International Transfer of Technology : Myths and Facts*

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The revolutionary advances in the field of technology have, while improving material conditions of human life, raised certain basic issues specially pertaining to the continued use of present type of technology for productive purposes. These questions range from the impact of technological advances on environment, resources conservation and capital-output ratios. It is feared in some quarters that present pattern of technological advances is not in a position to respond sufficiently to the changing ecological and other requirements. Further, the need to distinguish between real wants of human beings from those created by artificial means and their impact not only on resource utilization but also on creating a more desirable way of human life. The role of technology in this respect has been seriously debated. Hence, there is a growing body of opinion that technology should be made to respond to these new needs. The advance of technology should be regulated in such a way that it would answer many of these questions. One of the most important questions that is arising specially relevant to developing countries is the international transfer of technology, its implication to their growth process and its significance to sustenance of independence and cultural identity.

Why Transfer of Technology ?

The international transfer of technology had not been a subject of serious investigation for the decades and centuries. In fact, it had been primarily taking place among the advanced countries. The technology transfer problem did not bring about any conflict among these countries. This is mainly due to that most of the countries opted for a specific economic system, i.e., the private enterprise system and had achieved a comparable level of economic development, especially, industrialization.

* The views expressed in this article are those of the author and do not necessarily reflect the views of the Institute to which she belongs.

Culturally, there existed considerable homogenity. Although the strength of these factors in perpetuating the historical character of transfer of technology has been slowly eroded in the face of resource scarcity, pollution etc., they have not yet assumed large dimensions. The basic issue of international transfer of technology has been transfer of technology from developed to developing countries. This is indeed understandable, for the very basic features which have not necessitated a detailed investigation of implications of transfer of technology among advanced countries are missing in developing countries. After the attainment of political independence these countries are searching for a form of economic system which would not be necessarily a pure private enterprise oriented one. The search for new system has been forced on them most often by the structural difficulties of achieving economic growth. Second, inequality arising out of economic development between developed and developing countries has also brought in a large number of issues, such as advance terms of trade, transfer of resources from developing countries to developed countries. The factor endowment of these economies specially labour abundant has also made the indiscriminate international transfer of capital biased technology a questionable proposition. Finally, the life styles of developing countries are different from those of developed countries, despite the existence of a small section of the population imitating the western ways of living. Hence, the relevance, cost, mechanism and appropriate character of transfer of technology from advanced countries to developing countries are being examined.

Concept

Before analysing the issues of transfer of technology in this context, it is necessary to define the concept of transfer of technology At times, it is believed that transfer of technology is a gift from the seller to the buyer. Or, it is considered that by transferring a technology along with the capital, the seller is selling the technology to facilitate production with not much cost. This is distortion and a wrong interpretation. It has been established now that selling of technology is essentially a commercial proposition. It is sold with all the motivation that gives rise to a commercial transaction with one fundamental difference. The technology is being sold in an oligopolistic market. A few large multinational firms hold the technology as a powerful weapon of bargain.

In fact, it is believed that the strength of multinationals lies not so much in their technology but on this capacity to keep exclusive control over it.

In this transfer process, it is also believed that the developing and developed countries trade in technology with equal strength. Since sales of technology is purely a commercial transaction, the buyer is expected to play an equally powerful role as the seller. What is, however, overlooked is that the developing country as a buyer is a weak partner. The most important element in the purchase of technology is knowledge on the type of technology, its price etc. The developing country very often simply does not possess this required knowledge. Therefore, at the initial stage itself, the developing country starts with a great disadvantage of not having the power of bargaining. Superimposed on this, it has foreign exchange constraint. Thus, the bargaining on the basis of knowledge is one of the most important lacuna that the developing country has. To build up information on the basis of which it can effectively bargain specially with giant multinationals, therefore, should become the first policy objective of any developing country intending to purchase technology.

Myths and Facts

One of the important myths that is perpetuated and sustained by a deliberate policy of multinationals is the belief that they invest substantially in developmental research. As a result, they seek protection from all countries for their technology ownership. So patents are used as vehicles of monopoly protection. Thus, the research activity of the developing countries gets strangulated and does not get any initiative. In a survey conducted by the UN regarding the holders of patents in developing countries, it was found that as much as 95% of patents are held by foreigners in the developing countries.

Applying the same argument to them, the producing unit in a developing country either in the form of subsidiary or in the form of collaboration has to abide by certain considerations. These include a large number of restrictive clauses, and purchases of raw materials etc. from the parent body. The chemical and pharmaceutical industry of the world enjoys profits much beyond the necessary costs. In fact, many

fundamental breakthroughs in life-saving drugs had taken place in mid-sixties. Later, whatever additional research has been done has not basically changed the availability of such medicine. As a result, enjoying the exhorbitant price over their research findings for a long period has been one of the most important elements of costs in transfer of technology. In fact, the latest revelation on Indian drug prices wherein a foreign firm is importing basic raw materials from parent company 1,000 per cent more than the cost of production, 700 per cent over market price of other marketing countries is no exception. This has been the case in all the drug companies selling drugs to developing countries. Therefore, it is not essentially for technology that a developing country is paying; it is the perpetutation of monopoly rights of multinationals in technology which is being paid for by the developing countries.

