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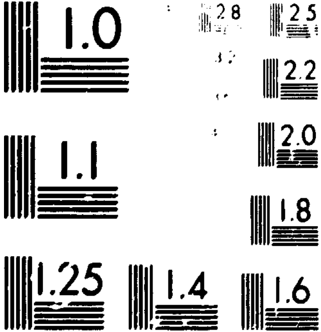

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BACKGROUND AND GUIDELINES
TO
STEELMAKING NEGOTIATIONS

Prepared for the United Nations Industrial Development Organization by Developing World Industry and Technology, Inc.

10 May 1982

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BACKGROUND AND GUIDELINES TO STEELMAKING NEGOTIATIONS

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PREFACE

This paper has been prepared as background for two principal issues identified at the Estoril meeting (February 3-5, 1982) for presentation at the Third Consultation on the Iron and Steel Industry to be held in Caracas in September 1982. One of the principle issues concerns the particular problems faced by "newcomers" in negotiating for iron and steelmaking technology. The other relates to the problems of financing iron and steel projects. A third issue relates to availability of engineers and technicians from US industry sources.

The paper draws upon a contextual framework developed in an earlier paper[1] along with other material in the "normative scenario" prepared for the Estoril meeting.[2] Following the "normative scenario", this paper contains guidelines for three distinct groups of iron and steel negotiations; namely, (1) large-scale and complex projects, (2) direct reduction projects, and (3) mini-steel projects. For each of the foregoing categories, both the negotiable variables and the respective strengths, interests, and strategies of involved parties (buyers, suppliers, and financiers) are delineated.

Insofar as the buyer country groups are concerned, categorical distinctions are drawn between

(1) newcomers (such as many of the African countries) with little or no experience and/or capabilities from either an operational or negotiation viewpoint; and

(2) experienced countries (such as Brazil, Korea, Mexico, and India) in terms of both operational and negotiation capabilities.

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[1] "Guidelines to Negotiating for Iron and Steel Technology", prepared by DEWIT for UNIDO, 10 March 1982.

[2] ID/WG.363/2, 25 January 1982.

Particular attention focuses on group (1) to indicate how they may optimize their negotiation advantage. In connection with the foregoing, the concept of operational and negotiation gap, as a function of the level and sophistication of the transmitted technology, the absorptive capability (both operative and negotiational) of the buyer country, and the capability of the supplier (as a transfer agent - including the training function) has been developed.

In order to explore the feasibility of utilizing engineers and technicians from the US steel industry who may now be in surplus and available for assisting developing countries in related fields, a series of interviews has been carried out with representatives of US steel companies, design-engineering groups, labor unions, professional steel engineering societies, and steel industry trade associations. The results are contained in a final section of this paper.

Part A sets forth the analytical framework for negotiation guidelines. Chapter I covers the two sets of negotiation elements - (1) involved parties, and (2) negotiable variables and trade offs. Chapter II deals with the relative bargaining power of involved parties (purchasers, suppliers and financiers). Following an outline of strategic considerations, bargaining for technology and financing are analyzed. A final section discusses ways and means for purchasers to improve their bargaining position vis-a-vis suppliers and financial sources.

Part B provides detailed negotiation guidelines for three categories of iron and steel projects - (1) large scale and complex plants (Chapter III), (2) direct-reduction facilities (Chapter IV), and (3) mini-steel plants (Chapter V). Under each of these categories, relevant technical features are described, followed by an analysis of negotiable variables (as outlined in Part A). Chapter VI summarizes the negotiation guidelines, with special reference to newcomers (to steelmaking and/or negotiation).

Part C provides an analysis of U.S. receptivity to technology transfers, particularly as it concerns the availability of engineers and technicians to assist in transferring operative technology. Chapter VII outlines the factors inhibiting technology transfer, and Chapter VIII presents the results of a survey of U.S. firms involved in supplying technical support services associated with international transfers of steelmaking technology.

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This study has been prepared by Dr. Jack Baranson, with the assistance of Mr. Robin Roark. The material in this report is based in part upon interviews and correspondence with knowledgeable experts in the iron and steel sector and other technology suppliers. Mr. Bernt Rollinger was particularly helpful in providing background materials and insights pertaining to technology sales.

Part A

ANALYTICAL FRAMEWORK

I. NEGOTIATION DIMENSIONS

In negotiations for iron and steel technology, the <u>involved parties</u> are (a) purchasers, (b) suppliers, and (c) financial sources. The <u>negotiable variables</u> include raw materials, capital goods, technical and marketing assistance, ancillary infrastructure, and financing terms. Each of the elements are explained in what follows:

A. Involved Parties (See Chart 1)

Purchaser Groups

Developing country purchaser groups may be private or public sector enterprises and are often a combination of the two. They may also involve domestic owners of mineral and energy resources relevant to steel making. The proportion of government participation in iron and steel industry projects is large and growing, especially in the NIC's.[1] State participation may be direct (often as a majority shareholder) or indirect (as the developer of supporting infrastructure and increasingly as loan guarantor to obtain international financial credits).

The principal objective of iron and steel projects in developing countries has traditionally been to supply the local market. This is true even in countries that have achieved some success in exporting their

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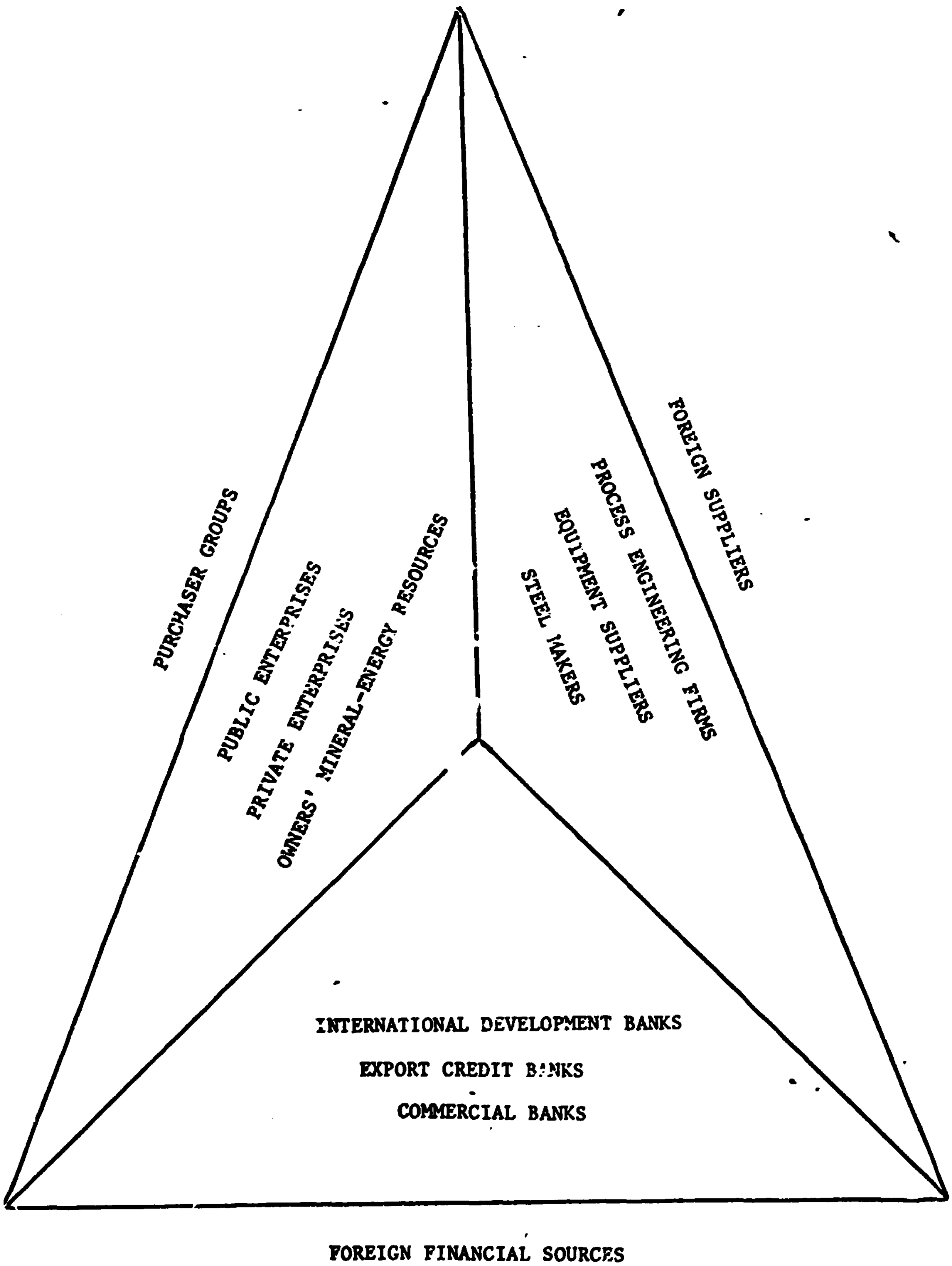
[1] Currently more than 80% of the iron and steel projects launched in the developing countries result from the initiative of the state or from state ownership. See UNIDO, 1990 Scenarios for the Iron and Steel Industry - Part One (Document #IS 213/Rev. 2, 15 December 1981), p. 26.

Chart 1

INVOLVED PARTIES



surplus products, such as Brazil and Korea. The viability of projects geared solely towards exports remains to be proven.[2]

Corollary economic objectives may include: net foreign exchange savings resulting from local production, as compared to the alternative of imports; forward linkage effects to iron and steel using industries; backward linkages to local raw materials and energy suppliers; the development of indigenous design-engineering, research and development, and industrial management capabilities; and regional development activated by the iron and steel industry.

The bargaining power of the purchaser group may be enhanced by the ownership of either abundant and/or high quality mineral or energy resources; or conversely, the purchaser can be disadvantaged by domestically available, low-grade mineral or energy resources, which it insists upon utilizing to develop a domestic steel industry.

Supplier Groups

The foreign technical group may be a single entity or a consortium of companies that will design and engineer the facility (technology and know-how), supply processing equipment, supervise or assist in plant run-in, train personnel locally or in home facilities, and assist in domestic or international marketing of end products. Suppliers may be classified into four main types whose objectives are outlined below:

[2] For example, the ISCOTT project in Trinidad and Tobago is geared mainly to export markets in the Caribbean region.

1. Design-engineering firms. These are generally independent enterprises that offer services in planning, design and detailed engineering of iron and steel works, on a fee basis. Some may provide overall project management and supervision through startup and run-in. They generally do not participate in financing projects, nor do they get involved in construction, training, startup or maintenance (except in a supervisory role, as noted).

2. Equipment suppliers. Equipment for iron and steel projects is supplied by merchant vendors and by integrated steel producers. The objective of both is generally to sell as much as possible with minimum risk. The merchant vendor's involvement generally ends with delivery and acceptance by the purchaser, although many will provide erection, startup and training assistance if requested to do so. Some steelmakers supply equipment based on proprietary designs used in their own steelmaking operations, as noted below.

3. Steel producers. This category of technology supplier includes the larger integrated and semi-integrated steel producers located in the industrialized countries of east and west, and in those developing countries with advanced iron and steel industries such as Brazil and Mexico. Some large steel producers offer design, engineering, and managem ervices directly or through a subsidiary or affiliated company. Many sell proprietary designs and equipment through subsidiaries and foreign licensees. This type of supplier is also more likely to accept a financial stake in the NIC project -- either directly as a shareholder or indirectly as marketer or purchaser of the completed plant's output.

A design-engineering subsidiary of a steel producer may tend to specify the use of the parent company's proprietary technology. This may serve the commercial objective of an affiliated equipment manufacturer, or could be designed to defray the cost of R & D and engineering know-how that originally produced the technology. In negotiations involving such a subsidiary, it is important to assess the "arm's length" nature of its operation and willingness to use someone else's technology.

4. Combinations of the above supplier groups. A consortium of several suppliers may provide a mixture of any or all of the services and equipment for an iron or steel project. Negotiations with a consortium of this type are inevitably complicated unless one member is designated to represent the rest. In this case the purchaser should have a good understanding of the identity and role of all of the consortium members, since each of their separate objectives will be reflected (and perhaps hidden) in the negotiating position of their common representative.

Financial Sources (Foreign)[3]

Foreign financial sources may include international development banks, commercial banks, and export credit banks. Domestic banks and governmental agencies may have an ancillary role in financing the domestic component of a project, and foreign lenders often insist upon their participation to reinforce project viability potential. The nature and source of funding will impact upon the terms and conditions of lending, and the extent to which economic (as distinct from commercial rate

[3]Certain projects, or project components, may be financed in whole or in part from domestic banking sources. This may be the case with countries enjoying foreign exchange surpluses or those having domestic industrial banking facilities with foreign borrowing capabilities. See p. 12 on the role of domestic financial institutions in improving a country's bargaining Position.

of return) criteria are applied.

1. Commercial and Investment Banks. These banks (often in consortia) are most interested in financial rate of return and minimizing risk. Their participation often depends upon that of the other financial sources listed below.

2. International Development Banks. Lenders such as the IBRD and IADB act as "lightning rods" to attract other sources of finance. In return for their seal of approval these agencies have emphasized the need for strong foreign technical assistance throughout the project, and commitment of host-country government resources and leadership, especially in the development of ancillary infrastructure.

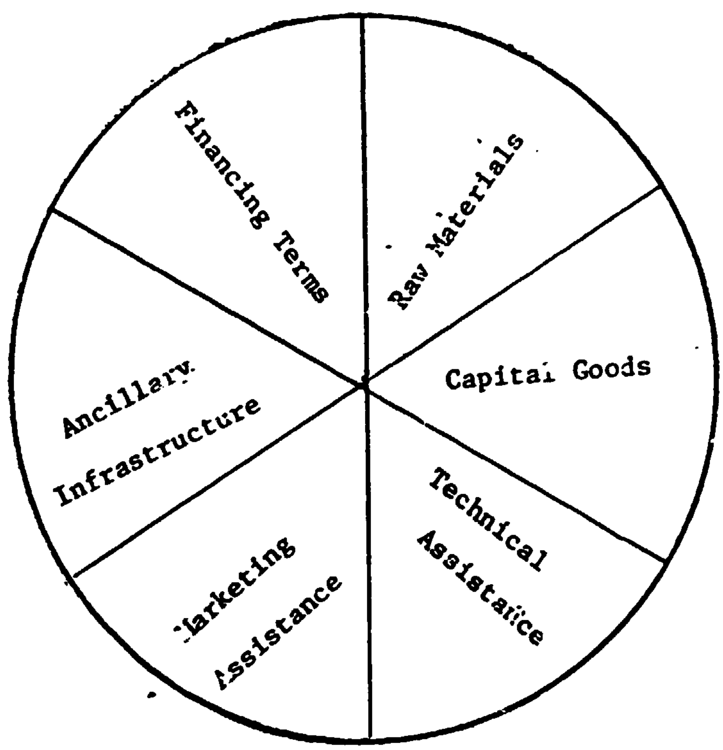
3. Export Credit Banks. Credits from these eximbanks are linked to purchases of equipment and technology from national suppliers. Foreign aid agencies may provide ancillary funds for technical assistance or training in connection with particular projects.

B. Negotiable Variables and Trade-Offs (See Chart 2)

In negotiating for iron and steel technologies, purchasers will have certain choices (and trade-offs) among alternative technologies and sub-components or inputs. The trade-offs are based upon often conflicting sets of objectives, principally a) minimizing capital outlay and subsequent operational costs (i.e., technical efficiencies of the operations); b) minimizing the risk and uncertainties of construction and eventual operation of the industrial facilities (see Appendices A and B for examples of problems in this area); and c) the long-term economic and technological development goals of the host country (see Strategic Considerations in Part B, below). Sub-components of particular technology systems include the following:

Chart 2

NEGOTIATION VARIABLES



1. Raw materials. Mainly ferrous minerals, energy (and reductant) sources, including natural gas, coal, and other hydrocarbon sources. Choices include domestic versus foreign sources, and if the latter are used, the quality, abundance, and accessibility of local raw materials. The cost and efficiency of certain technologies are highly sensitive to the physical and chemical characteristics of mineral and energy inputs.

2. Capital goods. The choice of capital equipment for iron and steel processing facilities may be among alternative foreign suppliers or from domestic capital goods industries (with many of the more advanced developing countries insisting upon maximizing local procurement in order to minimize foreign exchange costs and to reinforce the development of indigenous capital goods industries and design-engineering capabilities.) Once again, the cost and efficiency of certain industries may be highly sensitive to trade-offs in equipment design and construction (operating efficiencies).

