FOREIGN CONSULTANTS: AGENTS OF TECHNOLOGY TRANSFER OR TECHNOLOGICAL DEPEDENCY?

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This paper examines the role of consulting firms with emphasis on engineering consulting firms, in the development process of late industrializing countries. Specifically it is concerned with the role of consulting firms in the choice and adaptation of technology and in other economic and engineering decisions taken in developing countries.

This study assumes that the capacity to apply and sustain technological innovation is a critical condition for a more autonomous industrialization, autonomy being necessary not only because it affords greater choice in economic welfare policies (i.e. the ability to choose the type of products and the techniques to produce them and thus decide which sector of the population will benefit most from industrialization) but also in order to lessen a developing country's depedence on technological and economic decisions taken elsewhere by foreign companies operating in different economic environments and motivated by different objectives.

How can this capacity to finance research in selected products and processes innovations and to exploit them commercially be realized in developing countries? We can visualize it as the final stage in a continuum of stages, starting with what is generally an indiscriminate adoption of imported technology without any modification, moving on to a stage of formulation of guidelines for more appropriate choices of technologies and of adaptations of technologies to local conditions, and finally progressing to a stage where an indigenous capacity to design selected new processes and products has been developed. The last stage cannot be achieved unless local talent and expertise is mobilized when it exists and created when it is scarce, in the second, intermediate stage. The expertise in question is that of informed, skilled people: engineers, financial experts, technicians, scientists and motivated en-

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trepreneurs making intelligent choices using as guidelines distinct and specific government policies.

This study will concentrate on the second stage, that of choice and adaptation. It will deal mainly with engineering consultants as agents of technology transfer and the manner in which foreign consultants choose or influence entrepreneurs choose technology in developing countries.

A) The Evolution of Consulting Services

There are many sources of technological information and know-how which offer consultation. A well known source is the individual consultant who is especially suited to small scale enterprises and had his beginning in the efficiency expert of the assembly line days. His task is to oversee a particular, specialezed aspect of the operation in which he has achieved expertise and has become known for it. University staff and retired professionals and businessmen have habitually filled this role in the early days of the technological revolution in the (now) developed countries.

Industrial research institutes, have provided consulting services to specific sectors of industry, such as steel. An example is the Indian National Metallurgical Laboratory which has built a number of pilot steel production units and established standards for the washing and blasting of iron ores for the Indian steel industry. Their services are of a technical character though sometimes they cover the whole gamut from feasibility studies to marketing surveys.

The government has become involved in this field too, and has in many cases established a variety of agencies to satisfy some technical and administrative needs. These agencies may take the form of central planning directorates, commercial, industrial and agricultural development banks, productivity centres, etc. Not negligible are the services provided by international organization agencies. These generally provide statistical services, information banks and publications on various topics.

There are three other sources of information and consulting services: vendors of equipment and suppliers of materials, owners of proprietary information, and consulting firms. The first source is widely used by entrepreneurs in developing countries but is not considered to be very helpful because,

> To the machinery wholesaler or manufacturer's agent, the diffusion of knowledge is incidental to the diffusion of goods. The smaller the market the greater the variety of machines handled by one importer and the less competent the explanations and demonstrations.[1]

Licensors and patent owners are also poor sources of consultancy. In licencing agreements, the licensor is the one who "initiates and controls the flow of informa-

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1. Paul, Strassman, *Technological Change and Economic Development The Manufacturing Experience of Mexico and Puerto Rico.* Ithaca, New York: Cornell University Press, 1968. p. 33.

tion. He is allowed to choose what developments should be communicated at what time, and in what manner".[2] Clearly the opportunities for adaptation are limited. The same apllies to patents which now play a rather limited role in technology transfer. Many patents are not filed outside the country in which the innovations are made. For example, in a study of ninety American firms, Behrman and Schmidt showed that 72 per cent of these companies' patents had not been filed outside the U.S. or Canada.[3] Thus there is the problem of access to patents. Another factor inhibiting the application of patents is that the information contained therein may be incomprehensible to an entrepreneur in a developing country. Most developing countries make limited use of patents. (India, for example, concluded 600 know-how agreements and only 25 patent agreements over the same period of time).[4]