Another difficult aspect of this transfer of technology is its inappropriateness. Very often, it is not appropriate in terms of meeting factor endowment. Further, it also leads to the production of inappropriate products, bringing considerable distortion in the developing country's consumption pattern.

The technology thus transferred also does not get a self-sustained development in the developing countries for the R & D efforts are so limited that hardly any self-sustained growth of technology can take place.

While technology has to be imported, it has to be selective. The first task of a developing country is to develop various measures to protect itself from many adverse aspects of international transfer of technology. The role of the Government is very important. It is indeed worthwhile to study Japanese experience. They purchased technology with minimum of these costs. The Japanese Government was a dominant partner in bargaining the collaboration agreements

Under the guise of transfer of technology, very often trade marks and brand names are sold. This would cost necessary outflow of foreign exchange. These trade marks and brand names also have serious impact on the growth of local industry and local brand names.

One of the most important areas in which confusion arises is the mechanism of transfer of technology. It is being transferred under four forms,

subsidiary, majority ownership of industry, minority ownership and technical collaboration. Most of the developing countries believe that the best mechanism to transfer technology from abroad would be via the control of host country in the industry and minority ownership of the foreign collaborator. Further, they also believe that technology transfer through technological collaboration agreements are the best vehicles of transfer. Experience has, however, shown that these forms are a necessary first step to keep the control on the industry by the host country, but they do not guarantee any protection from the ill-effects of the indiscriminate transfer. In fact, technology transfer through technical collaboration as it is in the experience of India is accompanied by a large number of restrictive clauses. In the case of some firms in other developing countries, it was found that the control on technology being critical despite regulation, the entire operation was in foreign hands. The Government of the country, therefore, should look into these various aspects in formulating its policy. It should play a critical role.

Transfer of Technology Among Developing Nations

T. N. Chaturvedi

For developing countries, transfer of technology has come to acquire a meaning beyond the physical aspect of gaining access to technical skills. It is being regarded as the most important tool for bringing about the desired economic development. The developing countries have given top priority to expansion of their industrial base through harnessing resources in men and materials for achieving a self-generating economy. A judicious implementation of the technology transfer programme has therefore, become an essential pre-requisite for facilitating rapid industrialistion.

Modes of Technology Transfer

Before taking up the detailed consideration of the issue, it would be appropriate to state briefly the various modes through which the transfer of technology from one country to another can take place. These can be broadly categorised as :

(*a*) *Through Foreign Investment* : A part of the capital, majority or minority, and technological resources are brought into the host country by the foreign firm. In such a case, the financial participation acts as a vehicle of technology transfer. The local contribution is to the extent of providing the balance capital, infrastructure, skilled and unskilled man power etc. The control of the enterprise is either in the hands of the foreign firm or the local partners depending upon the proportion of the equity held. The technical know-how comes from the foreign firm under a separate agreement which may or may not involve additional payment.

(*b*) *Through Technical Collaboration :* The firm in the host country purchases the know-how from a party in another country on purely payment basis. The payment consists of lump-sum or royalty (related to a percentage of turnover) or a combination of both. The transfer of technology brought about by this method does not affect the pattern of management of the host firm.

(c) *Through Equipment :* Technology is in a large measure embodied in the equipment employed. "Equipment suppliers have served as an important source of technology in many developing countries. The arrangements have varied from the know-how that a salesman could supply with purchase of few machines to the design and installation of complete plants."[1]

(d) *Through Turn-key Jobs :* Here an organisation in the donor country is given the job of starting the plant and handing it over to the local firm. The services required under this include detailed planning and engineering, choice and procurement of equipment, initial training of personnel and ultimate commissioning. This is a slight variant of Category (b) to the extent that the job awarded is quite specific and relates only to commissioning of operations.

(e) *Through Arrangements on Government to Government basis* : The Government of a country makes technology and other facilities available to another Government under terms which are far easier than those which can be arrived at between two private parties. Such an arrangement generally applies to State financed projects like building Power Stations, Dams, Public Health Services, etc. This may also be incorporated in a biltateral plan of economic, trade and technical cooperation without any separate payment being involved in a transference of a specific know-how. Indian assistance in setting up power projects in Nepal and bridge construction in Bangla Desh as also the recent launching of "Aryabhata" are examples in this respect.

(f) *Through Centralised Purchase :* An organisation in the host country, preferably state controlled (to ensure effective horizontal transfer subsequently), purchases technology on an outright basis and after adapting it suitably passes on to one or more firms in the country. The payment by the individual firm in such a case is most nominal and a number of firms get simultaneous benefits. Such a method has the advantage that the central organisation in consultation with the collaborating firms can associate R & D Institutions in the country at the outset to achieve an increased degree of self-reliance over a period of time.