3. Technical assistance. Choices and trade-offs in this area are between the nature and extent of foreign technical support (for planning, design, construction, start-up, trouble-shooting, run-in and subsequent maintenance and/or design changes), and the extent and timing of training for take-over by local people to carry out the foregoing functions.

4. Marketing assistance. In certain projects, there may be the need for assistance in domestic marketing of a diversified product line, or there may be opportunities for export of steel products or intermediaries. In the latter case, certain foreign consortia of companies may agree to take on the export function among its

diversified tasks.

5. Ancillary Infrastructure. Provision of ancillary infrastructure (such as township and port facilities) is often a key component of steel projects, especially large scale and greenfield projects (see Appendices A and B). Negotiable issues relate to the division of primary responsibility between contractors and host countries, and performance guarantees.

6. Financing Terms. The finance component will often make or break a steel project, from the buyer's point of view. Often equipment and technical services are financed separately, giving rise to problems (See Appendices A and B). The negotiable issues concern trade-offs between attractive financial terms (including desirable equity involvements) and other characteristics (e.g. supply of proprietary technology or marketing assistance) that meet purchaser country objectives.

II . BARGAINING POWER

The ability of purchaser enterprise groups to obtain the technology and financial packages suitable to their needs and interests is conditioned by the strategic objectives of concerned parties and is a function of the relative bargaining power of the involved parties (purchasers, suppliers, and financial sources). (See Chart 3 for overview)

A. Strategic Considerations

From the purchaser's viewpoint, there are two fundamental sets of considerations in negotiating for technology acquisitions. One set concerns the type of technology sought and the side effects the purchaser enterprise or country seek to realize. There are three functional categories of technology packages in this regard: operational, duplicative, or innovative capabilities. Operational capabilities generally relate to turnkey packages, where the purchaser is primarily concerned with rapid and cost-efficient transfer and phase-in of operational technology. Duplicative capabilities involve the training of indigenous personnel and organizations to perform the complete array of activities normally carried out by foreign contractors (ranging from site selection and preparation to deta[illegible]gn engineering and construction). Innovative capabilities [illegible] the development of indigenous process design and engineering competence to adjust to variables such as changes in scale, site selection, raw material and energy inputs, equipment utilized, and end-product mix.

A second set of purchaser considerations relates to the need to develop an internationally competitive facility with high levels of quality standards and cost-effectiveness, or whether the facility is being constructed essentially to serve the internal market and can

Chart 3

NEGOTIATION PARAMETERS

Purchaser Groups	Technology	Supplier/Financial Groups
*Enterprise strategies: Internationally competitive technology Duplicative and/or innovative design and engineering capabilities Training of technical managerial manpower Fast, efficient technology transplants Entry into export markets *Government objectives: Minimizing newly incurred foreign debt burden Developing indigneous capital goods and design-engineering industries Exports as offset to incurred foreign exchange costs *Bargaining power (enterprise): Absorptive capabilities Alternative sources of technology Astuteness in bargaining Financial resources and credit rating *Bargaining power (government): Debt-servicing capability Attractiveness of economy Strength of financial and technology negotiation institutions	*Distinctive characteristics: -Quantum and complexity -Operative-duplicative-innovative -Stage in product/process cycle	*Enterprise strategies: Competitive product company, design engineering, management, or equipment supplier Willingness to assist purchaser to become internationally competitive Firm exiting from iron and steel business and willing to sell off technology *Country objectives: Interested in trading technology for access to purchaser country's mineral-energy resources Political interest in assisting purchaser country's economic development *Financial Group's Objectives & Strategies: Minimize risk of default on payback because of cost overruns, or diminishing profitability of project Insistence upon foreign technical equity and/or managerial control to insure project payback *Bargaining Power: Extent to which supplier/financial group offers unique technology or indispensable syndicating function in financing project

therefore tolerate products that are higher cost or of lower quality during the "learning period" of industrialization.

On the supplier side, strategic considerations relate to the type of firm that is supplying the technology (design-engineering group, equipment manufacturer, or product company in the steelmaking business). The foreign suppliers' ability and willingness to accommodate purchaser strategies to move beyond operational capabilities (to assisting the purchaser enterprise to develop indigenous design-engineering capabilities) are contingent upon the type of business they are in. Japanese, U.S., and German enterprises cover a broad span of activities which are integrated back to mining operations and integrated forward to the manufacturing of steelmaking equipment and design-engineering groups in the steelmaking field. Individual firms that are in the design-engineering business exclusively may be anxious to build turn-key plants, but reluctant to teach a client enterprise group how to do their own design engineering.

The institutional policies of financial sources influence the contents of agreements between purchasers and suppliers. Whereas commercial banks are narrowly concerned with payback on a loan, institutions such as The World Bank have to balance judgments between hard-headed appraisal of payback on the project and the impact on the economy at large, including the forward and backward industrial linkage effects.

B. Bargaining for Technology

Purchasers' bargaining positions for technology are determined by a complex combination of factors, including the relative strengths vis-a-vis suppliers, the policies and attitudes of financial sources, and world market conditions. The bargaining elements may include the nature and content of the received technology and management support services, the price and credit terms of the received technology package (see below), and other related considerations such as assisting in international marketing of end products.

<u>Relative Strengths of Purchaser/Supplier</u>

On the purchaser side, determinants of bargaining power relate to the institutional capabilities at the enterprise and governmental levels a) to make (and defend) technical judgments on the choice of technology (basic design and engineering parameters), b) to be able to negotiate with (and make choices among) alternative foreign technology sources, and c) to be capable of participating in technical adaptation and run-in of received technology. The relative experience and astuteness of alternative supplier groups as transfer agents and negotiators is the other side of the coin. In iron and steel technology, commercially powerful groups from the major steel-producing countries are able to provide completely integrated technology transfer systems (design-engineering, construction, procurement of equipment, and training of operational personnel).

<u>World Market Conditions</u>

The rising costs per ton of installed capacity coupled with a worldwide decline in the profitability of the industry have contributed to a willingness on the part of steelmaking complexes in industrialized countries (U.S., Japan and Western Europe) to earn profits through the sale of iron and steel technology.[1] Earnings derive from the sale of capital equipment, design-engineering services, and management support and training services. In many instances negotiations for steel complexes are part of larger trade negotiations involving access to minerals and energy resources in purchaser countries or other forms of offset trading.

Financial Sources

Financing sources can play a crucial role in the relative bargaining position of purchasers and suppliers. The World Bank has had a prominent role in this regard. They have generally insisted upon massive and comprehensive involvement of foreign technical support in the complete range of planning, engineering, construction, and run-in of iron and steel facilities and complexes. Their knowledge and experience in this field are legendary -- if not always completely welcome by purchaser nations -- who depend heavily upon them to obtain the necessary financial packages (see below).

C. Bargaining for Financing

The bargaining position of purchaser groups for financing (which includes the obtaining of credits and/or foreign equity investment on favorable terms and conditions) is a function of

[1]Between 1960 and 1975, capital costs per installed ton rose from an average of US $350 to US $1000 for integrated plants producing a million tons per year. With rising capital costs have come increased financial charges and rising energy and labor costs. The proliferation of steel production facilities (and the compulsion to maintain employment even when world demands exceed available supplies) have led to excess supply, intensive price competition, marginal pricing on world markets, and (particularly for Western Europe and the U.S.) declining profits.

the relative strengths and structured characteristics of purchasers, suppliers, and financial sources. On the purchaser side, the relevant factors include a) the country's debt servicing position; b) the enterprise group's credit rating; c) the access to foreign credit sources (i.e., extent of development of national banking institutions to assist them in packaging and negotiating international credits); and d) the attractiveness of the purchaser's economy as a market opportunity and a place to do business (particularly important in the case of equity participation).

On the supplier side, the purchaser's negotiating position is often reinforced (particularly in the case of Japan, Germany, the U.K., and France) by a phalanx of government agencies, trading companies, and banking institutions, that constitute a formidable body of knowledge and experience. But these enterprise groups and their supporting governments are anxious to promote the sale of capital goods and engineering services, and are intensely competitive in offering attractive financial packages to the purchaser's advantage).

International institutions, such as The World Bank, once again play a critical role in this financial arrangement -- as syndicators of comprehensive loan packages and as "honest broker" whose presence is desired by both purchaser and supplier groups for different reasons. Supplier groups consider World Bank approval critical to lend credibility to the project for purposes of involving other foreign lenders. They also want The World Bank presence as insurance against unreasonable demands or unwarranted pressures being imposed upon them by host governments. Purchasers are ambivalent about The World Bank's role. On the one hand, they welcome the knowledge and experience of World Bank staff in formulating projects and in producing the exhaustive cost and feasibility studies needed to obtain international financing. On the other hand, they often object to what they consider the excessive role of foreign technicians in the design, construction, and run-in of facilities -- preferring to use larger numbers of their own nationals and engineering companies (particularly true of countries like Egypt, Brazil, Mexico, and Korea).

D. Improving Purchaser Bargaining Position

Improving purchaser bargaining positions may be achieved in three principal ways: 1) strengthening the bargaining position of purchaser groups, 2) shifting to "weaker" purchaser/financial groups, and 3) adjusting strategic objectives so that the purchaser can attain a more advantageous position vis-a-vis supplier/financial groups. (See Chart 4.)

1. Strengthening purchaser positions.

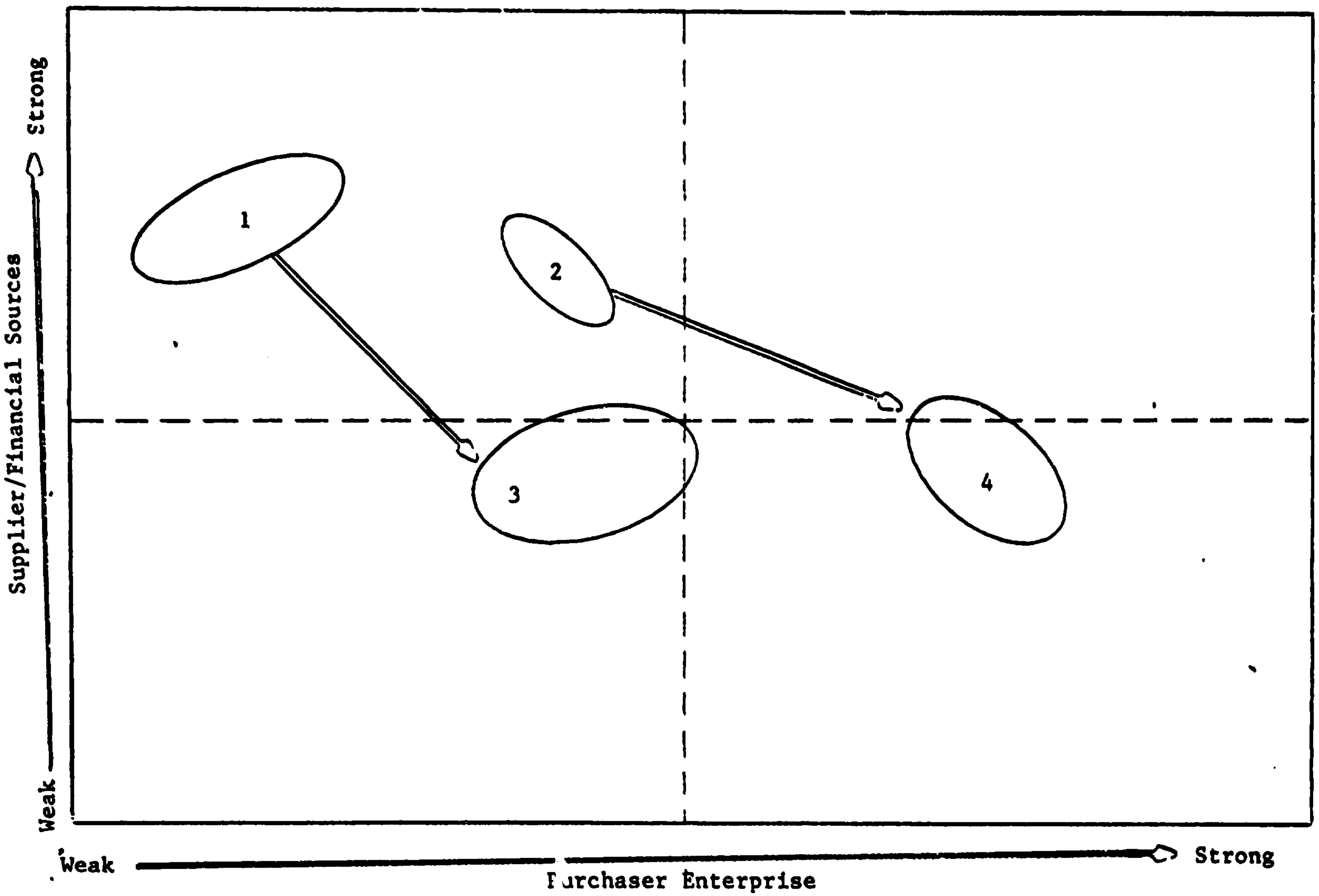
A. Strengthen purchaser's capabilities to make technical decisions, to negotiate for technology, and to absorb and adapt received technology. This applies both to purchaser enterprise groups and supporting design engineering and capital equipment fabricators in the purchaser economy.

B. Develop basic information systems on alternative (foreign) technology sources and the package they offer to similar purchasers in other parts of the world.

C. Develop financial institutions and develop appropriate staff knowledgeable in negotiating for technology and

Chart 4

ENHANCED BARGAINING POSITIONS FOR PURCHASER ENTERPRISES



Note: 1=Weak purchaser enterprises buying from strong supplier move to 3 (strengthens own bargaining positions and shift to weaker supplier/financial groups.)
2=Relatively stronger purchasers buying from strong to weak range of suppliers move to stronger purchaser position 4 (strengthens own bargaining position and expand to include weaker supplier/financial groups.)

financial packages.

2. Shifting to "Weaker" Supplier/Financial Groups.

A. Seek out capable suppliers (and countries) that are either more flexible in willingness to adjust contents of iron and steel technology packages and/or are more anxious for foreign business. Where feasible, move to smaller size enterprise groups and countries -- such as Finland and Austria -- provided technical competence can be matched with financial credits. Appropriate opportunities to obtain derived technology from newly industrializing countries (Korea, India, Mexico, and Brazil) should be explored and possible quality trade-offs considered.

B. Potentially advantageous distinctions need to be drawn between industrial groups that are in the iron and steel business themselves (and may be less willing to release advanced and potentially competitive technology), enterprise groups that are in the business of designing and engineering industrial systems for other enterprise groups. In the latter case it may be critical to combine design-engineering capabilities with operational know-how (including tailoring products to customer needs and developing external markets).

C. Find supplier/financial groups that are more amenable to purchaser strategies and objectives (such as minimizing the use of foreign technicians for run-in operations or training indigenous personnel to progress beyond operational to duplicative and innovational (adaptive engineering) capabilities.

3. Adjusting Strategic Objectives.

   A. The choice of technology (quantum, complexity, stage in the product-process cycle) and whether the package transfers operative/duplicative/innovational capabilities needs to be weighed against the relative bargaining power between the purchaser group (including both technical absorptive capabilities and financial resources and debt servicing position) and supplier/financial groups (and their willingness and interests in accommodating purchaser requirements).

   B. In some instances it may be feasible to adjust the basic iron and steel program to more modest proportions in terms of overall financial and human resource development requirements. This may be accomplished by shifting to another technology (e.g., direct reduction); adjusting the scale of facilities (e.g., mini-steel plants); or developing the project in discrete stages (rather than fully-integrated self-contained complexes).

Part B

NEGOTIATION GUIDELINES

The negotiable variables for three categories of steelmaking projects are analyzed in this section: (1) large-scale and complex plants, (2) direct reduction plants, and (3) mini-steel plants. For each of these categories, the technical features are first outlined, followed by an analysis of the negotiable variables.

III. LARGE-SCALE AND COMPLEX IRON AND STEEL PLANTS

A. Technical Features

Process routes chosen for large-scale and complex projects (with output capacities of one million tons per year or more) include blast furnace, electric smelter, and direct reduction for ironmaking; and open hearth, Bessemer, oxygen converters and electric furnaces for steelmaking. Technology choices and combinations are determined by the availability of raw materials, energy, financing and technical/managerial resources. The route from liquid steel to final product (i.e., continuous or ingot casting and various types of rolling mills) must be integrated with the overall steelmaking process (especially in the case of continuous casting) for efficient production and depends on the structure of demand in the market to be supplied.