The main reason, however, for the limited role of patents in technology transfer to developing countries is the fact that most of the patents granted in Third World countries are owned by foreign enterprises. (Vaitsos estimates that nationally owned patents in developing countries are between 5 to 10 per cent of the total number of patents registered. Even this small percentage drops to less than 1 per cent if their economic value is measured by the sale value of the products and processes covered by these patents[5]). Because patents are exploited by multinationals which use them to maintain control over import markets in developing countries and to preseve their monopoly by restricting competition by other enterprises and especially other multinationals, it is evident then that the patents' role in developing countries has more to do with preserving foreign monopolies than with protecting indigenous inventions and innovations.

Finally, there remain consulting firms, and it is upon these that this study will concentrate. While the use of consulting services has increased since the second World War, the emergence of consulting as an autonomous (from production) activity is a long process which had its beginnings in the Industrial Revolution.

Roberts has traced the evolution of the independent consulting firms:

> With the progress of industrial capitalism, workers lost control over the design and management of the instruments and apparatus which they operated and industrialists found unprecedented opportunities for incorporating scientific and technical innovations into machines... The production process became much less a reflection of the skill and ingenuity of the skilled production worker; it became primarily the product

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2. J.N. Behrman and Schmidt, "New Data on Foreign Licencing", *Patents, Trademarks and Copyright Journal of Research Education,* Winter, 1959 p. 358 quoted by Paul Strassman, p. 38.

3. Ibid., p. 39.

4. Interregional Expert Group, *Transfer of Operative Technology at the Enterprise Level,* United Nations, ST/ECA 151, June 1972. p. 23.

5. C.V. Vaitsos, "Revision of the International Patent System", *World Development* Volume 4, No. 2, Feb. 1976. p. 87.

> of the combined skills of the applied research scientists and the design engineer together with their respective supporting staffs. The reasons why consultancy emerged as autonomous are akin to the reasons why machine building emerged as a separate activity in the course of the nineteenth century. Firstly, complexity and size affect the project design and engineering in the same way they affected machine building. It becomes preferable for the user or client to rely on the expertise of an outside specialist. Secondly, the irregularities of investment activities associated with the growing lumpiness of large-scale capital formation have made it uneconomical for the client to do all consultancy work. Furthermore, full economies of scale are only achieved if consultants can move from one enterprise to another, accumulating experience on the way.[6]

It is obvious that once the profit earning potential of investment in capital equipment was understood by enterpreneurs, and that once installation of this capital equipment had proceeded, its expansion, and improvement became necessary and thus emerged the need for more specialized disigners and engineers.

The increasing complexity of industrial machinery (in relation to the other factors of production) absorbed a large percentage of the investment funds and as such became an important element in entrepreneurial decisions. Research and development activities had to perform increasingly complex tasks. The information sources became more diversified, and on the job training was not enough preparation for an innovative designer. A general education in science and engineering was required and later on, specialization in one particular branch. More and more the consultancy function was divorced from production. In one developing country, China, there have been what appear to be successful attempts to reintegrate the design functions with production and to complement them with "worker innovation". This policy has been adopted after 1964 following a short period of separation of the formal, specialized engineering disciplines from the production site, a period which was characterized by a tendency to rely on foreign designs.[7]

Burns and Stalker, in their study of the organization of innovation, trace the beginnings of consultancy's autonomy to the 1900s.

> The whole content of industrial innovation had changed. Before 1850 the worlds of science and industry, though separate, had not been distinct; the very existence on such a large scale, of amateur scientific and technical enquiry demonstrates the ease of access to the world of science

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6. John Roberts, "Engineering Consultancy, Industrialization and Development", *Journal of Development Studies*, Vol. 9, No. 1, Oct., 1972. pp. 40-41.

7. For a preliminary evaluation of Chinese technology policies see G. Dean, "A Note on the Sources of Technological Innovation in the People's Republic of China", *The Journal of Development Studies*, Vol. 9. No. 1, Oct. 1972.

> enjoyed by anyone with interests which might be satisfied by scientific information. By 1900, science and industry were distinct social systems... The work of producing innovations is now largely in the hands of salaried professionals.[8]

Freeman's findings from his examination of the pattern of innovation in the synthetic materials industry corroborates this view.