1. United Nations, 'The Acquisition of Technology from Multinational Corporations by Developing Countries,' New York, 1974, Page 35.

(*g*) *Through Consultants :* Here the technology transfer takes place through the association of consultants of two countries on a commercial basis. One consultant supplements the other to the extent of the capability available with him having due regard to the requirements of the job undertaken.

(*h*) *Through International Regional Seminars and Conferences :* These ensure exchange of information which are useful in promoting R & D activity. These help the country in keeping abreast of latest trends in developments giving it an opportunity to evaluate them in their own context for making continuous improvements.

(*i*) *Through Training and Education :* This is accomplished by sending personnel from one country to another for advanced training or acquisition of additional qualifications. These programmes are generally financed by international or inter-government organisations like UNDP, Commonwealth, Colombo Plan, etc.

"Because of the varied and complex nature of industrial operations, it is difficult to compare qualitatively, the various services involved in a technological transfer or transplant carried out through a direct investment (which itself may take several forms) with various alternative arrangements singly, or in combination such as licensing, a management contract, purchase of a turnkey plant, purchase of equipment, consultant services and the like. . . . . .

Logic, seems to lead to two main conclusions (1) that a relatively simple framework of social cost-benefit analysis needs to be applied to governmental policy-making regarding the choice or the use of alternative contractual channels of technology transfer and (2) that the practical application of such analysis requires that the problem be analysed, if not by case, at least according to various branches of industry in which the balance may be tipped one way or another by judging just one or a few important aspects influencing the comparative merits of different forms of technology transfer."[2]

2. W. A. Chudson, "The International Transfer of Commercial Technology to Developing Countries" UNITAR, New York, 1971 pp. 8-9.

Background

It may be worthwhile to have a look at the situation in which the developing countries found themselves initially. After freeing themselves from the yoke of foreign domination they inherited stagnated economic growth and mounting social problems brought about by it. Their known reserves of natural resources had been emptied or misutilised, having served just as supplier of materials to developed countries. They were plagued by the paucity of capital, management expertise and technical personnel. While they had plenty of unskilled labour, the skilled manpower was very scarce. There was no R & D in industries worth the name, as in the past entire dependence for the scientific research had to be placed on principals in the colonial country. They hardly had any capital goods and intermediate goods industries necessary for sustaining further industrialisation. Having missed the industrial revolution, their endeavour was to make concerted efforts to make up for the lost time by trying to compress in a few years what the developed countries took decades to achieve. This was the general picture obtaining in the developing countries.

Of course, some of these countries, like OPEC countries, after the price hike in petroleum industry, did have funds but they had the same level of development or more appropriately under-development as other emerging countries not endowed with the possession of liquid gold.

Assistance from Developed Nations

With such a situation prevailing in the developing countries, it became a matter of utmost urgency to look to the developed countries for the flow of investment and technology with the object of achieving concrete results in a short period of time, partly to offset the initial handicap and partly to fulfil the promise made to the people. The aim was to raise living and health standards of the populace, provide them with food and shelter, clothing and education, create employment opportunities and utilise to the optimum extent the resources available in the country. Thus the emphasis had been to acquire technologies developed and proved in advanced countries and borrow management techniques followed by them in achieving their present position in the world economy.

The developing countries were virtually forced to hustle deals with developed countries for ready-made and turn-key know-how. At that time, the many inherent shortcomings of such arrangements were not fully considered nor was the borrowing country aware of them. In many cases, the know-how came under the aid programmes of developed countries leaving very little choice to the recipient country. This concept of combining technology transfer with aid did not give opportunity to the developing countries to buy the most suitable technology or appropriate technology for a particular job. The developing countries were not, in any case, equipped to evaluate the technology and assess from the long term view the benefit of the assistance made available. The existence of sellers' market in transfer of technology did not improve the situation. The donor countries were mostly unfamiliar with the environmental conditions, level of skill and technology, type of infrastructure facilities and quality of raw materials available locally. Even if these parameters were known to them, they did not understandably make any efforts to adapt the technology for use of the developing countries for fear of making it more expensive in view of the high cost of development at home. For example, the electrical/electronic equipments manufactured from know-how transferred was suitable for operation under an ambient temperature of 20°C, instead of 27°C accepted for tropical and sub-tropical climates. The know-how imported for the control of processes required high degree of sophistication and skills on the part of local manpower which was really not available. Automation came in where a good proportion of manual operations could be used. The size of industrial plants proposed to be built was too large to be transported by the available facilities.

The technology given did not always take cognizance of the availability of basic and intermediate goods; for example, lining of chemical equipment by fibre-glass was advocated when ceramics could easily do the job. There is an interesting example where nickel (an imported item) was specifically added to produce steel as the composition of the steel in he donor country contained some traces of the metal. The realisation that this material was tolerated in the donor country, because it was found in their ore, came rather late. This was a case of the inadequate appreciation and assessment of the quality of the raw material of the host country.

