CONSTRUCTION TECHNOLOGY TRANSFER: ISSUES AND OPTIONS

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Present situation

This paper summarises key findings in an aspect of a research study on construction technology development undertaken for a United Nations agency. Its main theme is that the study of the transfer of construction technology, which is often undertaken in isolation, can benefit from the work on technology transfer in general. The inadequacy of the level of construction technology development in the developing countries is evident in: the massive unmet construction needs; failure to use the countries' natural human and material resource endowments; and reliance on foreign sources for a large part of construction needs (materials, professional consultancy and contracting). This leads to high foreign exchange costs which contributes to high cost of construction with implications for affordability to the poor and pressure on national budgets. It also hinders the expansion of the construction industry, and hence the construction industry, and so on. The transfer of construction technologies from the industrialised to the developing countries has been of topical interest for decades. The increasing globalisation of construction further highlights the issue.

The low level of technology development is not unique to construction. By any indicator -- number of persons engaged in research and development (R&D), level of aggregate R&D expenditure, volume of exports of manufactured items, share of high-technology services, number of international patents owned and so on -- studies show that there are great disparities between the industrialised countries and the developing nations (UNIDO, 1980). The technological systems in most developing countries are characterised by dualism. A small modern enclave (normally associated with technological progress which conscious attempts are being made to improve) exists within (and operates independently of) a traditional, rural setting (containing know-how accumulated over centuries, which has been undervalued and underdeveloped) (UNIDO, 1980). This dualism is, in itself, perhaps, inevitable and not necessarily bad, as sectors of the economy (and different geographical areas) of any nation would develop at dissimilar rates, probably following different patterns. However, the lack of linkage between the "modern" sector and the "traditional" one, and neglect of the latter are undesirable. Generally, the developing countries are technically dependent on the industrialised ones; they import the elements of technical knowledge and the capacity to use it. This dependence hinders efforts by the former to develop suitable technologies (Stewart, 1977).

The technological weakness of the developing countries is attributable to (Choi, 1983; UNIDO, 1980; UNCTAD, 1990): (a) low level of accumulation of technology; (b) limited capacity to import technologies -- owing to a weak foreign-exchange earning capacity and inability to attract foreign investment; (c) tendency to adopt import-intensive models of industrialisation making industry unable to stimulate the development of local technologies; (d) failure to consider science and technology as integral parts of national development plans, and to adopt, implement and monitor relevant policies; (e) insufficient investment in science and technology owing to economic limitations and a relatively undeveloped private sector; (f) inability to select and manage suitable technologies owing to shortage of technology personnel -- due to inadequate educational and training facilities, insufficient attention to the orientation of educational traditions and curricula to technology; (g) insufficient institutional infrastructure -- non-existent, inadequate or poorly co-ordinated government agencies for promoting and/or supporting private sector initiatives, weak or non-existent R&D institutions, poor linkages between them and industry, and inadequate dissemination and application of their results; (h) inadequate physical infrastructure and information necessary for investments in technology; (i) social structures and culture not supportive of technology (for example, absence of "social carriers" or "champions" of technology development); and (j) lack of mechanisms to facilitate the transfer of technologies.

Nature and sources

Technology may be transferred (in many different formal and informal, direct and indirect ways) from one part of an organisation to another, between enterprises in the same sector of the economy, between enterprises in different
sectors, from a research centre to industry, and from one country to another. This paper concentrates on that at the nation-to-nation level. In its most common usage, technology transfer refers to the formal and direct forms whereby an agreement is signed between a buyer and a seller. Governments everywhere (and especially in the developing countries) have sought to control, guide and encourage technology transfer through various means: (a) training components are made mandatory in joint-venture agreements between a foreign and local partner(s), in the terms of engagement of foreign companies for construction projects or in agreements for direct investment by a manufacturing enterprise; (b) guidelines for licensing agreements are formulated and administered which prohibit the transfer of certain technologies, outline prices or pricing mechanisms, or suggest terms of contract; and (c) support is provided for technical information and extension services to facilitate the diffusion of technologies.