Detailed examination of the technical features of these various process routes is beyond the scope of this paper (but see Appendices A and B for case studies of two large scale projects). It is likely that the BF/BOF route will remain the primary route utilized in both developed and developing country large scale plants through 1990. Direct reduction/electric furnace steelmaking will see strong growth, especially in the developing countries, where some 40% of the additional

116 million tons/year of capacity to be installed by 1990 will utilize the DR/EF process (see Chapter IV for a separate discussion of direct reduction). The use of continuous casting is likely to grow during the decade as well, making the training of host country operative and production management personnel somewhat more critical than in the case of ingot casting.

The worldwide shift in demand toward higher quality steels (combined with slow growth in the overall level of demand) will place additional burdens on the capacity of the developing countries to absorb complex technology and managerial systems, and emphasizes the need for good training programs as part of the transfer process. Regardless of the particular process route, large scale iron and steel projects incorporate the following general characteristics:

1. Relatively high capital investment costs (including investments in supporting infrastructure) requiring an extended period for project payback.

2. Relatively complex technology that requires extensive and sustained foreign technical support and assistance to design and engineer facilities, train indigenous managerial and operational personnel, and to bring facilities to economically viable levels of operational efficiency. Economic viability of a project depends upon targeted levels of capacity utilization, and sustained technical difficulties can seriously undermine economic operation levels.

3. Requires extensive transport and other infrastructural development to supply required raw materials and energy inputs and to distribute voluminous and varied end-products.

4. Long gestation periods, during which time changes in world market prices and conditions affect the costs of construction and the ultimate cost and revenue structure of the project. Delays in construction,

in the development of supporting infrastructure, or other concomitant factors affecting time and cost factors, also have a critical impact upon capital investment costs, financial charges (interest), and debt servicing load, which in turn may have a critical impact upon economic viability of the project.

5. Dependence upon external (to project) economic conditions which can critically affect project payback and its ability to service the incurred (particularly foreign) debt. Included here are changes in raw material and energy prices, shifts in the market prices, and level and mix of demand for steel products.

B. Negotiable Variables

The foregoing characteristics give rise to problems of project viability including earnings level and the ability to service incurred debt. Negotiable variables are discussed below under the headings of 1) financing, 2) construction, 3) operations, and 4) infrastructure. (See Appendix A - Mexican Steel Project and Appendix B - Brazilian Steel Mill for detailed analyses of the particular problems that arise under these categories.)

1. Financing. From the purchaser's standpoint, the central problem is one of debt servicing over an extended period of time (12 years or more), both in local currencies and in foreign exchange -- the latter sensitive to fluctuations in world prices and exchange rates. These in turn can adversely affect the rate of return on a project and its ability to service external debt. The supplier of capital equipment and services has a short-term interest in payment, which may be

contingent upon performance in the construction and run-in stages. Foreign equity participants have an interest in the long-term viability of a project. Financiers of a project are concerned with a) the commercial viability of the project over the debt repayment period and b) the borrowing economy's continuing ability to service external debt.

2. Construction. Both purchaser and supplier have a shared responsibility and concern over capital costs to the project (principal and interest), which in turn may be augmented by cost overruns due to delays in construction or in supporting infrastructure, or the failure of the technical partner (supplier) and/or the local enterprise group (purchaser) to perform adequately or live up to contract obligations or agreed upon commitments (e.g., to construct required transport facilities It is for this reason that financiers or purchasers may require warranties on equipment or performance guarantees or changes in design-engineering characteristics, in order to assure anticipated performance results. Such guarantees may then increase capital costs to the purchaser. The financiers of a project are especially concerned to pin-point technical responsibility for such elements as cost overruns and plant performance (previous mention having been made of economic variables that can affect project performance, but for which it is much more difficult to assign responsibilities).

3. Operations. Once again, both purchaser and supplier have a shared responsibility for the following elements: transfer and absorption of operational technology, the training of key personnel, and the efficient management of the facilities during the phase-in period. Shifts in domestic and world market conditions affecting price of inputs (raw materials and energy and the price and level of demand

for plant products have an important bearing upon financial performance. The financiers of the project (and equity holders) are concerned with the commercial earnings of the facility and its ability to service external debt (and provide profit remittances).

4. Infrastructure. The purchaser and the host government may have a joint responsibility to provide (finance and construct) required infrastructure. This may include a) transport facilities to move in raw materials and energy and distribute plant products (railroad lines, port facilities, and pipelines); b) housing and other facilities for plant personnel (may be particularly important in "green-field" sites and for key foreign and indigenous personnel). From the supplier's viewpoint, efficient construction and run-in operations may depend heavily upon infrastructure being in place, when needed. As for the financier's interests, failure to provide required infrastructure will impact upon capital costs of the project, the financial burden to the purchaser, and during the operational period the project's ability to service incurred debt.

IV. DIRECT-REDUCTION IRON AND STEEL PLANTS

A. Technical Features

Production of direct-reduced iron (DRI) is an alternative to the coke-based blast furnace process. Many countries that have no coking coal can now establish iron and steel industries based on DRI. Direct reduction (DR), when combined with efficient electric furnace (EF) steelmaking, has become a viable alternative to the traditional blast furnace/basic oxygen furnace process.

DR processes all use a reductant for both energy and for chemical reaction with the iron ore. Either coal, charcoal, lignite, natural gas, synthetic gas, coke oven gas or oil is burned in direct contact with iron-bearing materials (lump ore, pellets, or fines) within some sort of vessel (vertical shaft furnace, rotary kiln, batch retort or fluid-bed combustor). (See Chart 5). This reaction produces highly metallized (90% and above) DRI, which can then be used in EF steelmaking, or as a partial substitute for scrap in open hearth and BOF steelmaking.

Certain DR processes produce an iron of lower metallization, which is suitable only as a feed stock for blast furnaces and iron foundries. These DR processes are not considered here, since they are likely to be economic only as complements to existing large scale steel plants in the

Chart 5

DIRECT REDUCTION PROCESSES

1. Purofer (Shaft Furnace)
   Materials: Lump ore or pellets or mixture.
   Fuels: Primary - natural gas. Alternates - synthetic gas from oil or coal, coke oven gas.

2. Midrex (Shaft Furnace)
   Materials: Lump ore or pellets or mixture.
   Fuels: Primary - natural gas. Alternates - synthetic gas from oil or coal, coke oven gas.

3. SL/RN (Kiln)
   Materials: Lump ore or pellets or mixture, and in some cases, concentrates.
   Fuels: Coal - non-coking or minor coking type.

4. ACCAR (Kiln)
   Materials: Lump ore or pellets or oil or mixture.
   Fuels: Primary - natural gas or oil or mixture. Alternates - natural gas and coal mixture; oil and gas mixture; natural gas, oil, and coal mixture.

5. HyL (Retort)
   Materials: Lump ore or pellets or mixture.
   Fuels: Primary - natural gas. Alternates - synthetic gas from oil or coal or coke oven gas.

6. FIOR (Fluid Bed)
   Materials: Sinter feed type ore fines.
   Fuels: Primary - natural gas or naphtha. Alternates - synthetic gas from oil or coal, coke oven gas.

7. Krupp (Kiln)
   Materials: lump ore, pellets, or concentrates.
   Fuels: Primary - coal.

8. HIB (Fluid Bed)
   Materials: Sinter feed type ore fines.
   Fuels: Primary - natural gas. Secondary - coke oven gas, gasified coal or oil.

9. Armco (Shaft)
   Materials: Lump ore or pellets.
   Fuels: Primary - natural gas. Alternates - coke oven gas, gasified coal or oil.

10. Koho, Sumitomo, Kawasaki, etc. (Kiln)
    Materials: In-plant fines.
    Fuels: Coal or coke.

Source: Stephenson, R. L. (ed.), Direct Reduced Iron (Warrendale, Pa.: American Institute of Metallurgical Engineers, 1980).

industrialized countries. We are concerned with DR processes that can provide the input for large scale steelmaking (1 million tons per year) in NICs that have substantial energy resources, such as the Middle Eastern countries, Venezuela, Mexico, Brazil, Indonesia, Nigeria, and a few other African countries. See Chart 5 for list of relevant Direct-Reduction Processes indicating respective raw materials and fuel requirements. Generally speaking, the outlook for large-scale DR/EF steelworks based upon economically accessible high quality and abundant energy and iron ore resources is favorable as compared to BF/BOF facilities which seem to have reached a saturation point. DR/EF facilities have a somewhat lower capital costs per ton of output (but slightly higher operating costs) than BF/BOF steelworks.

B. Negotiable Variables

1. Raw Materials and Energy

In order to produce the highly metallized (90% plus), low (40% or less) gangue (stone and earth residue) content DRI used in electric furnace steelmaking, a high-grade iron ore of between 60% and 70% iron content is required. Each DR process was initially developed to use a specific type of ore, prepared in a certain way (i.e., lump, pelletized, or fines -- see Chart 5.) While many of the processes are adaptable to different iron-bearing inputs, the cost of preparing local ores (via beneficiation and pelletization) to the required degree needs to be taken into account. Furthermore, the cost in terms of reduced productivity must be considered where the DR process is modified to use less than optimum local inputs.

The lack of high grade iron ore is often not a critical factor if the purchaser group has other important resources to compensate, such as energy, capital, skilled labor and strong markets. The highly developed worldwide trade and distribution system has contributed to a relatively low and stable price for iron ore. While this situation is subject to change (especially as transport costs rise), many NIC's are in a position to establish iron and steel industries based on imported ore. The Iron and Steel Company of Trinidad and Tobago (ISCOTT) is an example of this type of development.

While raw materials are an important factor, the nature of the locally available fuel has the greatest influence on the choice and economics of a particular direct-reduction process. From the viewpoint of energy, DR processes can be divided into those which use a gaseous reductant and those which use a solid reductant.

DR processes using natural gas, such as HyL, Midrex and Purofer are currently the most advanced and are backed by substantial commercial experience. These processes are still undergoing development and improvement in terms of efficiencies in energy consumption, module capacity and product quality. A purchaser must evaluate the competitiveness of particular DR processes (gas and solid reductant) based upon estimated operating costs at the projected site, as reflected in contract bids and performance guarantees.

A purchaser negotiating for gas-based (as distinct from solid-fueled) DR processes may benefit from the reduced uncertainty and greater efficiency they embody. Solid reductant processes, on the other hand, have not achieved comparable levels of technical development and commercial acceptance. They are potentially more attractive than gas-based DR processess since deposits of non-coking coals and lignite are more widespread than natural gas fields. In the long term, a sharp competition should develop between suppliers of solid-reductant DR plants and those of gaseous DR plants, who will try to base their processes on coal gasification as natural gas supplies diminish. This will work to the advantage of the NIC's with low grade coal deposits.

2. Capital Goods Procurement

Competitive DR processes must be evaluated in terms of the percentage of capital goods that can be procured locally compared to that which must be imported. With capital costs for a 1 million ton per year integrated DR/EF steel plant in the area of $500 million, most NIC governments want to use local procurement as much as possible. Some DR processes (and suppliers) will tolerate the use of locally produced capital goods more than others.

3. Technical Assistance

High performance levels and related cost effectiveness depend critically upon the technical support component. Previous reference (in Part A) has been made to the insistence of foreign lenders upon the extensive involvement of foreign technical assistance as a loan condition (in order to assure project viability and loan payback as scheduled). In the DR process, where technical proficiencies are critical to cost effectiveness, the opportunities to substitute local personnel for foreign technicians will depend, on the one hand, upon the level of development of human resources in a particular country and, on the other hand, the degree of sophistication of the particular process. Inevitably there will be trade-offs between the benefits of training and using nationals and the added cost and time delays of replacing (in some cases) more proficient foreign technicians.

In Mexico, the Hylsa Division of the Alpha Group is an outstanding example of success in training and developing indigenous cadres not only to successfully operate DR facilities, but to design and engineer follow-on generations of the DR process which have been increasingly energy efficient. But even Hylsa has found it necessary to associate with foreign licensors of established reputation (Dravo, Pullman-Swindell, Kawasaki) to achieve international acceptance.

In the case of the SICARTSA project in Mexico, efforts to replace foreign personnel with Mexican technicians resulted in considerable delays and construction cost overruns. (See Appendix A.)

The value and extent of replacement (and the consequent trade-offs) also depends upon the particular capabilities of a chosen technology supplier. An independent process engineering firm may be expert at choosing between competitive DR processes, but unable or unwilling to provide assistance in operator training and maintenance. Once a particular process is chosen, however, a foreign steel producer may provide the most effective assistance in implementation and operations. The creation (by purchaser groups) of adequate provisions to accept and absorb technical assistance must also be stressed. Experienced and qualified operators can bring a new DR unit up to rated production levels in a matter of days. On the other hand, years may elapse before output exceeds 75% of rated capacity, due to problems in operating a well constructed plant.

4. Product Marketing

A DR/EF steel plant produces an intermediate product, DRI, as well as long and flat steel products. A foreign supplier, especially a large steel producer, may be willing and able to offer marketing assistance to a newly established NIC steelmaker. Such assistance is more likely if the foreign supplier is an equity partner in the project.

In the current depressed world steel market, foreign equity participation is waning; and a large DR/EF steel plant is unlikely to be built unless an adequate market for its products exists. Yet such a plant can be envisioned in certain nations whose domestic steel market is small, but whose surplus natural gas resources encourage construction of a larger direct reduction plant than would be needed to supply the domestic market alone.

The ISCOTT project (in Trinidad and Tobago) was originally structured as a joint venture with the participation of Japanese and Dutch steelmakers to produce 1.2 million tons per year of steel in a DR/EF plant. The foreign partners withdrew because of the downturn in the world steel market and the project was scaled down subsequently. Still, only three-fourths of the 'RI output can be used in ISCOTT's own melt shop, and the rest must be exported. The help of foreign partners in marketing this surplus product is invaluable in such a case.

5. Ancillary Infrastructure

Infrastructure development can be crucial to the success of any steel project, as noted in the case of SICARTSA appended herein. DR/EF steel plants are no different from other plants of similar size in this regard, except perhaps their increased dependence on a reliable supply of electric power for EF steelmaking. The infrastructural dimensions of the project place an added burden on overall project logistics and the need for competent personnel to manage the project effectively.

6. Financing

A greenfield DR/EF steelworks with annual production of 1 million tons will require an investment on the order of $500 million. As noted, during the currently depressed world steel market, (significant minority) equity participation by a foreign supplier of technology is unlikely. In the past, controlling equity positions by foreign groups have been resisted, even though they sometimes brought with them the advantages of greater and more effective technical assistance.

Foreign steel producers are more likely than other types of suppliers (i.e.,equipment suppliers and process engineering firms) to accept equity participation in NIC direct-reduction plants. The developers and licensors of competitive DR processes may see equity participation in NIC steelworks as a method of insuring commercial success of their process. Given the strong competition among rival processes, the purchaser is in a position to benefit by negotiating favorable terms from foreign shareholders.

Foreign technology suppliers can also indirectly finance NIC steelplants through agreements to purchase a portion of the plants' output. Such "buyback" arrangements are possible where a plant is designed to produce for export (e.g., ISCOTT), or with temporary overcapacity in anticipation of an expanding local market. For such cases, the foreign supplier has an interest in making sure that the product (DRI or finished steel) it buys back is of high quality, and the technical assistance provided (especially in the areas of operations and maintenance) may be particularly good. On the other hand, a supplier group participating in a buyback agreement could concentrate on those aspects of the project that are in its own self interest to the detriment of the purchaser group's other marketing and production needs and objectives.

V. MINI-STEEL PLANTS

A. Technical Features

A mini-steel plant is here defined as one whose annual production is 250,000 tons or less. It produces primarily simple long productions -- reinfo cing bars and light structural shapes for the local market. Such a mini-steel plant is primarily of interest to a NIC whose market for steel products has reached a size where its objectives (in terms of net foreign exchange savings, downstream and upstream linkages, regional development, etc.) make it wise to consider alternatives to continued steel imports.

The type of plant we examine here would likely be the country's first. The decision to build a mini-steel plant must be based on possession of a comparative advantage in at least one of the resources needed for successful steelmaking: raw materials (primarily iron ore), energy, human resources or financing. The mix of these resources that the NIC possesses will help to determine the process chosen for the mini-steel plant. The steelmaking routes to be considered for this type of plant are:

1. Direct reduction of iron ore, followed by electric furnace steelworks.
2. Small blast furnace using coke, followed by LD steelworks.
3. Small blast furnace by using charcoal, followed by LD steelworks.
4. Open hearth furnace, supplied with hot metal via small blast furnace.