As regards capacities proposed, they were also quite high for the require-

ments of developing countries. A multi-national firm advised production of magnetic tapes by which the entire annual requirement of the host country could be met by a months' production from the plant. The capital-intensive know-how was mostly ill-suited to the local conditions and did not always help to solve the problem of ensuring availability of goods, services and employment.

Even in the acquisition of technology through training of manpower sent to developed countries, the gap in the requirements of the recipient country and the training imparted was too wide. These personnel often got too specialised a training to be only efficient cogs in the works and not as 'do-most and know-most' people needed at home to take on the mantle of leadership to identify and solve problems related to the development. Only a minority proved equal to the challenge and a sizeable number found themselves ill-at-ease to fully use their training leading inescapably to frustration and thus caused more problems than they solved. Maladjusted to conditions in their own countries, a number of them migrated to cosier and well paid jobs abroad. Developing countries could hardly afford the luxury of having their none-too-abundant technical man power resources engaged in work not contributing directly to the economic growth. The need for doing advanced research and specialised functions in developed countries to spearhead the work in that direction could not be denied but the priorities did require more stress and emphasis on adaptive development and building up of a strong applied R & D infrastructure.

Benefits of Transfer Among Developing Nations

The above analysis is intended to highlight problems which arose in the wake of technology transfer from developed countries to developing countries in the particular context of the compulsion of circumstances. In retrospect from one angle, this could perhaps be considered unavoidable. This is certainly not to say that such a transfer has not produced appreciable benefits in various areas. It has contributed significantly to the development of the recipient countries and has brought them to a stage when they can think in terms of an effective programme of technology transfer among themselves in view of the expertise and skills which have been developed by them in relation to their own requirements. Of special significance in this context is 'Intermediate technology'. The

term intermediate technology was coined by E. F. Schumacher[3] in mid-1960's. "There are three main sources of intermediate technology. The first is the development of traditional indigenous production and servicing techniques. Productvtiy is increased through the application of scientific and technological knowledge often derived from elsewhere, but continuity with prevailing social and cultural conditions is maintained. The second source, at the other end of the spectrum, is the adaptation of technologies currently in use in the advanced industrialised nations, but in a way that greatly reduces the scale of activity involved. It should also make technology suitable for a different capital/labour ratio, as well as for the use of local materials and other resources. Occasionally included in this category are technologies which have been developed and subsequently outgrown by the advanced countries during the course of industrialisation, but which may now be considered appropriate to the economic and social conditions prevailing in the developing countries. Finally, there are areas in which it is neither possible to upgrade traditional techniques, nor to adapt advanced techniques. In such cases, it is frequently necessary to carry out research and development into totally new techniques fulfilling the basic requirements of intermediate technology."[4]

The advantages of transfer of technology among developing countries are manifold. When a developing country obtains technology from another developing country, it has the privilege of shopping in a buyers' market. The technologies thus available are those which have been developed, evaluated and further perfected under more or less similar conditions. The equipments and plants designed in the developing countries are less capital and more labour-intensive and are especially more suited to withstand the rigours of the climatic conditions, thus obviating the need for plant shut-down and modifications during teething period. If the technology transfer takes place through consultants, it is beneficial to have them from another developing country as they are likely to have much vaster experience of operation of a number of industries running under similar constraints. They also have much better acclamatisation capability to provide adapted technology to show

3. E.F. Schumacher "Social and Economic Problems calling for Development and Intermediate Technology" Mimeographed ; undated.
4. David Dickson "Alternative Technology and the Politics of Technical Change" Fontano, 1974, p. 154.

tangible results in a short period in the recipient country. By seeking training facilities in other developing countries, purposeful knowledge can be acquired for immediate use and benefit in the recipient country and can act as a spring-board for further R&D effort. Thus alienation and brain drain can be reduced to a great extent.

What then are the ways and means of promoting a more meaningful cooperation for transfer of technology among the developing countries? One of the important factors inhibiting such a transfer is the lack of information on each others' capabilities. "There are two basic problems of communication to be tackled; one concerned with the assembly and proper mobilisation of knowledge about appropriate, intermediate' technologies, the other concerned with its reception and utilisation at the receiving end, in the rural areas of the poor countries. Neither of these "communication systems" currently exist on any significant scale, and their absence constitutes a major gap in the aid and development efforts of both donor and recipient countries."[5]

"Technical information raises problems not only of availability (access to information) and compilation (collection, organization, distribution), but even more important, of content, and more particularly, how far it covers the whole range of existing technical possibilities." [6]