> ... a new pattern began to emerge in the twentieth century industry in which the role of the inventor-entrepreneur became less significant...[9]

Freeman emphasizes the point that the success of the synthetics industry depended not only on the innovation of the materials and their applications but also on the development of process engineering which involved the specialization of the plant design and engineering functions and the consequent emergence of the new profession of chemical engineering.[10]

Roberts cites three ways in which consultancy emerged as a separate acitivity from production: First, production sought engineers and designers, chemists and physicists, to expand and modernize existing plant equipment and operating methods. In the large enterprises separate design departments were created.

Second, capital goods producers required the services of consulting engineers to develop new production processes and to install and adapt equipment to the individual customer's needs. These engineering plants established R&D departments as well.

Finally, these consulting departments assume more and more autonomy from the parent companies. Their expertise is built around one industry (metals, oil, petrochemicals and chemicals, paper, etc.) or one process. They are able to offer their services to outside clients. In the last phase independent consultants emerge, able to offer advice to firms which do not have their own engineering department, and as they merge with other disciplines they can offer a wide range of engineering and consulting services.[11]

In emphasizing the role played by engineering consultancy in modern industrial processes, Jacques Perrin says:

> If scientific and technical information is regarded as a production force, this explains the autonomy of engineering. More generally, information is characteristic of the second industrial revolution; the law of the transformation of energy sustained the first industrial revolution; the

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8. Tom Burns and G.M. Stalker, *The Management of Innovation,* Tavistock Publications, London, 1961, pp. 30-33.

9. C. Freeman, *The Economics of Industrial Innovation,* Penguin, 1974, p. 78.

10. Ibid., p. 105.

11. Roberts, op. cit., p. 41.

second is tied to the appearance of machines designed to transform not energy but information. Modern industry, characterized first by mechanization and later by automation, demands substantial knowledge especially at the stage of plant design and engineering more than at the production stage.[12]

The team of Perrin, Judet and Tiberghein has devised a scheme of four "poles" of an industrial development programme. They are:

1) production of final goods;
2) the supply of technology-embodying capital equipment;
3) engineering, and
4) research and development.[13]

Though it may be argued that consulting engineering may function in lieu of in-house R&D the two are separate though complementary activities. As Freeman has established, in the synthetics industry, for example, in-house and independent R&D was responsible for innovations in final products and energy use whereas engineering was responsible for process innovations which made production possible in large tonnage plants.

There are four types of know-how that a consulting firm needs to complete the different phases of a project; process know-how, equipment know-how, design know-how and engineering organizing know-how. The scientific and technical know-how contained in the "process book" bought from the process owner is elaborated and "tailored" to the project at hand in a series of documents, the schema, plan guide, execution plan, specifications for equipment and construction of the plant, and cost books.

Consultancy, however, can go beyond the strict technical boundaries and may cover all phases of a projects's life, and every aspect of its operation. It may begin with a pre-feasibility and a feasibility study to assess market opportunities and technical viability of a proposed plant. This study may include a sector analysis, estimates of the future demand for the product, export possibilities, sources of investment capital, loan availability, necessary cash flow, expected net returns on equity and other capital, pricing, etc., the technical part of the feasibility study may be concerned with such matters as plant size and lay-out, choice of production techniques, sources of supply for capital equipment and materials, cost analysis, labour requirements, installation of quality control mechanisms, specifications for machinery, over seeing the tender bids for the construction of the plant, etc. The diagram on the next page indicates the basic functions of engineering.