All of the above mentioned process routes to liquid steel could be followed by continuous casting, a process especially suited to larger-scale electric furnace steel-making, but which may also have advantages in many smallscale steelmaking applications. Simple bar and merchant rolling mills with capacities of 50,000 to 300,000 tons per year would follow the casting step.

The choice of a particular process route for a mini-steel plant should be based on the size of the market to be served, the range of produc ts required, and the availability of inputs (iron ore, energy, human and financial resources). The list of possible process routes above is meant to be indicative, not exhaustive. We have purposely excluded EF steelmaking based on scrap, since most of the NIC's we consider here will not have adequate scrap resources. Similarly, a mini-steel plant based on imported DRI, or a small rolling mill using imported billets (and similar non-integrated plants) may be valid options for many NIC's, but are not mentioned here.

Each of the process options listed above has characteristics which make it more or less attractive to NIC purchasers. The critical factors for negotiation are discussed in the next section. A characteristic shared by all of these processes is that they were each created in the industrialized countries and underwent subsequent development in that context. The result was optimization in terms of large scale production in response to rapidly expanding markets. Basic oxygen steelmaking has replaced open hearth furnaces to a large extent because of the scale economies it offers. The scale-up of DR processes is continuing now, with the size of a single module expected to double between 1975 and 1990 (from the 300 to 400,000 to 600 to 800,0000 tons per annum range).

The result of this "bigger is better" syndrome is that experience with efficient small scale steel production is at a premium. A supplier group that can offer such experience has a strong position in negotiations. Purchasers will want to carefully examine a supplier's track record in this regard, to avoid being stuck with a costly miniaturized version of plant that was designed for large scale production. The minimum economically viable size for any of these process routes is not firmly established for all cases, and could perhaps be lowered through additional research and development.

B. Negotiable Variables

1. Raw Materials and Energy

A purchaser that has high grade ore resources will be able to consider DR/EF steelmaking, while one with low grade ore will be more interested in one of the blast furnace routes. This initial choice brings up the closely related factor of energy.

Both EF and oxygen steelmaking require electrical energy (for arc furnaces and oxygen production, respectively). But energy really becomes a critical factor in ironmaking. Blast furnaces must have coke or charcoal, while DR processes use gaseous or solid reductants (see Section IV). As in the DR process, there are cost and efficiency trade offs related to the physical properties and quality of iron ore and energy sources utilized.

A purchaser that has resources of coking coal benefits because suppliers and financiers are familiar with it and its role in ironmaking. Coke can also be formed from different coals, but this process is still uncertain and less efficient. Charcoal has also been used in blast furnace ironmaking. This process is developing in areas with tropical forest resources (Malaysia, Brazil), specifically for small scale steel plant applications.

2. Capital Goods Procurement

Opportunities for local procurement of capital goods for mini-steel plants are more extensive than for large steel works, which are more sophisticated and require more advanced machinery built to stringent technical standards. Much depends upon the extent of development and the degree of sophistication of the local capital goods industry.

3. Technical Assistance

Mini-steel plants will require relatively less technical assistance than large plants, because of their reduced size and complexity. The quality and effectiveness of technology transfer, especailly in the design, construction and run-in phases is crucial, however, since mini-plants may be built and operated under tighter economic and financial constraints than larger plants. Intensive international price competition in the type of simple products a mini-plant produces means it must be well engineered and operate efficiently to compete with imports. These objectives may be realized by negotiating beforehand for effective technical assistance and training of nationals.

As noted, successful experience in small scale steelmaking will be at a premium. Relatively advanced developing countries (e.g. Brazil and India) with recent experience in this area may well be more appropriate suppliers of ideas and equipment in this regard than the traditional industrialized country sources, and NIC purchasers may be in a position to participate more in R & D on small scale steelmaking.

4. Product Marketing

As indicated earlier, mini-steel plant products are destined largely for the local market. When such a plant is the first of its kind in that market, product marketing assistance from a foreign advisor may be (at least for some initial period) indispensable to the financial health of the project.

5. Ancillary Infrastructure

Compared to a large steel project, infrastructure requirements for a mini-steel plant will be reduced in size but perhaps more critical to the project's success. This particularly may be the case where the mini-plant is the country's first and supporting infrastructure is absent at the project's start.

6. Financing

The reduced investment cost required for mini-steel plants does not imply an easy time in arranging financing. International credits may be hard to attract since mini-steel plants often represent unproven technology (or proven technology scalled down to inefficient levels), small markets, and stringent conditions for viability. Foreign equity participation is unlikely for the same reasons. A purchaser group may have to take unusual steps to minimize these risks if foreign capital and credits are desired. Import restrictions and tariffs are the usual (but uneconomic) expedients resorted to, in order to assure the commercial viability of a project. The smaller capital investment required for a mini-plant may permit local enterprise groups to "go it alone" as far as equity participation is concerned. This course brings the problem of assuring adequate commitment to the project by foreign suppliers who have no "stake" in it. It also heightens the foreign debt requirement to cover foreign exchange costs.

VI. SUMMARY OF NEGOTIATION GUIDELINES

Chart 6 provides a summary in the form of a matrix of the trade-off considerations of negotiable variables. The negotiable variables include: raw material and energy inputs, capital equipment, technical manpower (to manage production and marketing), ancillary infrastructural requirements, and financial participation (by foreign lenders and/or investors.)

The trade-off considerations include the cost and efficiency sensitivity to changes or variations in negotiable variable inputs (or the "criticality" factor); the risk and uncertainty involved in input variations (i.e., the "risk factor"); and the developmental objective "trade offs" in substituting domestic for foreign inputs or in being subject to domestic constraints (of a budgetary or financial nature).

Technologies with broad-spectrum tolerances to variations in mineral, energy and equipment inputs are particularly attractive in terms of the lower risk factor and the accomodation of developmental objectives to utilize domestic materials and to source equipment or components from local sources. This applies particularly to proposed direct reduction (DR) projects. In the mini-steel field there is the added problem of scaling down equipment to low-volume output requirements.

Technologies (and suppliers) that permit (with low risk and uncertainty) an efficient and rapid takeover by local personnel (and minimize foreign exchange costs for foreign technicians) in both the production and marketing of iron and steel products are advantageous in terms of national development of indigenous manpower, forward and backward linkages to domestic industries and the added exchange earnings from the agressive development of export markets. The external marketing function may be critical in certain projects (see Appendix D -- Qatar Direct Reduction Steel Mill.)

Chart 6

NEGOTIATING GUIDELINES MATRIX

NEGOTIABLE VARIABLES	TRADE-OFF CONSIDERATIONS		
	Cost and Efficiency "Criticality"	Risk and Uncertainty "Risk Factor"	Developmental Objectives "Trade-Offs"
Raw Materials and Energy	Sensitivity to input variations	Input variations "Criticality" and "Trade-off" effects	Utilizing domestic resources
Capital Equipment	Sensitivity to input variations	Input variations "Criticality" and "Trade-off" effects	Develop domestic equipment industries
Technical Assistance -- Production	Dependence on foreign technicians vs local training	Input variations "Criticality" and "Trade-off" effects	Train nationals
Technical Assistance -- Marketing	Dependence on foreign technicians vs local training	Input variations "Criticality" and "Trade-off" effects	Offset exports Internal linkages
Ancillary Infrastructure	Sensitivity of project to logistical planning	Input variations "Criticality" and "Trade-off" effects	Budgetary burden
Financial Participation	Acceptability of project to low-cost foreign financing	Willingness of foreign lender/investor to tolerate performance risks	Resource-poor country dependence upon foreign exchange

One of the attractions of mini-steel plants is that they do not require anywhere near the level of logistical planning, for ancillary infrastructure that larger scale projects (one million tons and over) demand. This reduces considerably the budgetary burden, the risk and uncertainty of time delays and cost overruns during project phase-in. The extent to which foreign financial participants (lenders and investors) are willing to tolerate performance risks implicit in a particular technology package can assist resource-poor countries in minimizing the foreign exchange burden of external financing.

For the large scale, complex projects, the trade-offs between operational efficiencies (and costs) and national objectives to train nationals, and to develop domestic equipment industries, are especially critical. The logistical problem of ancillary infrastructure and the related financial burden are also critical elements of operational and cost efficiencies. The advice and assistance of experienced and responsible supplier and financial groups are especially important in these larger and more complex projects.

Part C

U.S. RECEPTIVITY TO TECHNOLOGY TRANSFERS

VII. ISSUES AND CONCERNS

A. Declining Position of U.S. Steel Industry

The declining position of the U.S. steel industry, in terms of narrowing profits and diminishing market shares (the combined result of intensified competition and lagging productivity relative to foreigh producers, coupled with the closing of steel plants and the associated rise in unemployment) have inevitably led to a rising tide of protectionism in the iron and steel sector.

In the period 1970-1979, the net decline in employment traced to Japanese steel imports alone was 498,000 jobs (Congressional Record - House, 23 March '82, p. H1064). During 1981, the steel industry as a whole lost 43,000 jobs, incluidng 39,000 hourly workers laid off, some with 15 to 20 years experience (Steel Employment News, AISI, 11 March, 1982).

Steel demand has been sluggish for several years, with decreases in several key sectors such as shipbuilding and more recently, automotive products. The rate of capacity utilization dropped below 60% in early 1982, compared with 80% utilization in January, 1981. (Steel Production News, AISI, 26 February, 1982). Steel imports reached record levels, accounting for approximately 26% of U.S. domestic supply in January, 1982.

The situation described above results from two basic problems of the U.S. steel industry: lagging productivity and old, inefficient plants. Lagging productivity relative to Japan, and an increasing number of developing countries such as Korea and Brazil, has contributed to deteriorating cost competitiveness. U.S. man-hours per ton of steel now are about 40% higher than that of Japan (10 hours compared to 7).

The U.S. produces about 20% of its steel with continuous casting, compared to 60% in Japan. Italy, Austria, W. Germany, Sweden, France, Canada, Belgium and the U.K. all have a higher percentage of continuously cast steel than the U.S. This reflects the slowness of many of the larger U.S. steel companies to adopt new techniques. Nearly all of the major developments in steelmaking during the last 30 years were made outside of the U.S., and many have only been offered by U.S. firms in the past several years.

Worldwide steel demand is shifting towards the higher grade and specialty steels. The declining position of the U.S. steel sector has made it difficult for it to raise the capital needed to update equipment to meet this shift. The industry is in a period of painful restructuring, giving rise to calls for restrictions on steel imports, on exports of steelmaking technology, and on the provision of related financial credits.

An increasing number of small U.S. firms now produces steel from scrap in electric furnaces. Using the newest techniques in plants erected at a cost of only $125 per ton of installed capacity, some of these mini mills are producing a ton of steel with less than four man-hours of labor. While these firms do not fear competition from imported steel, some oppose the export of steelmaking technology, reasoning that this will raise world demand (and prices) for scrap. The price per ton of DRI pellets substitute is $120 compared to $70 for scrap. The U.S. has extensive supplies of scrap, without which small producers could not compete against larger integrated mills.

B. Industry Opposition to Export of Steelmaking Technology and Related Financial Credits

Some steel industry representatives have expressed opposition to the export of steelmaking technology on the grounds that it will eventually be used to produce subsidized steel exports back to the U.S. Others continue to compete successfully for contracts in developing countries (with the help of official export credits), despite the foreign competition (with more favorable export credits) from Japan and Western Europe.

The value of LDC steel projects financed by official export credits during the period 1977-1980 was $780 million in the U.S. (Eximbank). Italy ($1,024 million), Japan ($1,883 million) and W. Germany ($3,169 million) spent more. (See Chart 7)

There is a strong movement to restrict use of Exim Bank credits, especially for potentially competitive facilities (such as energy-saving continuous casting). Eximbank has provided significant support for steel projects in developing countries that are now the targets of "dumping" charges and other protectionist sentiments in the U.S. (See Chart 8).

The U.S. Trade Representative (USTR), in cooperation with Eximbank, is trying to negotiate international agreements on export credits (especially vis-a-vis Japan, the U.K., and France). Discussions center on three main issues: 1) interest rates and other essential terms of export credits; 2) proliferation in the use of mixed credits; and 3) the issue of how far a country should or may go in promoting exports. (See Appendix E for a survey of U.S. official export credit facilities.)

The U.S. Department of Labor has been particularly active in reviewing all projects during 1978-80 period, but they rarely took issue on providing credits for training. Beginning in the mid-70's, union representatives and the U.S. Department of Labor took an increasingly critical view of financing of iron and steel projects in developing countries. They opposed export credits at "subsidized" rates (below commercial rates) particularly as

Chart 7

LDC Steel Projects Financed by Official Export Credit*
(Export Value by Lending Country in $ Millions)

Country	1977	1978	1979	1980	Total 1977-1980
U.S.	115 (22)	21 (1)	326 (15)	318 (9)	780 (10)
Japan	108 (20)	760 (46)	883 (39)	132 (4)	1,883 (24)
West Germany	3 (1)	567 (35)	38 (2)	2,561 (75)	3,169 (41)
France	184 (35)	13 (1)	70 (3)	370 (11)	637 (8)
Italy	101 (19)	235 (14)	663 (29)	25 (1)	1,024 (13)
Other	15 (3)	48 (3)	272 (12)	-0- (0)	335 (4)
Total	526 (101%)	1,644 (99%)	2,252 (99%)	3,406 (100%)	7,828 (105%)

Source: Data collected by OECD Trade Committee, Group on Export Credits and Credit Guarantees "Statistics on Officially Guaranteed Export Credit Transactions with a Repayment Term of More than Five Years".

*Excluding communist countries.

Chart 8

Exim Support of Steel Projects in Brazil, France, Romania and South Africa: 1971-1981

Country	Project Description	Exim Authorizations ($ millions) Export Value	Credit	Guarantee
Brazil:				
	Cia Sid. Nacional expansion	93.6	42.1	25.3
	Cia Sid. Paulista expansion	56.8	25.6	19.3
	Cia A. Especial Itabi expansion	19.9	8.0	5.3
	various pipe/tube facilities	12.3	5.0	5.0
	Cia Sid du Guambara expansion	6.2	2.8	0.9
	Usiminas expansion	4.5	2.0	1.5
	steel forging facility	4.6	1.9	0.0
	cold reverse mill	1.8	0.8	0.0
	Subtotal	199.7	88.2	57.3
France:				
	Usinor hot & cold strip mill	35.9	16.2	0.0
	Solmer integrated steel mill	100.0	50.0	0.0
	annealing line	2.6	1.2	0.0
	Subtotal	138.5	67.4	0.0
Romania:				
	Galati heavy steel plate expansion	21.4	9.6	0.0
	extrusion presses and ancillary	10.4	4.4	0.0
	Subtotal	31.8	14.0	0.0
South Africa:				
	tandem mill/structural mill	28.0	0.0	22.4
	galvanizing line	13.0	0.0	9.8
	pickle line	7.5	0.0	5.6
	mechanical & electrical equip.	6.5	0.0	5.2
	steel plant equipment	5.9	0.0	4.3
	Subtotal	60.9	0.0	47.3
Totals for All Countries		430.9	169.6	104.6

Source: Eximbank

commercial interest rates have risen to double or more the Eximbank rate. But sellers of U.S. equipment and technology still argue that if foreign governments subsidize their exports, the Eximbank should match these rates.

Labor representatives now oppose the extension of preferential tariff treatment to countries like Brazil and Korea for iron and steel products on the ground that the facilities that produce these products are internationally competitive and do not warrant "underdeveloped country" treatment.

The most recent restrictive actions against foreign imports have involved Korean carbon steel and Brazilian steel exports. "Predatory competition" and dumping charges have been brought against Korea. Action against Brazil by the Special Trade Representative (STR) has been suspended temporarily under an agreement under which Brazil has agreed to phase out all export subsidies.

C. Labor Unions' Opposition to Steel Imports

U.S. labor unions have been ambivalent on the issue of foreign competition in iron and steel products until the mid to late 1960's. Before that time, they were free traders along with U.S. steelmakers.

In the later 1950's, U.S. steelmakers participated in an extensive program to train a thousand Indian engineers in iron and steelmaking at six university and steelmaking centers in the U.S.

Unions were also very friendly with Japanese trade unions, which were unionizing and progressively increasing wages (thus narrowing the gap between U.S. and Japanese wages). But this has not prevented Japanese competitiveness to intensify, since Japanese wages have traditionally lagged behind productivity increases.

During the steel strike in 1959 which lasted 116 days, U.S. industry began arguing against the impact of foreign steel produced by "cheap foreign labor."