It is a pity that the developing countries know more about the developed countries, a reflex condition no doubt by the salesmanship of the developed countries who can afford to spend large sums of money in advertising their technological achievements. As the developing countries cannot match the developed countries in this respect, because of the limited resources, it is up to the international agencies like United Nations (UN) and Organisation of Economic Cooperation and Development (OECD), who are no doubt already doing notable work, to intensify their effort in this direction. This can be done by compiling the information on (a) areas in which the developing countries are in a position to export technology to other countries, (b) training facilities available along with institutions which can impart the same, and (c) panel of experts suitable for secondment abroad with their field of specialisation. As a complementary function, designated institutions in the

5. O.E.C.D. "Choice and Adaptation of Technology in Developing Countries"' Paris, 1974, p. 108.

6. Op cit, p. 154.

developing countries can bring out national registers on these aspects. Where necessary, assistance by way of funds and expertise should be freely made available to these institutions by the international agencies. Another factor is that the developing countries find it difficult to ignore the carrot of aid or soft loans through which developed countries often transfer their technology. Even though the technology component may be more expensive than that available from developing countries, the package becomes irresistible in view of the financial constraints in which the developing countries generally find themselves. An obvious answer to this is that the World Bank and the Asian Development Bank should come forward to freely finance projects in which the technology transfer is from one developing country to another and earmark a portion of their resources for this purpose.

Need for Guidelines and India's Policy Regarding Import of Technology

It is also necessary that the developing countries, who are in a position to offer technology, should reflect their experience vis-a-vis developed countries in steering clear of potential areas of later irritants which tend to create a feeling of economic domination by the donor country.

As far as Government of India is concerned, the basic policy is to welcome foreign collaborations on a selective basis in fields in which such collaborations will be of advantage to the Indian economy. The fields where such a collaboration is required are kept under constant review and the Government issues illustrative list of industries where foreign collaboration, financial and/or technical, may be permitted. The selective import of technology has been understandably stressed in the Fifth Plan document on ensuring that simultaneously with the import of technology, "a specific programme is formulated to not only assimilate and adapt technology but undertake the R & D for improving it. Such programmes must then be closely monitored." The emphasis is more on the absorption of technology quickly so that the entrepreneurs do not have the need to depend upon the collaborator for continuous production and are in a position to sustain further technological development through indigenous efforts.

In India, generally a minority foreign equity participation of less than

40 per cent is allowed in selected areas. However, cases involving export-oriented industries (minimum exports being 60% of the total production) and industries requiring sophisticated technology, a relaxation in this limit can be allowed. Basically, foreign investment is considered only as a vehicle of transfer of technology. To give technical orientation to the process of industrial development keeping in view the country's needs and priorities, the Government of India has recently set up a Technical Committee of the various government departments dealing with science and technology and industrial research. The object is to bring to bear a total approach to the problems of technology and industrial development. The function of the committee is to consider technological aspects of proposals involving the import of technology within the framework of guidelines issued from time to time and offer a single-point integrated opinion keeping in view the availability of the technology and capability within the industry, the type of technology needed for its future requirements and the arrangements for inter-linking of the imported technologies with indigenous R & D to ensure self-reliance in the shortest period of time. The committee also calls the parties to explain their proposals at the meeting so that a consolidated view is taken for ensuring optimum utilisation of the technology.

A recent sample survery has revealed that most of the R & D effort in the industry is directed towards import substitution. The average expenditure on R & D as a percentage of the turnover in the surveyed firms works out to 0.95%; the variations being from 0.07% in prime movers to 2.39% in telecommunications. There is, therefore, need in improving the R & D effort for assimilation of technology. Also, an analysis of foreign collaboration applications received by the Technical Committee after July 1974 shows that the collaborations were weighted heavily in particular sectors like transportation equipment, electrical equipment, industrial machinery, etc. The foreign collaboration or extensions of agreements mostly involved multiple import of technology and were mainly sought from the marketing point of view. On the basis of these findings, steps are, therefore, afoot to ensure a more effective horizontal transfer of technology.

A clear set of guidelines for ensuring a purposeful technology transfer from the country, therefore, becomes a *must*. The Government of India has been all along quite particular in this regard. Majority Indian

participation in joint ventures overseas is not normally permitted unless it is specifically requested and is considered essential for the implementation of the project.

More developed of the developing countries like India* who have the required capability to export expertise and know-how in a variety of fields have not organised themselves in having their consultancy firms registered with the international agencies (like UN) for the award of sub-contracts. The sub-contracts have, therefore, not given their way even in areas where they are better equipped to give consultancy and prepare feasibility and project reports, because of their having done similar jobs under identical conditions. For marking a determined bid to wrest such an initiative, it is worthwhile to form a bank of best talents in the shape of a consortia of organisations to offer efficient and competitive services for specific projects. The Indian experience of organisation like Projects & Equipment Corporation, Engineering Projects (India) and Indian Consortium of Power Projects, deserves particular mention in this context.