The choices made in the technical part of the feasibility study have a clear and

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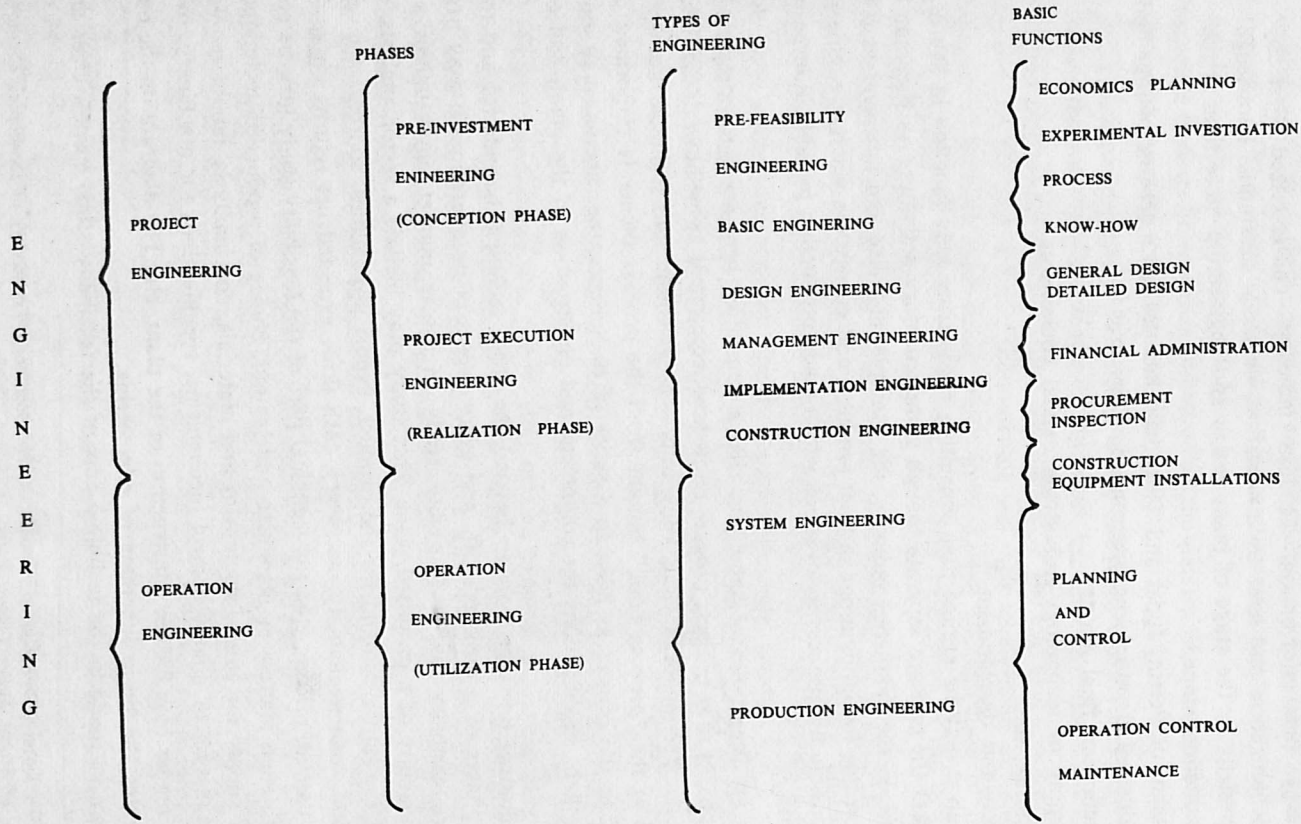
12. OECD, Development Centre, *Choice and Adaptation of Technology in Developing Countries. An Overview of Major Policy Issues*, Paris, 1975, pp. 97-98.

13. Ibid, p. 88.

BASIC FUNCTIONS OF ENGINEERING



SOURCE: Mario Kamenetzky- "Engineering and Pre-Investment Work", mimeo. Buenos Aires, 1976.

heavy impact on the desirability of the project from the macro-economic point of view in a developing country. The choice of plant site, for example, interests the government because it affects employment in one particular area which may be subject to a regional development policy. The choice of equipment and process and the terms of the agreements may affect not only a developing country's long range potential for indigenous innovations and waken or strengthen the ties of dependency, but it will also affect the short range balance of payments.

