viability of the project are analysed covering market surveys, economic data, the product-mix along with an assessment of the most suitable location of the integrated steel plant. During this stage the detailed project report is prepared outlining the merits and demerits of various technological processes and selection of the most optimum, the plant lay-out, transport network, the estimates of the total project investment costs, assessment of operational and production costs, cash flow and profitability analyses, etc.

The second stage involves the detailed project engineering of each of the plant units, such as the coke ovens, by-product plant, blast furnaces steelmaking shop, continuous casting rolling mills (hot and cold mills), processing and finishing lines and of the auxiliary units and services. It is at this stage that the capacity and performance of each of the individual self-contained units are determined and design of the auxiliary systems such as the internal water supply, gas and steam pipeline network, power distribution and communication systems and plant control schemes are developed. Detailed working drawings including civil work drawings for the foundations, erection and installation of the plant equipment and the related structural work drawings are also prepared.

During the third stage, the detailed engineering designs of the basic and auxiliary plant units and equipment are prepared including shop drawings and the blue prints for their fabrication. From these drawings, the fabrication of individual plant and equipment items is taken in hand followed by their assembly, erection and installation at the site. The manufacturers and suppliers of the plant equipment and machinery undertake their test-trials, after assembly at site and rectify any defects observed therein. In some of the technologically advanced countries, market surveys, feasibility studies, etc. are prepared by the companies or the organizations that plan to create these new or additional steel production facilities. Where these facilities do not exist, competent technical consultants are engaged. The third stage pertaining to the preparation of the detailed designs of plant equipment is carried out by the equipment manufacturers and suppliers themselves. There is always a number of equipment manufacturers making claims and counter claims. Not all the purchasers have competent engineering departments of their own to assess the validity of these claims, to supervise the erection and commissioning of these units and to evaluate their individual and co-ordinated performances. It is due to these reasons that several technical consultant organizations have grown up. Whilst these consultants have an advisory role to play, in practice the responsibility rightly or wrongly assumed by the consultants is so enormous that few clients would ignore their advice. And that is where their deficiencies and malpractices particularly in relation to developing countries do crow up. Over the years, consultancy services have grown in strengh; and in the discharge of their normal functions of catering to the client's needs and because of their special position as professional bodies, they have acquired a status and expertise which any purchaser or his engineering unit can hardly provide. In this role of a link between the client and the equipment suppliers, they have acquired a position of considerable significance and importance to-day.

UNIDO's role in the "Creation and Transfer of Metallurgical Know-How"

The role of UNIDO in promoting the "Creation and transfer of metallurgical know-how" is basically to provide technical assistance through short term and/or long range technical assistance programme. Without going into the details of the "modus operandi" of such technical assistance channels and programme, it may be said that the technical assistance coverage is comprehensive. The following examples are illustrative of the general trends of such technical assistance provided by UNIDO.

1. Technical feasibility pre-investment and techno-economic studies.

2. Appraisals of capital costs, negotiation of Contracts for metallurgical plants in developing countries.

3. Projection and project evaluation including expansion and modernization of existing facilities;

4. Promotion (developing, implementing, evaluating) of metallurgical industry projects;

5. Metallurgical industrial development planning on a national, regional and interregional levels.

6. Technical appraisal of raw-materials including their processing for iron and steel and non-ferrous metallurgical industries.

7. Production technology, selection of technological processes and equipment; new methods, quality of products; techno-economic evaluation of competitive processes and latest innovations and their implementation/adaptation with suitable measures in developing countries.

8. Market surveys and projections for developing countries and regions.

9. Provision of facilities for metallurgical testing, development and research including pilot plant installations.

10. Formulation of projects related to the development of iron and steel and non-ferrous metallurgical industries for developing countries and regions.

Among the more significant of UNIDO's projects, the following projects can be mentioned:

Assistance for the development of an alumina or aluminium industry based on locally available raw materials has been requested by or provided recently to Argentina, India, Madagascar, Mali, Qatar and Turkey.

A number of developing countries (Arab Republic of Egypt, Brazil, Ceylon, The Gambia, India, Madagascar, Senegal) have received or are receiving assistance of UNIDO for industrial processing of titanium containing ores or concentrates by smelting. In some of the developing countries mentioned pilot or prototype plants are under consideration for the production of a TiO_2-rich slag, which is in demand in the world market and of pig iron, a basic materials for use in local foundries or steel plants.

The establishment, expansion or operation of iron and steel plants continues to be the object of numerous requests submitted to UNIDO, showing the interest of developing countries for this basic branch of industry. A comprehensive study was completed in 1971 as a basis for planning the long-range development of the Peruvian iron and steel industry. UNIDO is also preparing a comprehensive study for the Brazilian Government, regarding the implications of technological innovations for the long-range planning of the country's rapidly growing iron and steel industry. Preliminary assistance for long-range planning of the Thailand steel industry was also provided. With the aim of increasing the short and long term profitability of the existing steel works, UNIDO is providing technical assistance to the Ghana Industrial Holding Corporation. Experts were provided to the steel industry of Yugoslavia to assist in increasing productivity and quality at the Zenica steel plant. UNIDO is assisting the Arab Republic of Egypt with a comprehensive programme of technical assistance in the iron and steel sector: pilot plant tests with Asswan iron ores carried out in 1971 will be followed by a feasibility study for the establishment of an integrated steel plant; assistance is being provided in the establishment and operation of a pilot project for technical data processing and organizing maintenance services at the Egyption Iron and Steel Works, Helwan; in addition, expertise was provided to the Helwan works for the modernization of their steel shop.

During the last two years increasing importance has been attached to technical assistance projects in the foundry industry programmed for a large number of developing countries. Assistance was rendered to both the establishment and development of foundries. Active projects include the supply of specialized expertise for improving existing foundries in the Arab Republic of Egypt, Argentina, Republic of China, Haiti, Iran, Iraq, Mali, Thailand, Yemen, and for the establishment of demonstration or prototype foundry shops (in Senegal and Togo). UNIDO is continuing its assistance in the establishment of prototype foundries, in combination with mechanical workshops, in Somalia and Sudan and initiated preparatory work for establishing a combined Foundry, Tool, Die and Mould making Centre in Malaysia.

UNIDO is assisting a number of developing countries in a more advanced stage of industrialization in the establishment of centres of metallurgical technology. The following projects are examples of UNIDO assistance in this field: UNDP/SF project assisting the Centre for Metallurgical Research and Development in the Arab Republic of Egypt is advancing its activities. A UNDP/SF project in Chile is operative and is assisting the National Mining Enterprise to establish and develop a Centre for experimentation and investigation of copper industry problems. Yet another UNDP/SF project is providing assistance to the National Metallurgical Laboratory in Jamshedpur, India, for the creation of a creep testing laboratory. Other technical assistance projects are under consideration for the establishment or strengthening of centres of metallurgical technology in Iran, Pakistan, Turkey and Yugoslavia.

All of the mentioned projects involve a more or less great amount of creation and transfer of metallurgical know-how. UNIDO is planning to increase its assistance to developing countries with an aim of enabling them to promote and make use of their own sources of know-how so as to avoid expensive "import" of the required know-how.

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