There is also the need to set up an organisation to evaluate the quality of goods available in developing countries so that the recipient countries do not entertain doubts about the efficacy of the transferred know-how. Unfounded suspicion of getting sub-standard equipments have driven many developing countries to developed countries even though they would have preferred to obtain the technology from another developing country. In India, the national certification scheme operated by the Indian Standard Institution, and more particularly, the pre-shipment inspection by Export Inspection Council require to be made use of more and can with advantage be followed by other countries.

Last but not the least, are the procedural bottlenecks which are the bane

* In international meetings, India has come to acquire the status of a country capable of giving technology. As a result of the understanding arrived at between the Government of India and UNIDO, consequent to the International Seminar on Technology Transfer held in '72, India has been initiating exchange of Missions with the developing countries in technology familiarisation/transfer programme. Under this programme, delegations from South Korea, Fiji, Philippines, Indonesia and Kenya have already visited India. Delegations from Malaysia, Thailand, Bangla Desh, etc. are expected in the near future. In the exchange of technological information with these delegations, the Indian Investment Centre has played a significant role.

of many countries. The red-tape and resultant delays in according clearances to donor as well as recipient country participation in the projects are surely not the best ways of instilling mutual confidence so very necessary for promoting successful joint ventures. Speedy and time-bound approvals at all levels are, therefore, essential and can hardly be over-emphasised.

It is felt that action on the lines suggested above would go a long way in encouraging a more positive exchange of technology among developing nations for their common benefits.

It would thus be possible to evolve a joint effort where the state, technological institutions and industry play their due role to establish a moving equilibrium for technological development so that its result can be manifested in the accelerated development of the country. It may also not be out of place to mention that the optimum advantage from the technology transfer process are obtained if the simultaneous effort to stress the importance of managerial, organisational and administrative effectiveness in the host country continue to be made with a view to reinforce the growing technological capability.

Role of Indian Investment Centre[7]

The Indian Investment Centre was primarily set up to stimulate the flow of foreign private capital and technical know-how into India. However, over the years, IIC's assistance to entrepreneurs has taken various forms. Besides providing the necessary information and contacts for the setting up of joint ventures in India, the Centre provides effective assistance to Indian entrepreneurs for the setting up of joint ventures abroad.

The Indian Investment Centre, both at the headquarters and the overseas offices has been identifying investment opportunities and providing background information on terms and conditions on which joint ventures are permitted in various developing countries and within the guidelines formulated by Government of India (see Annexure I) for Indian participation in joint ventures abroad.

7 For details refer T.N. Chaturvedi, "Foreign Investment/Collaboration in India"; The Indian Journal of Public Administration Vol. XX No. 3, July-Sep. 1974.

Indian Investment Centre has also undertaken compilation and storing of all relevant information on economic and political conditions, investment, exchange control, taxation and import policies, the laws relating to corporate bodies, the pattern of foreign trade, their foreign exchange situation, etc., in respect of various developing countries. In fact, the Centre has already brought out country profiles on Malaysia, Ghana, Indonesia, Fiji, Philippines, Iran and Nigeria. The Centre has also developed close liaison with a number of developmental agencies in various countries like Ghana, Indonesia, Malaysia, etc. IIC also maintains close contacts with Indian Missions in various developing countries to keep itself abreast of the changes in investment policies, economic and political conditions, etc. The Missions also refer to IIC specific enquiries or fields where investment possibilities exist.

The Indian Investment Centre is actively associated with the industrial promotion activities of UNIDO. The IIC participated in the meetings organised by the UNIDO for such promotional activities held in Vienna, Rabat, Manila, Nairobi and Kuala Lumpur.

The growth of small industries in India has amply demonstrated that it is one of the ways of promoting new entrepreneurial and managerial talents, for ensuring equitable distribution of income and in increasing employment opportunities. The small scale industries, through expansion and diversification, lead to the establishment of medium scale industries by the emerging class of competent entrepreneurs. Thus, the objective of diffusion of ownership dictated by the national policy for curbing concentration of wealth and monopolistic tendencies is served.

With the experience gained by India in the establishment of small industries and industrial estates, where all infra-structural facilities such as power, water, constructed sheds, etc., are provided, India is now in a position to co-operate with other developing countries in this field, particularly, in identifying industries for development formulation of suitable development programmes, planning and establishment of industrial estates and generally organising a variety of extension services, including provision of technical advice, marketing assistance, improvement of designs, etc. The areas in which India is in a position to provide knowhow and consultancy are given in Annexure II. In fact, a number of experts from India are now advising and assisting some of the developing countries for promoting similar programmes. In this connection, it is relevant to

point out that the Industrial Estate Project in Nairobi, Kenya, is looked upon as a very successful venture and the Kenyan authorities are appreciative of India's assistance in this regard. Details of various projects abroad with Indian assistance on stream or under implementation are given in Annexure III.