The autonomy of consultancy is reinforced in developing countries because in a skill-scarce environment the consultant is indeed external to the firm. In a developed country where the infrastructure already exists and there is more likely to be expansion and modernization of established enterprises rather than the building of completely new ones, the consultant has the staff engineers' experience and knowledge as a balance to his own. The entrepreneurs in developing countries are less likely to be as knowledgeable as their counterparts in developed countries and they are not likely to have the support of an experienced staff either. Consequently many important decisions are left to the judgement of the consultant. However, many of the Greek consultants inerviewed for this study said that the final dicision on process techniques, equipment suppliers, etc., were taken jointly with plant owners. They did add, however, that this participation of entrepreneurs in technical decision making was limited when foreign consultants were involved, both for reasons of communication and because many entrepreneurs felt more intimidated by the foreign "savants" than by their local counterparts.

The problems encountered by developing countries in the practice of engaging foreign consultants have been classified under the generic name of "maintenance of dependency". The following section will deal with some of the arguments and the data pertinent to this question.

B) The Experience of Developing Countries with Foreign Consultants

From the literature on the subject, five short statements have been formulated to summarize the experience of developing countries with foreign consulting engineering firms: 1) The links of foreign consulting engineers with producers and contractors in their country of origin, encourages the consultants to act as procurement agents for these firms, thus introducing too costly, obsolete (or sometimes untested equipment) or otherwise unsuitable equipment to the recipient country; 2) The standards and specifications of their designs suit the equipment with which they are familiar from their country of origin thus preventing diversification of supply sources and creating a dependence on the same spare parts and components suppliers; 3) Foreign consulting engineering firms coming from a capital intensive environment introduce a dependence on mechanization and automation when this might not be the most ef-

ıicient use of the factor endowments of the recipient country; 4) Foreign consulting firms fail to adapt the technology they import to the economic peculiarities of each country, and finally, 5) The engagement of foreign consulting firms results in the "wrong trasfer of technology" because the experience gained as a result of their work in a developing country does not benefit local consultants (some even say that there is a "reverse transfer of technology") and thus maintains the pattern of dependency on foreign skills. The remainder of this section will discuss these five points briefly.

Beginning with the first and second statements regarding the tying of engineering consulting to procurement practices, it has been acknowledged by U.S. government officials, for example, that procurement is an expected and desirable practice for American engineers abroad.

The Department of Commerce recognizes that engineering services are the spearhead of an export expansion programme. Engineers prepare the standards and specifications which permit U.S. material to follow.[14]

In 1963, American engineering services earned $167.8 million in overseas engagements and generated $398 million in exports.[15]

TABLE 1

U.S. Earnings Abroad from Engineering Services and Procurement (In millions of U.S. dollars)

Year	Total Cost	Engineering Cost
1959	1,084.3	38.4
1960	825.3	28.4
1961	1,179.6	51.5
1962	1,902.4	108.7
1963	2,428.5	167.8

Source: *Engineering News Record,* May 28, 1964.

Repeated emphasis is placed on this theme of boosting exports through consultants' procurement efforts. U.S. Embassy staff is exhorted to aid consulting firms to get contracts abroad. A Commerce Department official phrased it thus:

> The government can assist by strengthening the communication system to and from foreign service posts, intervene with foreign govern-

14. "U.S. Consultants Get Only 10% of Overseas Jobs", *Engineering News Record,* 172, May 28, 1964, p. 2.

15. Ibid., p. 2.

ments on behalf of the profession and develop more effective export insurance guarantees for engineering services.[16]

Apparently these instructions to the embassy staffs yielded some results:

During discussions (in 1973) with Taiwan government officials, U.S. Ambassador to Taiwan, Walter McConagy, made it clear that a suitable *quidpro quo* for continued U.S. economic aid and political support would be to award to U.S. firms a substantial slice of the $1 billion of foreign procurement expected under the development plan. In less than three days of negotiations, the mission won committments for about 100 million dollars in design and construction contracts for program projects many of which were receiving assistance from the U.S. Export-Import Bank.[17]

A company executive, Marvin Ramer, made this comment in relation to government support: "It was a revelation getting that kind of support. Some of the deals were practically made in the Ambassador's residence".[18] This is the view of one consulting firm president:

Only recently have the U.S. State and Commerce Departments recognized that the sale of American services precede the sale of American products. If a British firm, for example, secures a contract as a consultant, it only knows and specifies British products. Entry into the market at this stage (1974) is important for the long term national interests because standards and codes are now being adopted in these (Middle Eastern) states.[19]