The unions, in time came over to the industry viewpoint. But until the mid-1960's, neither management nor labor were worried about foreign competition, particularly not from the LDCs. But toward the late 60's attitudes changed. There was then a conflict between capital goods industries anxious to export equipment and technology and steelworkers concerned about keeping out foreign imports and restraining the proliferation of steelmaking -- particularly in competitive processes such as continuous casting, which could undercut U.S. prices with the combination of advanced technology and cheap labor.

VIII Survey of U.S. Firms

This chapter outlines the extent to which U.S. firms are prepared to extend technical support, including the training of indigenous personnel, for local steel projects. We surveyed about a dozen firms known to have had involvement of this nature. Our survey posed the following questions:

1) What types of technical support services including training of personnel, do you provide LDC purchasers?
2) Could you indicate briefly the "technical services and training" component of steelmaking technology sales to LDCs over the past five years?
3) Are you able to finance the sale of technical services on the same basis as the hardware component?
4) Do you have any staffing problems in servicing technology sales to developing countries?

We also surveyed technology suppliers on features attractive to a steel project insofar as training was concerned and on the financial aspects, if, as suppliers, they took an equity participation position. Chart 9 presents a summary of the aspects they emphasized. Items with an asterisk(*), were mentioned by more than one firm.

Other observations reinforced by our survey and phone interviews were the following:

1) Decline of the steel industry position in U.S. has meant that financial and personnel resources formerly available for overseas projects have been cut back in many firms.
2) This decline (and resultant protectionist sentiment) has also meant that even the larger size U.S. firms are less able or willing than in the past to take equity positions in steel projects overseas.

Chart 9

TRAINING AND FINANCING - FEATURES ATTRACTIVE TO U.S. TECHNOLOGY SUPPLIERS AND INVESTORS

Training

(*) "Train the trainers " -- to assure continuity.

( ) Perform training wherever possible in similar cultural and language environment.

( ) Make sure that trained individuals stay with the job they have been trained for.

( ) Allow for a large enough number of expatriates from industrialized countries to assist in the operation initially.

(*) Provide environment for obtaining real experts as expatriates, not the "legionnaire" type of people hunting for jobs everywhere.

( ) Include a smoothly designed and long enough transition period from expatriate to national labor.

(*) Technical assistance contracts are very important; they should be based on incentive type payments.

(*) Responsibility for main equipment supply and technical assistance should always be with one company (a steelmaker with engineering business or vice versa), the consortium approach on this aspect is generally no good.

Financial Aspects

( ) Limited number of years for the joint venture combined with certain pay back guarantees.

( ) No obligation for foreign company to participate in future increases in share capital.

( ) Custom barriers for a certain number of years after start up.

(*) Tax incentives.

(*) Free money transfer of profits.

( ) Proper sharing of rights and duties in joint venture contracts.

( ) Open discussion of political change in host country and potential of some international agency involvement in such cases.

(*) Package financial aid programs of an industrialized country/ countries or for a specific project.

3) Availability of lower-cost technical support and training services for "mature" steelmaking technologies from countries such as India and Brazil means that U.S. firms stress capabilities in fields such as direct reduction and specialty steel production.

4) As might be expected, operating steelmakers in the U.S. can often provide the most effective training (for both operating and support staff) based upon their experience. Equipment suppliers will usually provide only the minimum training needed to run their equipment. Independent design, construction and engineering firms must often resort to hiring outside personnel to provide training (if they provide it at all).

5) U.S. firms all emphasized the need for the LDC purchaser to establish a good program to receive training and to follow through on it. U.S. firms, in a sense, can only "train the trainers".

Company A (AC)

AC is known as a specialty steel producer and, for over 50 years has been involved in licensing specialized know-how to operating steel companies around the world. Its specialized knowledge includes coated steels (zinc and aluminum), stainless steels, silicon steels for electrical applications, and special drawing quality grades. In addition, AC licenses a process for injecting coal into a blast furnace as a replacement for oil and/or coke. All technical assistance agreements have involved engineering consultation, operator training, and start-up assistance.

AC operates several large-scale integrated plants in the U.S.

and abroad, including blast furnaces, coke ovens, basic oxygen plants, open hearths, electric furnaces, refining and degassing units, and continuous casting units. These typically feed hot rolling, cold rolling, and processing facilities for sheet, strip, plate, shapes and bar and wire products. Integrated operations reach out to include many continuous coating facilities.

AC operates a mini-steel plant in Mexico. It has used this plant as a location to conduct training programs and as a source of experienced operating personnel.

AC operates a professional service division in cooperation with another U.S.-based group that has had steel plant design and erection experience, both in the U.S.A. and abroad. AC is not a supplier of steel mill equipment.

In the past AC has offered a wide range of technical assistance to developing countries including preliminary studies, design and engineering, training and startup in developing countries. AC is currently deemphasizing the steel portion of its business (in light of declining profitability), however.

AC's Consulting Services group acts as liaison with licensees, usually foreign steel operators who want to expand into specialty steel production. Transfer of operating know-how is emphasized. AC prefers that foreign personnel be trained in one of its own plants (often for 4 to 6 months). It sends few of its own people overseas as trainers, and these for short terms (2 months).

Company B (BC) Engineering Group (BCEG)

BCEG was established as a subsidiary of BC to sell its proprietary technology and expertise. BCEG'S policy is not to take an equity position in overseas projects, although BC has done so in the past.

BCEG offers technical and management services for the following types of projects:

- o material handling systems
- o coke ovens (including coal chemical recovery systems)
- o sintering plants
- o blast furnaces (including cast-house emission control systems)
- o steelmaking furnaces (electric and BOF)
- o continuous casting facilities
- o hot- and cold-rolling mills
- o sheet and wire coating lines
- o wire-drawing lines
- o pipe-making lines
- o steel product manufacturing plants
- o fabricati shops (structural steel and reinforcing bar)
- o air/water-pollution control facilities
- o plus maintenance and other ancillary installations associated with the above installations

BCEG can provide services ranging from feasibility studies, through project engineering and execution (including construction management) to startup and operator training by drawing on BC personnel as needed. Proprietary technology is licensed in some cases.

BCEG works with technology purchasers to "train the trainers". Operator training is provided at one of eight BC plants in the U.S. Training in facilities maintenance and corporate services in support of steel operations is offered at their headquarters. Some of these training programs can be provided on-site overseas.

BCEG, a relatively new division, has provided the following services in developing countries:

- o Engineering for a large iron ore mine, concentrator and pellet plane for a developing country (including transfer of technology to local personnel).
- o Purchasing assistance for high technology items.
- o Technology and engineering assistance on a manganese steel foundry in an Asian country.
- o Engineering study and specification preparation for a coke oven battery in a Latin American country.

Company C (CC)

CC is exclusively in the business of designing and engineering of sponge iron DR/coal facilities -- typically in the 75,000 to 100,000 tons/year range. They have pilot plant facilities in the U.S. have under construction a facility in South Africa, and are discussing projects in two Asian countries. They are affiliated with a large European engineering group, and both finance and procurement on most projects are handled through them. CC technology is available under a licensing royalty system. Technical training is financed as part of the technology sales package, which includes procuring equipment.

CC prefers to train operational personnel on site. Their training staff consists of (8) people to cover plant management, process engineering, and labor supervision. The group includes chemists, metallurgists, and chemical chemical, metallugical, mechanical and electical engineers. On-site training requires about 10 person-months over a 3-month period.

Company D (DC)

DC provides a wide range of technical services to clients who purchase direct reduction plants. These services include:

- o personnel training and technology transfer
- o consulting
- o engineering support
- o operating assistance
- o raw material testing
- o plant technical audits
- o computerized operating data compilation
- o operations seminars
- o spare parts supply
- o technology exchange among plants
- o updates on patents, technical literature and innovations
- o DRI marketing and market development
- o construction supervision
- o procurement of equipment

Normally, when DC sells a direct reduction plant, the technical services are part of the overall package and financing is the same for both hardware and software. In special cases where a construction licensee sells a plant and asks DC to provide training or other technical services, DC usually receives cash with normal payment terms.

Operator training is conducted at one of DC's U.S. or Europe. DC and its construction licensees have had no problems in providing training and technical support staff for technology sales to developing countries.

Company E (EC)

Firm was active in technology transfer until a few years ago. Decreased activity was due to a scarcity of critical technical personnel, as steelmaking activities declined.

Firm now has a limited number of contracts with small private steelmakers in Latin America. Contracts usually run for a three-year period, with a fixed annual rate, plus variable charges as needs arise and provide a specified range of technical support services. In many cases, firm uses ex-employees as consultants on their contracts. They also sell computer application associated with steelmaking (e.g., "coil-tracking" to control client orders in continuous steel coil-making operations). Firm also has technical support services for specialized steel product applications. In cases involving proprietary technology, (such as non-destructive testing for steel pipe) licensing arrangements, including royalty payments, are generally required.

Company F (FC)

FC primarily consulting engineering and project management for the iron and steel industry, specializing in the design of mini-steel plants. FC can offer turnkey design and execution of steel projects in collaboration with a European engineering construction group.

FC not provide training services for host-country nationals, but would try to arrange these services through the equipment supplier. In some cases, FC recommends that the management of mini-steel plants in developing countries recruit staff on a contract basis, from other countries, for "on the job" planning and training for maintenance and operating personnel.

FC prefers not to take equity positions in developing country projects, and its technical services are usually financed via the Canadian Export Development Corporation.

Company G (GC)

The group is a joint-venture effort with a Japanese industrial group (GCJ). , specializing in a direct reduction process developed originally by them. The special feature of the process is that it is able to use low-grade, high-sulphur petroleum residue as an iron reductant. GCJ is a manufacturer of heavy industrial equipment for the steel industry, and they originally designed and developed the process. GC has built in the U.S. a demonstration plant based on the process, and they are responsible for detailed engineering and construction supervision on particular projects. GCJ is responsible for basic design and equipment selection. GC trains operational and managerial personnel at its simulation and demonstration facilities and/or on site, as needed. The group generally relies on Japanese financing for both the equipment and training/technical-assistance component because of favorable terms for project components.

Company H (HC)

HC offers comprehensive training programs for each installation that it engineers and constructs. HC is capable of training all employees of a new plant, from the general manager to the operators, and possesses a large pool of knowledgeable engineers and technicians to draw upon for the start up of a plant and the training of operators. Training may take place on-site, at one of HC's operating facilities worldwide, or is sometimes contracted to another U.S. steelmaker operating a plant of a type that HC does not. In large part, HC uses its own personnel to "train the trainers," and then assists the buyer to set up his own program on-site.

In summary, HC considers the training of operators at plants engineered and constructed plants an integral segment of turnkey construction. Through its international stature, HC can finance this training and technology transfer through the same creative means used to finance the plant equipment. Equity participation in developing country steel projects would be considered in some cases their European affiliate has taken such a position in the past), as well as buy-back arrangements.

HC is also available for the performance of technical investigations, feasibility studies, and technical services. The international nature of the HC Corporation allows for comprehensive understanding of the needs of various regions. The wide representation of HC in the world's countries may lead to local involvement and the balance of payments benefits of such arrangements.

Company K (KC) Engineering Group(KCEG)

KCEG is a wholly-owned subsidiary of KC which provides the expertise of the present company to clients worldwide in the mining, iron and steelmaking, chemical, construction, and related industries.

KCEG capability includes technical and economic feasibility studies, engineering and construction supervision for new or improved facilities, management, and transfer of know-how to and the training of operating and maintenance personnel, start-up assistance establishment of operating practices and procedures, testing of products and processes, development of performance and maintenance standards, quality control, and production planning.

These services are offered in:
- raw material evaluation, mining, processing, storage, and handling.
- iron making which includes both conventional blast furnaces and direct reduction.
- steelmaking that includes advanced methods such as continuous casting, bottom-blown basic oxygen steelmaking, vacuum melting and pouring and modern techniques for producing coated steel sheets. The latest electric furnace technology is provided from one of their division's designers of electric furnaces for mini-mill and large shop installation. Technology from KC's range of electric furnace sizes from 30 tons to 300 tons will accommodate the smallest mini-mill to the largest steel plant.
- chemicals and plastics from coking by-products to plasticizers and polyester resins and finished plastic products are also areas of expertise for this organization with 70 years experience.
- fertilizers and crop protection chemicals.
- research.
- metal treating, shaping, finishing and coating.
- business systems and computer services.
- license on KC proprietary equipment which includes coke quenching. sliding gate technology, riband grades of steel, and their own electrotinning process, USS Carosel and radial cell and others.[1)]
- training of both plant management and operating personnel at the clients location and in steel plant facilities.

In many parts of the world a KCEG project is underway with clients uisng as little, or as much, of KCEG's total capabilities as they may need. Following is an outline of typical services provided to a developing country's greenfield steel project on site:

- feasibility study which included market studies, preliminary engineering and definitive estimates.
- assistance in securing suitable financing.
- detailed engineering, specifications, bid review and recommendations for purchase of equipment.

-construction supervision by acting in a scheduling, counseling, coordinating and monitoring capacity and advise client in regard to suppliers discharge of their responsibilities.
-operator training at U.S. Steel plants.
-technical, operating and management assistance for start-up and subsequent operations.

KCEG's Canadian subsidiary is also a consulting engineering firm specializing in mining, raw material handling, energy conservation, steelmaking and related processes, port facilities, hydraulics and water resources. It performs services similar to those of KCEG, in either French or English language and develops financing from Canadian sources.

KCEG has been involved in iron and steel projects in several developing countries, including remote areas requiring extensive infrastructure development. KC has in the past accepted equity participation in overseas steel projects and sometimes accepts payment in the form of offset trading and buyback agreements.

APPENDICES

APPENDIX A

CASE STUDY: MEXICAN STEEL PROJECT

A. Background and Project Description

The Mexican Government began to study the possible construction of an integrated steel works to exploit the iron ore deposits of Las Truchas in 1948. The site is at the border between two of the poorest states in the country (Guerrero and Michoacan), adjacent to the Balsas River delta on the Pacific coast. Major factors in the choice of this site were proximity (19 km) to the iron ore deposits and a good natural harbor, and the availability of the necessary fresh water and electric power from hydroelectric stations on the Balsas River.

In 1969, a Government-owned company was established, Siderurgica Lazaro Cardenas-Las Truchas S.A. (SICARTSA), and charged with preparing a specific plan for a modern steel plant which it would eventually install and run. With the help of a team of overseas consultants, SICARTSA completed a prefeasibility study in late 1970 envisaging a plant to produce 1 million tons per year (tpy) of non-flat products from a raw steel capacity of 1.2 million tpy. This was to be the first of four stages leading to ultimate production capacity of 10 million tpy.

The Mexican Government approved the study and submitted it with a funding request to the World Bank (IBRD) in late 1971. The Bank insisted that SICARTSA appoint a team of foreign technical and operating advisors who would prepare a full feasibility report prior to any loan commitment on the Bank's part. The British Steel Corporation (BSC) was chosen for this job, and also to provide technical services during the implementation stage of the project. Its report included a detailed analysis of the scope of the project, its capital cost, and of certain issues (i.e., sufficiency of ore supplies; infrastructure requirements) the Bank felt had not been properly addressed in the rapidly prepared initial investment plan.

After completion of this second appraisal, an IBRD loan of US $70 million was approved in September, 1973. The joint borrowers were Nacional Financiera S.A. (NAFINSA), the Government development bank, and SICARTSA, with the Government acting as guarantor. Other sources (including the Inter-American Development Bank and foreign bilateral lenders) participated in financing the Las Truchas steel project as well. Here we have focused on the World Bank's role, since other lending institutions generally follow its lead in LDC projects.

The project consisted of the development of iron ore and limestone mines and construction of an iron ore crushing and concentrating plant nearby. A pipeline to transport ore slurry from the concentrating plant to the steel works was built. The steel works consist of a pelletizing plant, a battery of coke ovens to use imported coal, a blast furnace for production of pig iron, a steelmaking plant with two basic oxygen (BOF) converters, three continuous billet casting machines, one wire rod and bar mill of 500,000 tpy capacity, and one bar and light section mill of 500,000 tpy capacity.

The project was begun during the second quarter of 1973 and physically completed 3½ years later in November, 1976, approximately nine months behind schedule. The total financed cost of the project was just over US $1.0 Billion. This figure includes a cost overrun of $330 million, equal to 49% of the appraisal estimate of total financing required. This overrun was financed by additional loans from NAFINSA and increases in the Mexican Government's equity share, in such proportion as to maintain SICARTSA's debt: equity ratio within the 60:40 limit set by its loan contract with the IBRD.

The steel plant attained a capacity utilization rate of 16 per cent in 1977, and 35,50 and 70 per cent in each succeeding year. SICARTSA expected to produce at 85% of capacity in 1981.