India's competence in the establishment of an enterprise on collaboration basis as well as the ability to offer technical assistance is being internationally recognised. At the various meetings convened by the UNIDO to promote specific industrial projects in Asian and African countries,India has been invariably invited as a potential country to offer technical and industrial collaboration to developing countries. In fact, in the Third Asian meeting on Promotion of Joint Ventures between developed and developing countries organised by the UNIDO at Kuala Lumpur in November 1973, India was identified as a resource-giving country.

In recognition of the role being played by the IIC in the field of promotion of joint ventures abroad the Government of India is associating the Centre in its programme of economic cooperation with other developing countries. The IIC was represented in the delegations sponsored by the Government for such purposes to Nigeria and Manila. The Executive Director of the Centre has been nominated as the Chairman of the Indo-Yugoslav Sub-Committee for economic cooperation in third countries.

The Indian Investment Centre maintains a close and effective liaison with the other organisations concerned with technology development such as Department of Science and Technology, Directorate General of Technical Development, Council of Scientific and Industrial Research, National Research Development Corporation, etc. so that it is in a position to give information on the extent and level of availability of indigenous technology to the interested parties for the purpose of establishing joint ventures in India as well as abroad. The IIC is further strengthening its capability to promote more effectively the Technology Transfer to other countries by providing a clearing house of information on the subject.

Annexure I

General Guidelines Governing Indian Participation in Joint Overseas Industrial Ventures

(i) Normally minority participation only by Indian parties is allowed. The intention is that Indian parties should not insist on majority holdings abroad, but if the foreign party and the foreign Government are willing to accept majority Indian participation, there would be no objection. Government favours association of local parties in foreign countries; also local development banks, financial institutions and local Governments, wherever feasible.

(ii) No cash remittance will be allowed except small amounts required in connection with preliminary expenses for setting up the company abroad.

(iii) Indian participation should be in the form of indigenous machinery, equipment, technical know-how, etc., required for the new venture. Value of structurals, steel items, construction materials, components, etc., are not allowed to be capitalised. However, where the value of machinery, etc. falls short to make up the necessary reasonable equity and there is need to retain Indian equity holding at a level higher than what is obtainable through export of capital goods alone, there will be no bar to consider such cases on merits for permission to include structural, steel items and construction materials (but not components) to the extent these are required for the particular project against Indian equity.

(iv) Machinery, etc. exported should be of Indian make; no second-hand or reconditioned machinery would be allowed for export against Indian investment.

(v) Normal import replenishments, as available to exporters under the import policy for registered exporters, will be allowed on export against equity capital.

(vi) Cash assistance, if otherwise admissible, will also be allowed on exports of machinery and equipment against Indian equity, subject, however, to a ceiling of 10 per cent f. o. b. value.

(vii) Indian industrialists should as far as practicable, propose turnkey jobs, as this will lighten the responsibilities of the foreign investor.

(viii) Indian parties should as far as possible provide in their agreements with the foreign parties for training facilities in India to nationals of the country of investment.

Annexure II

Areas of Know-how for Industries and Consultancy Services

A. Know-how for Industries

1.	Cement plant	Complete
2.	Cane sugar plant	"
3.	Textile mills	"
4.	Vegetable oil complex	"
5.	Crushing and grinding plants	"
6.	Tea plants	"
7.	Foundries	"
8.	Rolling mills	"
9.	Sub-stations and electrification projects	"
10.	Transmission line projects	"
11.	Asbestos Cement sheets and pipes manufacturing plant	"
12.	Alcohol plants	"
13.	Rice mills	"
14.	Materials handling units	"
15.	Chemical plants	Part
16.	Petroleum refineries	"
17.	Petrochemical plants	"
18.	Fertiliser plants	"
19.	Paper plant	"
20.	Air conditioning, heating and ventilation units	Complete
21.	Complete railway projects	"

B. Consultancy Services

1. Roads, bridges and highways
2. Water supply and treatment schemes
3. Sewerage and effluent disposal
4. Town planning, urban and civic development and architecture.

5. Design of public buildings—schools, technical institutes, office buildings, hospitals, commercial buildings, hotels, auditorium, cinemas, airport terminals
6. Electric power generation—thermal, hydro-electric, nuclear
7. Power transmission and distribution
8. Multi-purpose projects—irrigation, drainage, power and flood control
9. Techno-economic survey to cover different sectors of the economy
10. Geological surveys
11. Oil exploration
12. Mining development schemes
13. Construction of railways and projects for increasing speeds of trains
14. Port and harbour development
15. Standards institutions
16. Industrial testing centres
17. Industrial research and development institutes
18. Safety codes institutes
19. Economic planning institutes
20. Statistical institutes.
21. Industrial financing institutions
22. Investment promotion centres

Annexure III

Indian Joint Ventures Abroad
(as on 28.2.1975)