Another statement by the same executive is also revealing. In his assessment of selection procedures for consultants in the Middle East, he says:

The Kuwaitis have a sophisticated process of screening design firms and *unlike* (emphasis mine) other countries prohibit the use of agents or ties with contractors, manufacturers or distributors.[20]

This practice of procurement through engineering consultancy is by no means limited to the United States engineers. West Germany for example, offers subsidies to its consulting engineers in order to promote exports. Most feasibility studies executed by German consultants in developing countries are subsidized by the German industry. The East European countries, especially Yugoslavia and Poland, as well as the Soviet Union, provide engineering services free of charge but tie them to ex-

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16. Ibid.

17. "Trade Mission Results" *Engineering News Record,* 190, March 22, 1973. p. 188.

18. Ibid.

19. "New Business Said to Abound in the Middle East", *Engineering News Record,* 192, May-June 1973, p. 12.

20. Ibid.

ports.[21] One well documented case is the building by Soviet engineers of the Bokaro steel plant in India. The director of Gipromez, the Soviet engineering agency, insisted on the "linking (of) the supplies and the designing of equipment" with the argument that "the suppliers of equipment are required under contract to give performance guarantees and that these guarantees can be given only if the Project Report is prepared in detail according to Soviet norms, standards, and specifications".[22]

Even when engineering services are not openly tied to the increase of the volume of exports and the offsetting of trade deficits for developed countries (as is perhaps the case with the more independent French and British firms, even though the former advertise their ability to offer potential clients "access" to banking and other financial institutions whose officers sit on the board of directors of the consulting firms) they are often associated with "tied aid programs", as is the case of Canadian International Development Agency, 66 per cent of whose aid is tied to Canadian exports.

The American organization, Agency for International Development (AID) had listed in 1964, 110 U.S. firms which were engaged in 66 countries on 273 different projects of a value of over $157 million. For projects over $5 million the aid recipient was obliged to call on an American engineering firm to do the design and for projects of under $5 million, the recipient had the choice of calling an American firm or a local firm to unertake the design of the plant, with AID having final say in the matter.[23]

Tying of engineering consultancy to procurement lays the foundations for further dependency because the specifications and standards are drawn to fit the machinery in the engineer's home country. Even when an engineering firm is not formally or informally a part of a contracting or manufacturing firm, the tendency still exists for preference of home-manufactured equipment over any other. An expert on technology acquisition in one developing country stressed the importance of price comparisons. He explained, ... the advantage of being able to select and/or shop around for technologies from as many countries as possible, so that the specific needs of the developing country could be met without it running the risk of becoming the victim of technology monopolization. His country's successful experience indicated that even within the same industrial sector considerable deversification of purchases could be achieved to the technology importer's advantage.[24]

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21. C. Young, *Consultancy in Overseas Development*, Overseas Development Institute, London, 1968.

22. For a detailed study of the conflict between the Soviet engineers and Dasturco, the Indian consulting engineering firm, over the Bokaro Steel plant, see Padma Desai, *The Bokaro Steel Plant. A Study of Soviet Economic Assistance*, American Elsevier Publishing Company Inc., New York, 1972 (the quote appears on p. 44).

23. "110 Engineering Firms at Work on AID Jobs Abroad", *Engineering News Record*, 172, 22, May 1964. pp. 23.

24. *Transfer of Operative Technology at the Enterprise Level*, op. cit., p. 20.

Another important point to keep in mind about the mechanism of dependency is that an engineer's education and previous experience in a particular working environment will predispose him towards familiar to him products and techniques. Of course, the initial establishment of a specific type of capital equipment means a continued dependence for spare parts and components on the initial supplier.