SICARTSA's financial performance has been poor since the beginning of operations in 1977. Cumulative losses were estimated at US $200 million by the end of 1979, despite Government subsidies equivalent to US $148 million. The project was projected at the time of appraisal to show an overall profit during its third operational year. Cost overruns, low capacity utilization and poor financial performance were due to a variety of factors, some of which were characteristic of many iron-steel projects, some that were external to the project or beyond the control of the parties involved, and some that were unique to this particular project. These factors, outlined below, must be taken into account by negotiators from all involved parties in order to avoid the type of problems described above.

B. Negotiation Problems and Issues Directly Related to the Project

1. <u>High Capital Investment Costs</u>: Total financing required for the Las Truchas project was appraised at just US $680 million, making it the largest industrial project ever undertaken in Mexico at the time. Finance cost of the project at completion had grown to more than US $1 billion, thus increasing an already heavy debt burden for

SICARTSA and extending the project's payback period.

2. Complex Technology: The blast furnace/BOF process chosen by SICARTSA is fairly complex, and based on imported technology (as opposed to the direct reduction process developed by HyLSA, a private Mexican firm). Co-development of mining operations and a new (at that time) slurry pipeline system increased the technological complexity of the project. Extensive foreign technical services were required, and indeed insisted upon by the IBRD as a condition of its involvement as a lender. The British Steel Corporation's contract with SICARTSA (which was approved by the Bank) covered all phases of design, procurement, construction management, training of local personnel, startup, and initial operation. For reasons explained below BSC's contract was cancelled by SICARTSA just as the period of initial operations was beginning, resulting in technical and managerial difficulties that led to low capacity utilization and unprofitability.

3. Extensive Infrastructure Requirements: Electric power for the Las Truchas steel project is supplied by the La Villita and Infernillo hydroelectric stations on the Balsas River, which predate the steel project. The new deepwater port of Lazaro Cardenas was built by the Ministry of the Navy between 1973 and 1975, following IBRD review and approval of its technical and economic aspects. It was initially intended to handle shipping connected with the steel project -- imports of coal and equipment and exports of steel products. SICARTSA's share of cargo handled by the port was 90% in 1977, but is expected to be less than 50% during 1982.

Over 75% of SICARTSA's domestic shipments of finished products are destined for Mexico City. SICARTSA concluded that existing roads would have to be used until a rail link could be built for direct shipment of steel products beginning in 1978. The Mexican Government committed itself to implement this plan in 1973. Rail transport was preferable because of lower shipping costs as well as the inadequacy of existing roads. The rail link did not become operational until 1980, due to delays in allocation of the necessary funds by the Government in view of monetary constraints (see Section C.1 below).

The Mexican Government gave assurances in the IBRD loan guarantee that adequate support would be given to construction of the town of Lazaro Cardenas, whose population grew from about 6,000 in 1971 to over 29,000 in 1977 and 45,000 in 1981. Characterized by the belief that shelter and other urban services required could either be generated without intervention or taken care of by a traditional housing program, the efforts to develop a social infrastructure lagged far behind implementation of the steel plant.

The unattractive image of Lazaro Cardenas resulting from its lack of shelter, medical, educational and recreational facilities contributed to a very high rate of turnover among technical, managerial, and operational personnel at all levels during both the construction and initial operation phases of the project. This problem is being solved, but contributed to the project cost overrun and low capacity utilization through delay and the cost of training new personnel.

The cost of infrastructure directly related (in the narrowest sense) to the steel project has been estimated at US $250 million. The port, hydroelectric power plants, rail link and development of

the town are not included in this estimate since they are considered by both the Government and the Bank to be part of the Government's larger regional development objective
of which the steel plant is only a catalyst. The cost of this overall regional infrastructure has been estimated as high as US $3.5 billion.

4. Long Gestation Period: The Las Truchas steel project began with the creation of SICARTSA in 1969. The IBRD's formal participation began with loan approval in late 1973, and informally in 1971. BSC entered the project in mid-1972. Construction began in 1973 and was finished in late 1976. Startup began in January, 1977, and the nitial operation period (during which efficient operation and near-full capacity utilization would be achieved -- the "learning curve") was to be complete by mid-1979 according to the appraisal report.

The six-year period foreseen between initial construction and successful operation is relatively short by international standards, and was recognized as such at appraisal. Construction of the plant was accomplished only slightly behind schedule, a good achievement in view of the project's complexity, local constraints and the adverse effects of factors external to the project, such as the 1973/74 oil price hikes. Rapid construction did not serve to avoid a 49% cost overrun, however.

The period of initial run-in of the plant has been greatly extended from the appraisal estimate, since the goal of near-full capacity utilization has not been met. Partly because of this, SICARTSA's financial flows have been negative, and the projects equity partners (primarily the Government) have been forced to assume the entire debt servicing load.

5. "Green Field" Effort. The project established a completely new plant without the support of an existing corporate structure with operating service and administrative capabilities. It was prepared and implemented by a new company primarily established to promote the project and headed by an executive team with very little operating experience.

C. Negotiation Problems and Issues External to the Project

1. Economic Factors: The growth rate of the Mexican economy declined to about 3% per annum during the period 1973-77, when it had been growing at an average annual rate of 6.3% in the late 1960's - early 1970's. The annual rate of inflation increased from about 6% in 1972 to 23% in 1973-77. This, of course, was stimulated by the oil price rises of 1973/74 (prior to Mexico's discovery of vast oil reserves). Mexico's balance of payments deficit doubled between 1973 and 1974, and remained above US $3 billion through 1976.

These circumstances led the Government to devalue the peso by around 80% in August, 1976. SICARTSA's peso cost of imported raw materials and equipment, and of debt servicing for loans in foreign exchange thus increased substantially.

The Mexican Government began a fiscal austerity program to overcome the economic disequilibria. The resulting delays in Government spending on infrastructure development at Lazaro Cardenas affected SICARTSA through high turnover, absenteeism, low labor productivity, and the diversion of management attention from production buildup and marketing. Fiscal austerity and the devaluation also combined to severely constrain growth of the construction sector, SICARTSA's main market. It's growth became negative in 1976 (-2%) and again in 1977 (-3%), just as SICARTSA was beginning commercial production.

2. Other Factors: The Las Truchas steel project came into being during the term of President Echeverria (1970-76) and received his strong support throughout. Indeed, the rush to complete construction of the plant during his term was responsible for some otherwise avoidable lapses in the quality of construction. These, in turn, contributed in part to the initially slow production buildup, when maintenance personnel were overloaded with unusual adjustments or repairs resulting from hasty erection.

President Echeverria earlier had reportedly said that it would be a national disgrace for Mexican erection contractors to act as sub-contractors to foreign main contractors. Consequently, equipment contracts were let only for supply and delivery, cost and freight (C. and F.). The foreign equipment suppliers got what they wanted -- the sale of hardware from their factories, the most profitable part of their operations. They would have accepted the obligation for erection, without expecting to make much profit on it, as a means of selling hardware. But once they had the supply contract (C. and F.), they came to regard the erection as a separate, profit-making operation.

In line with Presidential pressure to finish the project (and despite the advice of BSC), erection contracts were written to give bonuses for early completion, but had absolutely no control over the amount of manpower used. An erection contractor (whether equipment supplier or independent) thus had better profit prospects (irrespective of performance) with more men packed onto the site to finish early. It is not surprising, then, that man-hours actually used for erection and commissioning exceeded appraisal estimates by about 50% and accounted for about US $55 million of the cost overrun.

A final external factor was the change of administrations at the beginning of 1977. This coincided with completion of the plant and its initial startup and run-in, with the attendant difficulties. The BSC contract was terminated at this time, officially because of cash shortages at SICARTSA. This decision was also related to the way SICARTSA had become a political football, and BSC, as the foreigners, had become the obvious focus of criticism for the new Lopez-Portillo administration.

In spite of the realization that technical expertise and training assistance were sorely needed at this crucial-point in the project, the Bank failed to formally insist that BSC be retained. The Bank was (at that time) also associated with the previous administration and may have felt its argument would go unneeded.

APPENDIX B

CASE STUDY: BRAZILIAN STEEL MILL

A. Background and Project Description

This project covered the second stage of the vast, three-staged expansion program conceived in the late 1960's by Companhia Siderurgica Paulista (COSIPA). Stage II was intended to expand the capacity of COSIPA's plant located at Cubatao (on the coast of the highly industrialized Sao Paulo state) from 1 million tons of raw steel annually to 2.3 million tpy. Other objectives of the Stage II expansion were to improve product quality and lower operating costs.

The Stage II expansion included the following tasks: certain alterations to existing equipment, expansion of port facilities and the primary material storage yard, a coal year, a battery of

53 coke ovens, a second blast furnace, an additional 100 ton converter for the BOF shop, an additional oxygen plant, a 160 inch wide plate mill and a coil inspection line for the cold strip mill.

The plans, specifications and cost estimates for the COSIPA Stage II project were originally prepared by the Arthur G. McKee Co. (U.S.). In 1971-72, the IBRD and the IDB jointly appraised the project and agreed to lend US $64.5 and US $43.0 million respectively toward its financing. Work was begun in 1973 and the expansion was completed in September, 1978, approximately 27 months behind schedule. Total financing required (including interest payments) to complete the project was US $1.1 billion, which turned out to be close to 140% over the original appraisal estimate.

Startup was expected to begin in 1976 and full capacity production to be reached fairly quickly, by the end of 1978. Startup of some facilities began in 1976, but because the entire expansion was not complete until late 1978, full capacity production was not reached until the following year. In fact, once the project was complete production rose rapidly, reaching 130% of rated capacity in 1980.

B. Problem Areas

COSIPA is one of three large flat steel producers owned by the Brazilian Government, each of whose capacity was expanded (with Bank financing) during the 1970's as part of an overall program (formulated by Brazil's National Steel Council) to meet large projected demand increases. The Government had previously been able to finance Stage I expansions of these steel plants on its own.

For the COSIPA Stage II project described here (and later Stage III expansion), World Bank participation was sought so that its approval would encourage bilateral lenders (commercial banks) to participate. This was also an objective for the Bank, and is usually the case with Bank loans (whose share of the financed cost in this case was significant but not large). In this case both parties were successful, since COSIPA was able to obtain the required funds relatively easily on favorable terms and conditions.

From the World Bank's point of view, COSIPA's management structure was inadequate to cope with the expansion project and its own increased size. At the Bank's request, COSIPA hired the firm of Booz, Allen and Hamilton (U.S.) to design, implement and monitor a general reorganization of COSIPA's corporate structure and managerial system. There was some resistance to this reorganization at COSIPA, since outside consultants were considered unnecessary by some, and their advice was ignored. As a result, recommended cost control and planning systems were never fully developed. This, in turn, contributed to difficulties and delays in implementation of the project, and the large cost overrun.

Also at the request of the IBRD, COSIPA entered into a technical assistance agreement with Nippon Steel Corporation (NSC), which was to assist with procurement, supervision of construction and startup. COSIPA's management again resisted implementation of its technical consultants' advice in some cases, leading to errors and delays in the project.

The COSIPA Stage II expansion was a large, complex project, involving procurement of equipment and erection services from a wide variety of Brazilian and international suppliers.′ The size and complexity of the project was underestimated at appraisal by both the Bank and COSIPA. Since this was not a "green field" project and infrastructure requirements were minimal, COSIPA (which had been operating since 1953) considered itself equal to the tasks assigned to it (overall project implementation). For this and other reasons (nationalism, perceived cost savings) it resisted the advice of outside technical and management advisors, who were seen to be imposed upon COSIPA at Bank insistence.

The Bank recognized the need for outside advisors in its appraisal, but failed to adequately explain and express this need to COSIPA. Nor did the Bank adequately monitor COSIPA's compliance with its advisors' suggestions. These related failures contributed to poor project implementation until 1977 when a replacement of top management at COSIPA took place and the project seemingly got back on track. In spite of strong performance in the 1979-81 period, the delays and cost overruns associated with the Stage II project contributed to the continuing poor financial performance of COSIPA. Because of cashflow stortages in 1976, COSIPA undertook additional short and long term debt and still struggles under a heavy debt service load.

APPENDIX C

SURVEY OF FOREIGN SUPPLIERS OF DIRECT REDUCTION AND MINI-STEEL TECHNOLOGY

Firms surveyed were asked to indicate:

(1) Type of business they were in (design-engineering, equipment supplies, or steel making)

(2) Particular projects in NIC's over past 5 years in direct reduction or mini-steel field (country, size, year, capital cost, source of financing)

(3) Comments on how "critical variables" (raw materials, capital equipment, training and other technical support services, and ancillary infrastructure) affected cost and efficienty of direct reduction or mini-steel operations.

The following is a sampling of responses received.

<u>MIDREX CORPORATION</u> (US/GERMANY/AUSTRIA)

1. Midrex Corporation is an international engineering Company which offers proprietary direct reduction process technology.

MIDREX Direct Reducation Plants are marketed and constructed world-wide by Midrex and its Contruction Licensees: Korf Engineering GmbH, Lurgi Chemie and Huettentechnik GmbH and VOEST-ALPINE AG. The expertise of Midrex and its Construction Licensees, combined with the overall steelmaking know-how of the Korf Group, provide the most advanced and innovative technology in the design and construction of both direct reduction plants and entire steelmaking complexes.

Midrex and each of its Contruction Licensees is responsible for marketing, sales, engineering, construction and startup for a certain territory as described below:

Korf Engineering GmbH - Dusseldorf, West Germany

Jointly owned for Korf-Stahl and VOEST-ALPINE, Korf Engineering plans and builds not only MIDREX Direct Reduction Plants but also entire steelmaking complexes, rolling mills and fabricating plants. The company acts as technical consultants to the steel producing and fabrication industry throughout the world. Korf Engineering is responsible for marketing the MIDREX Process in Western Europe (except Spain), the USSR, most of Africa, and the Middle East.

Lurgie Chemie Und Huettentechnik GmbH - Frankfurt, West Germany

Lurgi is an experienced international engineering group involved in the design, construction and supply of plants and equipment for chemical, metallurgical and many other fields of industry. The company has a leading position in sintering and pelletizing plants for iron and non-ferrous ores. Lurgi is licensed to market the MIDREX Process in Eastern Europe, the Arabian Peninsula, Spain, Tunisia, Egypt, Nigeria, Lebanon and Jordan.

VOEST-ALPINE AG - Linz, Austria

Austria's most prominent steel processing enterprise and largest employer, VOEST-ALPINE consists of many subsidiaries and affiliates whose activities enciricle the globe. The company designs and constructs all types of industrial complexes, with particular emphasis on steel and chemical plants. VOEST-ALPINE is responsible for the marketing of the MIDREX Process in the Far East and Oceania.

Midrex Corporation - Charlotte, North Carolina, USA

Midrex Corporation is responsible for marketing the MIDREX Process in North and South America. In South America, Midrex is assisted by its sales affiliate Industria de Aco Korf S.A. (IKOSA) of Rio de Janeiro, Brazil.

Midrex maintains a continuing relationship with each MIDREX Direct Reduction Plant through a Process License Agreement. This agreement provides for a continuing exchange of technology between Midrex Corporation and operating MIDREX Direct Reduction Plants.

2. Midrex Direct Reduction Plants are available in unit capacities ranging from less than 400,000 tpy to over 1 million tpy and can be installed as multiple module plants to achieve any desired capacity.

At the present time there are 42 MIDREX Units in operation or under construction, contract or agreement, representing 17, 650,000 tpy of capacity. Currently MIDREX Plants produce more DRI than all other plants combined. A list of MIDREX Plants giving location, size and startup dates is attached.

Financing for direct reduction projects in newly industrializing nations is mostly provided by supplier credit along with some outside financing.

3. The Midrex product quality is unimpaired by using appreciable quantities of lower cost-lower grade iron oxide feeds in a blend with quality pellets. Elements such as phosphorus or sulfur are of no consequence to the MIDREX Direct Reduction Process but need to be considered for the economic steelmaking operation with

the EAF's. Fuel efficiency is unchanged, and some increase in production has also been achieved. The use of lump ores and lower quality pellets, however, also have lower product yield than those of higher grades. There are more oxide fines to handle prior to reduction and more reduced fines to briquette after reduction. Some natural lump ore of up to about 45 mm in size may be processed because lump tends to fragment into smaller pieces which reduce in a similar manner to the iron oxide pellets. The blending of natural ores with high quality pellets require more metallized fines briquetting capacity and the handling of more oxide fines. The cost of handling fines to recover their iron units must be weighed against the savings in purchasing the ore and the benefits of increased production. Most MIDREX Plants, including all Latin American plants, have installed cold briquetting facilities to briquette metallized fines.