Technology transfer among firms in the industrialised countries is generally a two-way commercial process which has taken place for a long time, and was used to close the "technological gap" between the United States and Europe in the sixties. Another successful example of technology transfer is that from the industrialised to the newly-industrialising countries. These successes have led critics of the process to blame it for the loss of economic pre-eminence by the United States, and to the competition being offered by the newly-industrialising economies to the industrialised countries in many areas. They have also inspired some writers consider technology transfer to be a short-cut to development for the emergent countries: it could stimulate exports, enable the country to substitute for imports, or generally improve the country's economic efficiency (Emmanuel, 1982). While underlining the importance of technology transfer, other writers have stressed the need for the technologies transferred to be appropriate. Despite these high hopes, technology transfer to the developing countries has been generally unsuccessful. Therefore, it has become a politically-sensitive aspect of the dialogue between the industrialised and developing countries. The latter call for the transfer of more appropriate technology under more favourable terms, and set up mechanisms to ensure these (Oldham, 1987). Technology transfer is characterised by differences in economic, financial and technological bargaining power between buyers and sellers; restrictions on technologies by sellers; attempts by governments in the buying countries to monitor and control such transfers; and suspicion and dissatisfaction among buyers, which among other things, led to the formulation of several handbooks and an international code of conduct.

Construction technology transfer arrangements cover different forms of technologies, ranging from those relating to particular techniques, systems, materials or tools to the complete design or construction (or both) of projects. This paper concentrates on the transfer of techniques to contracting firms. Such transfers do not always involve "modern" or advanced technologies (which have been given emphasis), but may be concerned with appropriate technologies: some foreign commercial firms specialise in such areas as labour-based road construction, technologies for infrastructure, alternative energy systems, and the production of appropriate materials. Construction technology transfer arrangements can take many different forms including: (1) setting up of a subsidiary in the host country; (2) joint ventures which may involve various degrees of integration of the partners' firms and operations; (3) supply of plant and equipment, sometimes incorporating an agreement to provide training, spares parts and/or technical services; (4) supply of plant and equipment with the disembodied technology, an approach widely adopted in the appropriate technology field by both non-governmental and commercial organisations; (5) counterpart training ("liaison engineering") abroad on formal courses and/or at the foreign firms' head office or its projects in other countries and on-the-job training on the project concerned; (6) "downstream" training of operators or beneficiaries of the completed facility; and (7) government-to-government arrangements involving a range of technical assistance projects under a medium- or long-term programme. Others include (a) transfer through delivery of industrial property, approval of licenses, provision of information, training, and technical advice, and assistance in project development; (b) international contract (or sponsored) R&D; (c) agreement on technological co-operation between enterprises; (d) purchase of technical services; and (e) reference to literature, participation in conferences, education overseas and co-operative R&D arrangements (Choi, 1983).

The joint venture appears to be the most widely preferred vehicle of technology transfer in construction. The World Bank favours the formation of joint ventures, although it likes these to be voluntary arrangements rather than the mandatory ones which some countries tend to specify as a condition to the award of major contracts. There are several problems relating to joint ventures including: difficulty of effecting and monitoring the transfer process; finding a local partner able to benefit from the joint venture; and matching the foreign partner's commitment to technology transfer with its technical ability and suitability for the project (Andrews, 1984; Chow, 1985). In a cross-cultural situation, where the partners would have different technical practices and styles of operation, the potential
for conflict is considerable. However, some foreign firms use technology transfer as a marketing tool, and have used it to break into, and stay in, particular markets.

Trends and problems

Through government-to-government agreements, the developing countries received "aid" from the industrialised ones (mainly for projects in the manufacturing sector) for pre-investment feasibility studies and market surveys; selection of suitable technologies for manufacturing; design of production facilities; construction of buildings and installation of plant; production management; and marketing. However, several criticisms were, and are, levelled against this form of technology transfer: the technologies are often restricted to particular sectors, techniques or aspects, and are seldom up-to-date, are transferred on unfavourable terms (including, for example, prohibition of the export of the goods produced), and are often inappropriate to the host countries (being capital-intensive, import-dependent, high-energy-consuming and polluting); licensing fees also tend to be high. The technologies tend to lead to the decay of indigenous and traditional technologies (Stewart, 1977; Sharif, 1983). Over the past few years, technology transfer through direct foreign aid has increased in importance. Studies by UNCTAD (1990) show that despite policy changes and liberalisation of investment-control regimes in many developing countries, foreign direct investment in these countries actually diminished during the eighties. Thus, some writers brand technology transfer as a myth, and consider the international firms as using access to key technologies and innovative capacities as instruments of domination. Technology transfer had increased international inequalities, as the transnational corporations were selective in their choice of countries where they would invest, partners with whom they would cooperate or firms (and countries) to whom they would sell technologies (Ernst, 1983).