This, however, is not the end of the matter. The decision of consulting engineers on how much capital equipment to import and how mechanized or automated a plant will be, has serious macroeconomic effects for the developing country, and this consideration concerns point number 3 on the list, i.e., that foreign engineers coming from a capital intensive environment and being subject to the influence mentioned in the previous two points, introduce too much mechanization resulting in inefficient factor use. Foreign consultants will ignore such imperatives as employment and may decide on a capital labour mix which is not the most appropriate one, because whereas, in a developed country it may be increases in the productivity of every unit of labour that is desired, in a developing country the emphasis may be on increasing productivity per unit of capital. A country, for example, which is financing the purchase of capital goods from savings, after having bought the equipment and having exhausted these savings, must either turn to deficit financing or borrowing. The former is mistrusted and the latter is expensive because of the long term cost of debt-servicing. A likely turn of events is that there will be internal inflation and import controls. If intermediate goods, components, spare parts and materials are reduced, underemployment of the plant will occur. This underemployment of modern industrial units usually situated in urban centres, is considered to be one of the leading causes of urban unemployment in developing countries.[25]

This tendency towards capital intensity can be observed even in small scale, private enterprises. Two explanations have been offered for this. One is that market imperfections are responsible for distortions in factor prices, i.e., that market prices are not an accurate indicator of relative capital-labour scarcities thereby invalidating the results of cost-benefit analysis. Paul Strassman says in this regard: "... pesistently and in a variety of ways the price of capital is lowered and the price of labour is raised so that most entrepreneurs will produce too capital intensively, and thus abandon many potential employees to unemployment or relatively unproductive jobs".[26]

Frances Stewart who advances the second argument[27] believes that product innovations resulting from western R&D become increasingly capital intensive as older labour intensive production techniques become obsolete and are replaced. (The picture becomes more complex if we add the factor of scale as newer generations of

25. C. Young, op. cit.

26. Paul Strassman, op. cit. p. 121.

27. Frances Stewart, "Choice of Technique in Developing Countries", *The Journal of Development Studies*, Vol. 9, No. 1, Oct. 1972, pp. 101-121.

machinery are built for and operate more efficiently in large scale plants[28]).

Thus, any advanced technology transferred to a developing country has a built in capital intensity. A foreign consultant as an agent of this type of technology will probably be making an automatic decision favouring capital intensive techniques.

According to Baranson, choice for and adaptation of techniques to local factor endowments can take place in three related spheres: product design and innovation, production techniques and control systems.[29] The adaptation of product designs to the local market (and this pertains to point number 4) is of prime importance to the success of an enterprise. Yet foreign consultants, perhaps as a result of cultural determinism have frequently committed errors in their decisions about product innovations, adaptations and design. Lee attributes this failure to assess correctly the proposed product before attempting to market it, to the mechanism of the Self-Reference Criterion, i.e., to the unconscious reference to one's own cultural values, which are foreign by definition for foreign consultants, and which make them fall prey to eerror when operating in an alien environment.[30] Often, there is only token adaptation of products, that which is required by law (for example, laws requiring that labelling be in the native language) and that which is necessitated by local peculiarities such as different voltages for appliances.

One immediate result of this failure to adapt products to local conditions may be the failure of the product and the closing down of the plant. However, there is another dimension to this which goes beyond simple commercial failure (though for the local entrepreneur this may be catastrophic) and that is that trasplantation of products designed to appeal to developed country consumer markets, to adeveloping country, may be commercially successful but may also distort consumer tastes towards a preference for luxury goods and brand name products. It is not immediately clear what role consultants can play in the choice of products. It would appear that this choice is exercised by the entrepreneur (we are assuming here a wholly-owned national private enterprise or a joint-venture private enterprise where the decisions are taken locally) and the consulting engineer is then called in to specify techniques, recommend equipment and suppliers, etc. Product invention is outside the scope of consulting firms, since it habitually takes place in the in-house R&D departments of manufacturing firms. However, there is a role for consultant engineers in product adaptation. This may involve "simplifying" the product or eliminating one or more of its characteristics which make it a "luxury good". For example, in the case of toilet soap, cardboard packaging, perfumes, oils and creams,

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28. Ibid., p. 107.

29. Jack Baranson, "Transfer of Technical Knowledge by International Corporations in Developing Countries", *The American Economic Review*, March-May 1966, p. 260.

30. James A. Lee, "Cultural Analysis in Overseas Operations", *Harvard Business Review*, March-April 1966, p. 107.

can be eliminated without adversely affecting the essential qualities of the soap (of course this "simplification" can occur only where no brand name products are involved). Similarly, process adaptation can occur; more labour can be used for certain functions (packaging, for example in the case of the soaps) allowing both greater flexibility in plant scale (since labour is divisible but machinery is more difficult to adapt to varying capacities) and creating employment,and allowing for some linkages.