Fortunately, ores of lesser quality may be successfully fed to the MIDREX Plants by blending raw materials. It is common practice to take advantage of the relative costs of several types of pellets and lump ores by using a mixture as the plant feed. In fact, this is practiced in most plants for economy and productivity. MIDREX Plants have used over 35 different ores since 1969. Some plants have used as many as nine different oxide feeds during a single year and blend two or three each day. This blending permits greater economic and technical flexibility in the selection of ore feed.

MIDREX Direct Reduction Plants operate successfully with oxide feeds consisting of 100% pellets, or 100% classified natural ores, or blends of the two. The design of the MIDREX Reduction Furnace is much more tolerant to fines and a wide range of particle size in the burden than either a blast furnace or a static bed reactor. This flexibility to tolerate fines and allowing mixing of a wide range of particle granulometry in the burden enables the plant operator to select a larger variety of oxide raw materials and, therefore, can maximize productivity, product quality and plant economics. Operation with either mixtures of pellets and lump or with 100% pellets has little affect on the fuel efficiency of MIDREX Plants. Midrex experience to date indicates that the addition of lower quality pellets or lump ores to a high quality pellet can actually increase plant capacity in some cases as a result of fragmentation of the lower quality pellets or lump. High fragmentation ores generate more fines during reduction due to thermal and reduction fragmentation than high quality oxide pellets.

FERRCO ENGINEERING LTD (CANADA)

1. Ferrco have become specialists in the design and construction management of mini-steel plants and have been working almost exclusively in this field since 1963. The plants with which we have been associated were initially below 300,000 tons annual capacity, but several have been expanded since then.

We supply design engineering. We also act as project managers, including procurement and construction supervision. All these services are generally provided in a consulting engineering role to the client who is either planning, or constructing or expanding a mini-steel plant. In addition, we have recently reached an agreement with Babcock Contractors Ltd. of the U.K. to collaborate with them for turn-key projects if the client wishes to adopt this approach to the construction of a plant.

We have some proprietary designs of equipment for mini-steel plants. These include — ancillary equipment for a steel melting shop, such as scrap buckets, transfer cars, alloy systems, ladles, etc.; peripheral equipment for continuous casting machines, such as ladle and tundish cars, billet cooling beds, etc.; reheat furnaces; horizontal and vertical rolling mills for bars and light structural products; cooling beds; hot and cold shears; and straighteners, bundlers and stackers.

We do not design, but specify and procure for clients electric arc furnaces, overhead cranes, continuous cooling conveyors ... etc.

Ferrco is one of the companies which comprise the Co-Steel International Group. This group manufactures nearly 2 million tons per year of steel products from 4 mini-mills. While Ferrco, therefore, does not produce steel, we are in a unique position of having a close relationship with operating steel plants.

2. We are just completing the engineering for a major modernisation programme, at the Irish Steel plant in Haulbowline, County Cork. This comprises an electric furnace, 3-strand casting machine, and a new bar and light structural mill -- total capacity 285,000 metric

tonnes per year. The cost was approximately $100 million. The financing was from the Irish government and the ECSC.

We have carried out feasibility studies for a stainless steel plant in Taiwan (1978), which has subsequently been constructed by others to our design concepts. Shortly before, we had carried out similar studies for mini-steel plants in Iran and Saudi Arabia - the former was a victim of Iran's internal problems and the latter proceeded, but with different owners.

3. Mini-steel plants are sensitive to four main factors: raw materials, energy costs, available markets for products and labour (quality and cost).

Scrap and direct-reduced iron are almost interchangeable as a raw material for melting, and do not significantly affect the technical requirements of steelmaking. The proportions used will, of course, affect the handling system for charging electric arc furnaces, and the quality of scrap could be detrimental both for certain steel grades and for high production rates. To date, scrap has consistently been available at a lower cost than direct reduced iron, but is not generally available in developing countries in sufficient quantities.

Much attention is being paid to reducing energy costs -- principally by preheating raw materials, direct charging from casting machines to mills, and by recuperative systems. Ferrco is active in all these areas.

Whereas in feasibility studies, we direct attention to infrastructure needs and assess their quality, in order to determine the suitability of plant locations, it has not been our practice to take part in infrastructure development. Inadequate resources will, however, affect both the capital cost and the construction time.

Training of nationals has not been part of Ferrco's services in the past. Many equipment suppliers provide start-up assistance. We would recommend that the management of mini-steel plants in developing countries recruit staff on a contract basis, from other countries, for "on the job" planning and training for maintenance and operating personnel.

DAVY MCKEE CORPORATION (USA)

(1) and (2)
Davy McKee is well qualified to engineer, construct, and equip iron and steel plants throughout the world. With the recent acquisitions of the Swindell Furnace group of the United States and the Birlec Furnace group of Britain, Davy McKee now possesses a proven record in electric arc furnace design and construction. Studies are underway to combine the best points of both designs to yield superior electric arc furnaces, from small tonnage units for foundry application and special steels production up to very large ultra high power units for bulk steel production in modern steelworks.

Davy McKee can provide continuous casting equipment with its licensing agreement for the Rokup horizontal continuous casting machine for billets. For other shapes Davy McKee has cooperated in the past with many of the present suppliers of continuous casting machines.

Davy McKee Equipment Corporation markets and supplies an extensive line of additional equipment, including the most advanced designs of blast furnace and stove equipment, forges and presses, mill control and automation equipment, strip cooling, heat treating furnaces, mill modernization, and powder matallurgy.

Davy-Loewy, a division of the Davy McKee Equipment Corporation, supplies a complete line of finishing equipment to process the steel to a final product. Davy McKee also offers the Fluid Iron Ore Reduction (FIOR) process. The process developed by Exxon and since purchased by Davy McKee.

For any project Davy McKee offers a full line of engineering and management services covering design, planning, scheduling, budgeting, and training functions. The increasing size, complexity and cost of modern steel plants give rise to increasingly difficult problems of financing which require specialist skills to solve. Davy has long regarded this requirement as an essential part of its service and over the years has acquired a unique experience in the assembly of multinational credit packages.

With the ability to offer British, German, French and USA finance, Davy companies are exceptionally well placed to offer a complete and fully coordinated financing solution to a client, frequently involving parallel credits, without going outside the company. Very often better financing conditions and terms can be obtained in this way than the client could expect from dealing with different parties for the separate source elements.

Davy is managing many projects in Africa, Latin America, Eastern Europe and Asia which depend on export credits from two or more countries.

Davy's knowledge and experience of the financing world enables the company to select the best collaborators appropriate to the project, the market and the financing requirements.

Davy McKee has had interaction pertaining to Direct Reduction facilities in at least (15) developing countries. Of special interest to NICs is the "FIOR" process (Fluidized Iron Ore Reduction) a unique direct-reduction process developed by Exxon for producing highly metallized briquettes from iron ore fines. The first commercial FIOR plant, designed and constructed by Davy McKee for FIOR de Venezuela, is routinely producing product for export to steel mills around the world. Its strategic location at Puerto Ordaz, near the Orinoco River, with large iron ore and natural gas resources, provides an economic basis for this merchant plant to export an enriched value-added product at competitive prices.

The FIOR process cuts steelmaking costs in the following ways:

- o It uses low-cost iron ore fines as feed to produce a premium iron product.
- o High density, stable FIOR briquettes can be stored and shipped as a merchant product without need for costly protective or precautionary measures.
- o FIOR briquettes' low tramp-metal content results in consistently high steel quality, minimizing possibility of off-specification steel production.

- o Uniformity of composition enables FIOR briquettes to be used in continuous charging for increased productivity.
- o The FIOR process employs standard methods, and equipment for dust collection, fines recycling, waste-water treatment, etc., eliminating need for special environmental control systems.
- o FIOR permits design of large-capacity, single-train plants, providing capital and operating cost advantages over multi-train plants.
- o FIOR plants can be custom-designed to produce briquettes with optimum metallization and carbon content for use in either electric arc or basic oxygen furnaces.

(3) FIOR briquettes are uniquely suited to basic oxygen and electric arc processes due to their high density and purity. In the basic oxygen furnace, high density FIOR briquettes readily penetrate furnace slag and melt rapidly. Other lower density direct reduced iron products, when entrapped in heavy slags, have produced undesirable operating results and erratic control.

Lower density DRI has also caused problems in electric arc furnaces, where furnace eruptions have occurred. Because of their high density, FIOR briquettes are ideally suited for continuous addition to electric arc furnaces, promoting rapid melting, vigorous carbon boiling with a foaming slag and improved heat transfer efficiency.

Under optimized conditions, continuous addition of FIOR briquettes at up to 30 per cent of the charge results in significantly increased electric arc furnace productivity. Depending on the price and availability of local scrap, FIOR briquette concentrations up to 100 per cent of the furnace charge have been utilized. However, normal revert scrap from steelmaking would indicate 85 per cent of the charge would be a more reasonable maximum level.

The FIOR product is commonly used in electric arc furnaces as 10 to 30 per cent of the charge, and is routinely used in BOF operations as a trim coolant in amounts up to 5 per cent. Under some BOF operating situations, a 2 per cent increase in liquid steel production per net ton of hot metal has resulted with the use of the FIOR product.

FIOR briquettes are relatively free of impurities. This not only allows steelmakers to exercise many options with regard to scrap purchases, but also improves control over residual elements, which is so important to producing high quality steel.

APPENDIX D

Qatar Direct Reduction Steel Mill — Development Experience, Feedback and Prospect*

Iron and Steel Industry in the Middle East

Contrary to the recession of the iron and steel industries in the advanced countries, the demand for iron and steel in the developing countries is remarkably increasing as shown in table 1. Aiming to break from foreign dependence of steel products, a number of steel plant projects has come into plan around the Middle East Countries since the middle of 1970.

The steel demand in the Middle East was brought by the construction boom in the urban areas and also due to a noticeable development in cement and other chemical plants.

Inception of the Steel Plant in Qatar

The projected Steel Plant was to produce steel bars for concrete reinforcing and production of 75,000 t/y was projected in the initial plan.

However, the plan was finally extended so that the target of steel production was to be 400,000 t/y of crude steel and 300,000 t/y of rolled products with Direct Reduction Plant – Electric Arc Furnace based steel plant by taking full advantage of abundant natural gas in this country.

Supported by recent Technological innovation on the Direct Reduction process, Direct Reduction-Electric Arc Furnace based integrated steel making process was hi-lighted in the region where natural gas is abundantly produced.

1. Construction Agreement:
   A contract pertaining to supply and construction of the plant and training of employees.
2. Management Service Agreement:
   A contract for corporation for planning, supervision of plant commissioning, administration of marketing, purchases and daily business operations, plant operations, etc.
3. Marketing Agreement:
   A contract for exclusive marketing for export.
4. Industrial Agreement:
   A contract pertaining to the plant site, infrastructure, and favorable conditions on tax assessment amount

Engineering Features

In order to reduce the ocean transportation cost of oxide pellets or iron ore, a 100,000 DWT-class Ore Oil ocean carrier was to be schemed. For this purpose, the berth and approach channel was constructed deep enough to accomodate the large ship.

With respect to the market share of various type of Direct Reduction Process in production capacity from 1970 to 1980, Midrex Process hold share of approx. 50.4 %. Midrex has a possibility of an additional market advantage by its cold briquetting technology for both oxide pellets and reduced pellets fines.

Total energy consumption of Midrex Process is estimated 2.7 – 2.8 G cal/production which is better than other Direct Reduction processes.

Ideally, direct reduction products must have homogeneous properties with high in metallic iron, necessary physical strength and chemically stable characteristics.

However, in actual case, Direct Reduction products rarely possess complete homogenity and they tend to degrade in handling and generate fines.

With respect to product features, Midrex process shows a remarkable record of steady operation with few unpredictable variation in product metallization and carbon content. It is much advantageous for steel making practices.

In order to decrease the consumption of industrial water, the following methods were applied.

Sea water is used as much as possible for cooling purpose; the materials used for the fabrication of cooling machines and devices for various equipment were selected so as to withstand sea water corrosion.

In order to minimize the consumption of industrial water, cooling tower system was not adopted because of large water loss due to evaporation and splashing. In the place of cooling tower system, closed circuit heat exchanger system was adopted. Sea water is used as a cooling medium of heat exchanger to cool industrial water indirectly.

*Excerpts from article by
M. Nishihara, K. Ueyama, S. Mitsushima and T. Nishida, Kobe/Japan"

Because of unavailability of suitable contractors for repairing machines and parts, a workshop with a centralized maintenance workshop system was equiped with necessary repairing machines to cover whole maintenance service to the plant equipment. In addition, the repairing of motors up to 30 KW and armature rewinding can be done by QASCO itself.

A much larger warehouse than that possessed by an ordinary steel plant in Japan was constructed in order to secure an appropriate stock of various kinds of spare parts, consumables and subsidiary materials.

Furthermore, various kinds of standardization, selection of brands of hydraulic and lubricating oils easily procured in

Construction works

Construction Agreement became effective on December 18, 1974, and the completion date was contractually settled to be after 30 months from the effective date of the Agreement.

Management service

Based on the Management Service Agreement which was made as one of the supplements to the Joint Venture Agreement, Kobe Steel embarked on the establishment of the new joint venture company, and by the end of 1977, totally 128 of management staff were dispatched to Qatar Steel Company to establish and prepare all necessary activities locally.

On the other hand, from the early stage of project, QASCO supporting group was organized in Kobe Steel's head office to support and backup activities of management team.

Major function of management were as follows:

1. Legal registrations required for company establishment
2. Financial projection for the operation of the company
3. Establishment of company organization, and Recruitment and deployment of operatives and staffs
4. Training activities
5. Establishment of all sorts of management system and standards
6. Tender and Execution of Civil and Building Works
7. Coordination of Steel Plant construction works, and expedition and coordination of infra-structure-water, electricity, natural gas, wharf equipment, industrial roads, etc., to be executed by the Government
8. Procurement of raw materials, various subsidiary materials and supplementary facilities
9. Establishment of market and sales route for the products

Financial aspect

Total capital invested for the Steel Plant construction was amounted to about 300 million US dollars. Sources of fund are from share capital, loan from the Export-Import Bank of Japan and Qatar Government, and from so-called syndicate loans of foreign banks guaranteed by Qatar Government. In principle, shortage of capital is to be covered by Qatar Government, or the Government gives a reliable guarantee when the company is to be accommodated by any foreign bank loans. In the operation stage of the Steel Plant, working capital is to be accomodated by domestic banks of Qatar and by syndicate loan from several foreign banks.

Company organization

Through intense assessment of local conditions, totally 128 of Japanese management staffs and about 1,000 work-forces were projected for the operation of the steel plant. Management staffs took up position of General Manager, Assistant Manager, Works Manager and Department Manager.

Senior Engineers and Senior Administrative Officer were also posted by management staffs.

Recruitment and deployment of personnel

According to the steel plant operation scheme, workforces of about 1200 are required.

Since Qatar is under the circumstance of early stage of industrialization, qualified workforces, such as engineers, foreman and skilled workers are not available. Those workforces, therefore, must be recruited from abroad. Recruitment staffs of management team set up recruitment centers in Cairo, Bombay, Calcutta and Chittagong and carried out recruitment activities with the help of local government.

For recruitment, several types of examination and interview which had been well established on the basis of job categorywise necessities were applied. In addition to intelligence and mentality requirement, more than five years actual service experience in steel works were taken as standard qualification for application.

Training Activities

One of the important duties of Kobe Steel stipulated in the Construction Agreement was to give personnels of Qatar Steel Company, totally 280 man-month of training service. Out of those recruited personnels, 10 engineers and 68 skilled workers expected to be foreman were selected to be trained in Japan. Categorywise training schedule is shown as attached. In the inplant on-the-job training in Kobe Steel, those personnels who were expected to be dispatched to Qatar Steel Company as management staffs were assigned as their training instructors to get fullinformations about trainees for their future management activities.

These training tactics were found to be great advantage in the stage of actual operation of Qatar Steel Company under their technical supervision.

Special consideration was paid for the training of Direct Reduction Plant workforces.

In the engineering stage of Direct Reduction, Kobe Steel's engineers and foreman who were to be engaged in Direct Reduction plant operation were selected mainly from pelletizing plant operation crew and dispatched to Midrex to get full knowledge about Direct Reduction Plant and to get quite inured for the operation and maintenance of the plant through theoretical lecture and actual operation duties with working crew of Georgetown Steel Corporation.