Construction technology transfer has been supported by public and private sector clients, and lending agencies. There appears to be more resistance to technology transfer in construction than in other sectors (Abbott, 1985). The transfer of construction technology faces hindrances including: (a) unwillingness of foreign firms to nurture potential competitors in a declining world market; (b) tendency of technology transfer to add a time and cost element (and managerial complexity) to the already difficult and risky business of contracting; (c) the usual lack of understanding (among foreign enterprises, local beneficiaries and clients) of what is to be transferred; (d) suspicion of the recipient and the client about the usefulness of what is being transferred; and (e) ineffectiveness of previous transfer, as the trained personnel seldom utilise what they learn (Abbott, 1985; Uko, 1987).

Technology transfer remains shrouded, not only in controversy and emotion, but also in considerable confusion, owing to the complexity of "technology" itself and the multiplicity of channels of its "transfer". Moreover, there is little relevant and accurate data to aid the measurement of the effectiveness of technology transfer which continues to be imprecise (Erdilek and Rapoport, 1985). A main difficulty lies in determining what to evaluate, since technology transfer has two main dimensions: that from the seller to the buyer, and that relating to the effective diffusion and application of the technology.

The way forward

Technology transfer is multi-faceted, diversified and dynamic (De Cubas, 1974; UNCTAD, 1990). Its success is determined, to a large extent, by the ability of the buyer to absorb, adapt, apply and integrate it into its existing technological, social and other systems, and eventually to further improve upon it. Technology transfer should be planned and continually monitored, based on a country-specific policy which recognises the practical limitations in the possibility and effectiveness of transfer. The supplier and the recipient(s) should also be carefully selected. The former should be committed to technology transfer, and the latter should be able to benefit from the transfer. Technologies should be appropriate, and should be considered in a complete sense (both the hardware and software of the technology, and related managerial skills), with special regard to their potential for supporting and promoting technological self-reliance (Oldham, 1987). Technology transfer should complement, not substitute for, R&D activities in the particular country. Additional principles for effective technology transfer include: selecting technologies to be imported by correlating national needs with available resources; applying imported technologies only after adapting them to fit local surroundings; and undertaking all repair, imitation and improvements in introduced technology with local trained personnel (Sharif, 1983). The know-how should be packaged with due regard to the background of the target group. Both suppliers and purchasers benefit from technology transfer and need to make some investment in it. The prerequisites for successful technology transfer include: realisation of the

676
nature of the task and a sound policy infrastructure with effective communication channels. Due attention should be paid to the genuine concerns of the transferor: exposure to risk, possible loss of competitive edge over transferees, transfer of a property developed at a cost, difficulties concerning the peculiarities of transferees, and political pressures both at home and in the host countries.

Construction technology transfer should be planned and co-ordinated by a central government body such as a unit in the ministry responsible for construction. Policies on the transfer of construction technology should be harmonised and integrated with overall construction-industry policies as well as macro-level policies, and be constantly monitored for possible revision. They should incorporate utilisation of the transferred technologies, and their dissemination, adaptation, integration with existing ones, and further improvement. The experience of other countries and sectors, and the many published guidelines on technology transfer would be useful. Various technologies would require different considerations as to the most suitable source, effective transfer mechanism, form of agreement, administrative system and support services. However, a balanced and integrated approach to technology transfer should be sought: the technologies to be transferred should be prioritised broadly according to national needs, the ease of transfer and diffusion, and the potential of the technology to contribute to national technological self-reliance. Policies which impose conditions in areas normally governed by voluntary commercial relationships (such as joint ventures) should be carefully considered (as to their potential benefits, possible negative influences, and difficulties which might be encountered in their implementation). For example, selecting a partner suitable for a particular project is governed by factors which are different from those relating to the choice of a long-term collaborator. Training arrangements should be monitored to ensure their effectiveness: candidates should be chosen on the basis of their potential to benefit from the expertise to be transferred, and should be provided with opportunities to use and disseminate their acquired skills. There is a limit to what policies can achieve: much will depend on the motivation and commitment of the beneficiaries of the transfer and their ability to make the most out of the opportunities offered.

References