Clearly there is a role that consultants can play in product and process adaptation but foreign consultants are again not motivated to play such a role because it is not any more profitable for them to adapt a product if it can be shown that a market exists for such a product "as is", and when an entrepreneur does not request it. (There is little reason to believe that a local consultant will act differently but there is a possibility that he will be better able to adapt a product, if asked to do so, than his foreign counterpart).

Production process technology (as distinguished from consumption technology by Helleiner and Lancaster[31]) has historically been the area where engineering has been most innovative. This creativity, however, has not benefited the developing countries. The role of international engineering and contracting firms according to Pierre Judet, is to assure the supremacy of processes which are disigned and owned by the big industrial, multinational companies. An example is the steel process which, linked to international standards, presently produces 60 per cent of the world's installed capacity. In petrochemicals, the big engineering firms Lummus, Kellog, Power-Gas, Snam Projetti, Technip, etc., dominate and propagate the processes of the big industrial concerns. FORTUNE reports that "Lummus has built half the world's ethylene capacity and has patented many of the processes in use. M.W. Kellog has done the same in ammonia"[32]. (This predominance of one process in these fields is not for lack of alternative technologies. Kamenetzky reports that there was an average number of four alternative technologies available for each chemical product and that for some processes there exist as many as fifteen alternative technologies in the United States alone[33]). A similar situation exists in quality control mechanisms where there is a great variety of manual automatic and semi-automatic mechanisms to choose from.[34]

There still remains the last point regarding the "reverse transfer of technology" from the developing countries to the foreign consulting firms. This concept, difficult

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31. G. K. Helleiner, "The Role of Multinational Corporations in the Less Developed Countries' Trade in Technology" *World Development*, Vol. 3 No. 4, April 1975, p. 168.

K. Lancaster, "Change and Innovation in the Technology of Consumption", *American Economic Review*, Vol. 56. No. 2 May 1966, pp. 14-23, quoted in Helleiner op. cit.

32. E. Faltermayer, "The Hyperinflation in Plant Construction", *Fortune*, November 1975, p. 102.

33. Mario Kamenetzky, "Engineering and Pre-Investment Work", Mimeo, Buenos Aires, 1976. p. 6.

34. Ibid.

to study empirically, has been briefly discussed by Judet, Perrin and Roberts. It is based on the following argument:

> The foreign consultant contractors and suppliers may be presumed to be experienced (though it is not unkown for certain enterprises to regard "turn-key" projects as test benches for processes or equipment which they hope to sell on a wide scale elsewhere). This experience will have been gained through practice and as a result of replicating the type of plant which they have been commissioned to build, for a variety of owners both in their country of origin and probably abroad. "The learning effects" derived from the replication will have enabled them to reduce the real cost of the plant design and construction in terms of materials and more importantly time spent on erection and construction.[35]

The entire argument is based on Arrow's learning by doing model with its empirically based assumption that production costs decline as experience increases. Thus as each consulting firm executes more and more projects within the framework of a constant technology greater efficiency results and costs decrease for the firm. When the technology changes some of these effects are lost but some are retained because a new technology is to some extent a derivative of an old one.[36]

The five points discussed in this section make good reasons in themselves for developing countries wanting to establish a national consulting agency or for promoting private consulting firms. Some additional reasons have been offered by their advocates in support of local consulting agencies, private or public. One of them is that because of the importance of information in the modern productive process (especially in the continuous flow industries) mastery of this technical knowledge is considered to be vital in the drive towards self-determination (knowledge = control = power).

Dependency on foreign technology is difficult to sever since research and development and the manufacturing of technology-embodying goods will continue to take place in the technologically advanced countries. But dependency on foreign technology can be spread around several suppliers and it need not cost astronomical sums if the market information becomes available and comparison shopping becomes the rule. Furthermore, there exists the real possibility that through conscious policies imported technology can be assimilated, unpackaged and adapted, parts of it may be locally built, processes may be altered and products simplified.

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35. Roberts, op. cit., p. 44.
36. Ibid., p. 45.