They, in turn, gave one month lectures of Direct Reduction Plant to the crew of Qatar Steel Company in Qatar before they were sent to Georgetown Steel Corporation for training. All in-plant training in Japan were scheduled to complete approximately 9 – 6 months before commissioning start for maintenance crew and about 3 months before for production crew to grant them enough time to get organized with equipment which they were to work with. It was aimed by having them engaged in the construction works under the supervision of Kobe Steel's construction workforces.

Procurement of raw materials, subsidiary materials and supplement facilities

Raw materials and subsidiary raw materials. Based on the start-up production schedule for the year of 1978, purchase schedule of main raw materials, subsidiary materials, spare parts and various consumables was established.

The first lot of oxide pellets to be used for the start-up operation of Direct Reduction Plant was projected to procure from LKAB (Sweden), and 50,000 T of next shipment was CVRD (Brazil) and LKAB (Sweden).

For the initial stage of the steel plant operation, high grade oxide pellets for Direct Reduction use is quite necessary to stabilize operation.

However, since the cost of raw materials, especially oxide pellet, accounts for almost 25 % of all production cost, it would be necessary to take good advantage of low grade oxide pellets or lump ore in near future. An approach for the use of low grade burdens is projected to push in collaboration with the Central Laboratory of Kobe Steel.

20,000 T of the first lot of scrap was from the West Coast of USA.

As efficient discharging of materials from the ship is one of important factors to hold down the cost of raw materials, habor unloading experts were dispatched from Japan as unloading supervisors and instructed local stevedores to give them whole idea of raw material unloading works, various ferro-alloy and additives were procured from Sweden, India or Japan through international tender.

Start-up of commercial operation

Direct reduction plant

The direct reduction plant was taken over to QASCO to 29th August, 1978 and started commercial operation immediately. The electric arc furnaces has been establishing an optimum operation procedures based on 100 % scrap charging since March 1978 prior to the start-up of Direct Reduction Plant.

From this date on, electric arc furnaces stepped out to operation with reduced pellets.

Steel making shop
. Electric arc furnace

The charging ratios of raw materials in the electric furnaces were 80 % of reduced pellet and 20 % of steel scrap in the original production programme. However, since the direct reduction plant started up 5 months behind the steel making shop and rolling mill shop, at the initial stage, QASCO had to depend on steel scrap only as a main raw material in the electric arc furnaces.

In addition, due to the delay of construction of a lime calcination plant in QNCC (Qatar National Cement Company), it became impossible to procure locally calcined lime, which is one of the important subsidiary raw materials for the electric arc furnaces and was schemed to be supplied locally. Furthermore, importing of calcined lime from abroad was difficult because of its quality apt to deteriorate during ocean transportation. Consequently, the use of domestic limestone must have unfavourably been substituted for calcined lime even after the start-up of Direct Reduction Plant. However, charging ratio of reduced pellet in the electric arc furnaces was gradually increased and reached to 80 % at the end of 1978. Due to the current price hike of steel scrap, it is planned to increase the blending ratio of reduced pellet up to 85 % in 1979's production schedule.

Continuous casting

After the completion of performance guarantee tests, the commercial operation of the continuous casting was started. The continuous-continuous casting operation started from September and the ratio of continuous-continuous casting was increased to approx. 60 % in October and November, as shown in fig. 18. However, during this period, there arised the necessity of producing ASTM Grade 60 deformed bar. In the early stage of casting this high grade steel breakout troubles were observed.

However, following measures were taken to hold down troubles.

1. Improvement of the assembly accuracy of the pinch rolls below the mold, and
2. Change of mold oscillation condition.

In addition to the above measures, S and P contents in the molten steel became stabilized at a low level by the use of reduced pellets, the casting process was improved, and breakout trouble was almost completely solved. Fig. 18 shows the record of continuous casting operations.

Rolling mill shop

The commercial operation of the rolling mill shop was started immediately after the performance guarantee test with gradual intensification of the shift schedule. Full capacity operation under 3-shift was started from November 1978.

At the initial stage of planning, the steel plant was not specified to produce deformed bar in accordance with market survey at that time.

However, in October 1978, Qatar Steel Co. has become a full range reinforcing steel bar supplier to cope with recent market demand of the area.

Market and cost competitiveness of the products

Market

Since start-up of commercial operation in March 1978, Qatar Steel Company has produced approx. 230,000 tons of steel products as of April 1979.

The markets of these products are distributed as follows:

Saudi Arabia	62	%
Kuwait	15	%
U.A.E.	11	%
Iraq	0.8	%
Bahrain	0.2	%
Domestic	11.0	%

Supported by growing market demands around the Gulf Area, as forcast 4 mill on tons in 1980, Qatar Steel Company is becoming vary important existence in the area and thereby bears good prospect as a profitmaking steel producer.

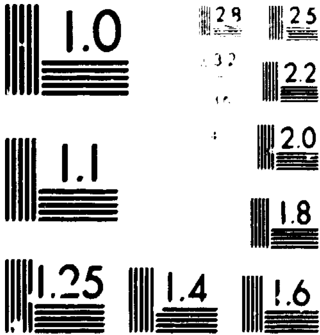
Production Cost

As far as construction cost is concerned, invested cost for the steel plant construction was US$750 per ton of annual production.

Cost participation in the production cost is some-how high in comparison with that of steel plant of well advanced countries of which construction had been made before so-called oil crisis.

However, government's low supplying cost of utilities such as electricity, water and gas, and operation performance exceeded expectation with production outrunning forcast production plan by 64 % contribute to the cost competitiveness of products.

Furthermore, vantage of ground of Qatar Steel Company as to product transportation cost to the consumers is granting great advantage over the products from Europe or Japan.



MICROCOPY RESOLUTION TEST CHART

APPENDIX E

SURVEY OF OFFICIAL U.S. EXPORT CREDIT FACILITIES

This appendix examines the in-place facilities and programs for financing U.S. exports -- particularly as they relate to the sale of technology and related engineering and transfer services. Included here are policies and programs of involved U.S. Government agencies.

Export-Import Bank (Exim)

Exim has both payment guarantees and direct financing programs in support of exports of goods and certain services by U.S. firms. Five Eximbank programs are available to support export sales (short-term up to 180 days and medium-term from 181 days to five years): the Foreign Credit Insurance Association (FCIA) programs, the U.S. Commercial Bank Guarantee program, the Cooperative Financing Facility (CFF), Bank-to-Bank (U.S. to foreign) lines of credit guaranteed by Eximbank, and Discount Loans to commercial banks.

The FCIA provides 100 percent political coverage and up to 90 percent coverage of commercial risks on export sales for up to five years. It also provides short-term coverage (up to six months for capital goods, commodities and spare parts). Engineering, architectural, and management consulting services can also be financed and insured by both Eximbank and FCIA on both a short-term and medium-term basis.

In mid-1973, FCIA/Eximbank undertook to expand the scope of its insurance programs through the introduction of a comprehensive service policy. Under the program, services performed by U.S. firms on behalf of foreign entities are eligible for comprehensive insurance coverage on both short- and medium-term bases. Short-term coverage is generally 100 percent political and 90 percent commercial;[1] medium-term coverage, after 15 percent cash payment, is 100/90 percent, subject to country Limitation Schedule exceptions. In all instances, coverage extends only to the amount of services actually performed by the U.S. firm, as opposed to the total value of the service contract.

Eligibility requirements for service insurance are similar to those applicable to the policies governing products; namely, the insured must be a U.S.-based firm, "doing business in the U.S." Insurable services are those rendered by U.S. personnel; generally 50 percent of the contract cost must be attributed to services performed by U.S. personnel

The Commercial Bank Guarantee program is available to all U.S. commerical banks,[2] certain branches and agencies of foreign banks operating in the U.S., and to Edge Act Corporations, engaged in medium-term financing (up to five years).[3] Political and commerical risk coverage is similar to that of FCIA.

The Discount Loan to U.S. Commercial Banks program permits U.S. commerical banks to receive fixed rate loan[4] support from Eximbank for

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[1]For small U.S. business with up to $2.0 million assets and $350,000 exports, the percentage can run up to 95 percent.

[2]About 300 to 400 U.S. banks actually avail themselves of the service.

[3]The going rule for Exim is to lend for only 5 years for a minimum of $200,000 loan. They have a descending schedule: 4 years for $100,000-$200,000, 3 years for $50,000-$100,000, and only 2 years for $50,000 and below.

[4]As of the mid-1980 about 13 percent for re-lending at 14 percent.

foreign loan obligations they hold involving supplier credits from U.S. firms to foreign purchasers. There are also bank-to-bank guarantees.[5]

The Cooperative Financing Facility provides revolving lines of medium-term credit (up to five years) on a matched basis (50 percent) to designated banks in developing countries for on-lending to local enterprises for the purchase of U.S. goods and services. These banks may borrow the other 50 percent from U.S. commercial banks, in which case the Eximbank may guarantee repayment to the U.S. banks (100 percent comprehensive guarantee). The foreign bank assumes all commercial risk (on creditworthiness of borrower and repayment of loan).

Overseas Private Investment Corporation (OPIC)

OPIC provides political-risk insurance to cover equity investments by both large-sized and smaller-sized U.S. firms and, in a few cases, for payments due under long-term technical or management services contracts which include an element of investment risk. "Investments" may include costs for manufacturing know-how, technical assistance, and turnkey plant run-in activities. OPIC also has a direct financing program (largely dollar-denominated loans) to cover substantial equity (customarily 25 percent) and management participation in LDC manufacturing projects by

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[5] A bank-to-bank guarantee (BBG) is an Eximbank guarantee of a medium-term revolving line of credit that a bank in the U.S. would extend to a financial institution in a non-industrialized country. The proceeds of this line of credit are utilized by the recipient bank to finance its customers' purchases from the U.S. at its own risk. Most BBG lines are $500,000 to $2,000,000 in size and increases can usually be obtained if necessary. The benefits of a BBG to a foreign financial institution include: (1) the foreign institution can receive financing from a U.S. bank which might not otherwise lend to that bank or country on terms of up to five years; (2) the foreign bank deals directly with the U.S. bank, which is probably already a correspondent, and does not have to deal directly with Eximbank; and (3) sales can be entered into without the prior consent of Eximbank.

smaller-size U.S. firms. OPIC also finances and, in part, shares the costs of pre-investment feasibility studies and provides grants for "reconnaisance" travel. OPIC political-risk insurance and finance programs may be extended through U.S. commercial banks for loans to LDC ventures with or without U.S. equity participation.

Trade and Development Program (TDP)

The TDP has been recently reconstituted under IDCA. The group was previously known as Reimbursable Development Program under AID. TDP expends four million annually (to be increased to $7.5 million in FY 1982) to finance pre-project services by U.S. firms to Third World countries. The TDP finances, among other activities, sector studies to determine demand for U.S. goods and services and the training of LDC technicians in the United States. TDP findings might be used in part to finance the pre-contract market-exploration activities connected with the sale of technology.

APPENDIX F

The Business of Technology Transfer in the Management of Technological Assets*

BACKGROUND

In the majority of viable business organizations, the financial assets and assets relating to equipment, buildings and real estate, and personnel are normally well attended to. Business schools, professional organizations, industry seminars, and internal training programs are well geared to preparing management for the job of maximizing profits from the use of these assets. However, often neglected is another form of assets, the firm's technological assets. These significant "Hidden Assets" represent the so-called crown jewels of the organization and should be given due consideration by executive management. They provide the technology base both for remaining competitive in the marketplace and for future growth.

When faced with the Business of Technology Transfer, many organizations flounder through trial and error. Licensing functions vary from a one-man staff, usually a part-time assignment for a Vice President of Engineering or Research, to a fully staffed profit center. Very few organizations appear to recognize that organizational development, special personnel staffing, and marketing strategy directed toward technology transfer are critical to the success of a licensing organization.

Numerous business decisions are required for maximizing profits through the control and use of intellectual property, such as decisions involving patents,

*Excerpted from a paper presented by William A. Stickel, U.S. Steel Corporation, at the International Congress on Technology and Technology Exchange, Pittsburgh, PA, May 3-6, 1982.

trademarks, trade secrets, and proprietary know-how. The first major decision for the company with sufficient internal resources is the decision to develop or purchase new technology. Intermediate decisions, such as whether to obtain development partners, whether to patent developed technology or protect it as a trade secret, and whether to obtain costly foreign patent protection, can be critical for long-term profits. The final major decision is whether to sell the internally developed technology or keep it exclusive.

DECISION V - MAINTAIN PROPRIETARY OR LICENSE

Today, perhaps the most important decision related to the maximization of profits through the management of technological assets is the decision of whether to keep the developed technology proprietary or exploit it through sale or licensing. Increasing R&D costs, unfavorable capital costs, current capacity limitations, antitrust laws, competition from low-cost offshore producers, trade barriers, and financial difficulties open the question of the marketing of technology through outright sale or licensing. A review of some of the advantages and disadvantages of either keeping the technology proprietary or sharing the marketplace through licensing may help in providing a basis for that decision.

MAINTAIN PROPRIETARY

Advantages

(1) The decision to keep newly developed technology within the organization, with proper patent or trade secret protection provides the company with an initial, legally enforceable, competitive advantage.

(2) With complete internal control of the technology, a business can plan a market with scheduled improvements and model changes.

(3) By keeping the new process or product for exclusive use of the company, the problems and costs associated with selling of technology

can be avoided.

(4) Internal use only can eliminate or reduce competition from low-cost licensed producers.

Disadvantages

(1) To exploit the technology completely within the organization, the entire R&D and implementation costs must be underwritten (amortized).

(2) The sale of the technology may be lost to a competitor with a similar process, with a resultant loss of potential royalties, along with the unwanted competition from low-cost producers.

(3) In some cases the company may face antitrust or related limitations on exercise of the monopoly position.

(4) With internal use only, the company will lose the potential technical input of others that could be licensed to use the technology through license "grant backs" or technology exchange.

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Advantages

(1) Selling, or out-licensing, allows full exploitation of technology while it is still viable. Technology is perishable.

(2) Licensing will expand the firm's international marketing capability, and limits the risk and cost of foreign markets. You may not be able to capture all potential world markets through the company's own production and marketing capabilities.

(3) Licensing provides profit potential from spin-off technology outside the scope of normal company business. This would include developments that do not fit into the company's major lines of business or the company's overall strategy, or developments that promise markets that are marginal or too small for the company's scale of production.

(4) Licensing extends the financial capabilities beyond the company's resources for commercial development of technology.

(5) Having several producers manufacturing under a license can establish industry standards for processes and products and discourage competitive processes which might obsolete the proprietary technology. In this respect, the initiator of a new technology has a clear early advantage. A standard established by the first product on the market and active licensing by the originator will ensure that the technology will be incorporated into the production of as many companies as possible.

(6) Licensing-out allows international marketing with special protective import restrictions.

(7) It strengthens worldwide patent protection by the addition of know-how sales and technical assistance to the license package.

(8) The decision to license results in the possibility of feedback of improvements through gran obligations and becomes, in effect, an extension of the compan own R&D.

(9) Licensing of the technology may help to avoid potential antitrust proceedings in cases perceived by the Justice Department as possibly involving an illegal monopoly.

(10) Licensing helps to justify R&D expenses and should be considered as one of the multiple objectives in the original R&D decision. It clearly increases the potential return on R&D investment.

(11) It increases the education of internal technical staff during the sale and provision of technical assistance. R&D organizations must be continuously informed of external scientific and technological developments to remain innovative. In the I.R.I. survey previously

mentioned, the responding member companies indicated that licensing of patents was a practice that results in increased innovation.

(12) Licensing generates income which may be used to underwrite a continuing research effort.

(13) It can be a useful tool to help sell products or services or equipment.

(14) Licensing reduces the incentive of others to find ways around the developed technology. An early decision to not license the new electrolytic galvanizing process for one-side-coated galvanized sheet steel mentioned in the Develop or Purchase Decision section of this paper stimulated independent development efforts and resulted in several competitive processes and products. We are actively licensing the technology now and have a slight competitive edge, but the competing products keep us on our toes.

(15) Licensing provides for a second source of supply, often required by some large purchasers before they will adopt new products.

<u>Disadvantages</u>

(1) The transfer of technology necessary with licensing may dilute technical and operating staffs.

(2) Maintenance of worldwide patent protection can be costly, as discussed previously, and in many cases requires maintenance of a sufficiently large package of technology just to justify sales expense.

(3) Loss of market share to licensees might affect internal production levels and profitability.

(4) Sale of technology might require giving away "seed technology" and future potential developments.

(5) Licensing may introduce competition from low-cost producers, causing the originating company to find ways to reduce its own costs to enable it to compete in its own developed markets.

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