Country	*Indian Collaborator*	*Field of Collaboration*
1	2	3
1. Afghanistan	M s T. Abdul Wahid & Co., Madras	Leather Tannery
	M/s Bharat Commerce Industries (P) Ltd., New Delhi.	Spinning plant
	M/s Everest Packaging Corpn., Bombay.	Corrugated Boxes and other packing materials
2. Canada	M/s Anil Hardboards Ltd., Bombay.	*Hardboards
3. Ceylon	M/s Jay Engg. Works, Calcutta.	*Sewing machines
	M/s Swastik Glass Works, Chandrapur.	*Glass factory
	M/s Bhor Industries, Bombay	*PVC leather cloth
	M/s Sahaney Steel Press Works, Bombay.	Auto electrical parts
	M/s Oberoi Hotel (India) Pvt. Ltd., Delhi	Hotel
4. Cyprus	M/s Modi Spg. and Mfg. Mills Ltd., Modinagar.	Cotton yarn & sewing thread
	M/s R.M. Goculdas, Bombay.	Cylinders
5. Ethiopia	M/s Birla Bros., Calcutta	*Textiles
	M/s Bombay Soap Factory, Bombay.	*Soap factory
6. Fiji	M/s Wallace Flour Mills, Bombay.	*Flour Mill
7. Hongkong	M/s Korse (I) Ltd., Bombay	Stationery items
8. Indonesia	M/s Bharat Commerce & Industries, New Delhi.	Spinning plant
	M/s Mahindra & Mahindra, Bombay.	Water meters
	M/s Century Spg. and Mfg. Co., Bombay.	Textiles
	M/s Raymond Woollen Mills, Bombay.	Engineers' steel files
	M/s Tata Exports Ltd., Bombay.	Storage batteries
	M/s Karamchand Premchand (P) Ltd., Ahmedabad.	Textile mills
	M/s Advani Orlinkon Pvt. Ltd., Bombay.	Welding electrodes

1	2	3
	M/s Ambica Mills Ltd., Ahmedabad	Malleable casting for pipe fitting & sockets
	M/s Andhra Steel Ltd., Calcutta	High tensile reinforcement.
	M/s Southern Steel Ltd., Calcutta	Cold rolled box strappings
9. Iran	M/s Mahindra & Mahindra. Bombay.	*Spare parts, automative components
	M/s Indian Aluminium Cables, New Delhi	Malleable castings
	M/s Gabriel India Ltd., Bombay	Shock absorbers
10 Ireland	M/s Mafatlal Industries Ltd., Bombay	*Tufted carpet yarn
11. Kenya	M/s K.T. Dongre & Co., Bombay	*Gripe water
	Shri R M. Goculdas, Bombay	*Textiles
	M/s Raymond Woollen Mills, Bombay	*Woollen Textiles
	M/s H.L. Malhotra & Sons Calcutta	*Light engineering complex
	M/s Orient Paper Mills, New Delhi	*Paper, pulp project
	M/s Indian Cork Mills. Bombay	*Cork factory
	M/s Atlas Cycle Industries, Sonepat	Bicycle Industry
	M/s Sarabhai 'M' Chemicals (P) Ltd. Ahmedabad	Pharmaceuticals
	M/s Salvi Super Structures, Bombay	Cast iron foundry
	M/s J.K. Synthetic; Kanpur	Synthetic filament yarns
12. Libya	M/s Indian Hume Pipe Co., Bombay	Pipes
13. Malaysia	M/s Godrej & Boyce, Bombay	*Steel furniture
	M/s Birla Bros., Calcutta	*Cotton textiles
	M/s Gupta Machine Tools, Calcutta	*Precision tools & gauge Mfg. Unit
	M/s Parry Confectionery, Madras	*Confectionery
	M/s Kirloskar Electric Co., Bangalore	*Electric motors pump diesel engines
	M/s Ajit Industries, Bombay	*Enamelled copper & electric accessories.
	M/s L.G. Balkrishnan & Bros., Coimbatore	*Time and automobile chains
	M/s Murugappa & Sons., Madras	*Cycle & Industrial chains

Transfer of technology from one country to another may take place by one of the means, such as through training and educational programmes, consultants, purchase of patents and licences, know-how agreements, turn-key jobs and foreign investments.[7] The first three are generally described as 'soft ware' devices and the rest as 'hard ware' ones. The U.N., through its exchange programmes, helps the international movement of scientists and engineers as a means of technology transfer. In many countries it is taking place through the establishment of a branch company or the participation of the owner of the know-how as a shareholder in the undertakings set up in the recipient countries. Know-how can also be transferred by supplying scientific literature, passing on of research findings and supplying maintenance instructions.

Japan is a unique example of absorption of transferred technology which produced miraculous results in the field of manufacturing.[8] The important reason for success was heavy investment made by Japan in plant and equipment, set up through imported technology. During the post-war period (1945-72), she was able to import as many as 8,561 items of advanced technology: and during 1951-60, the industries based on transferred technology produced about 25% of the total manufacturing output. The rate at which the technology flows from the advanced to developing nations depends on the social and geographic conditions as well as educational and technical standards of the recipient countries. Japan has spent an average of 50 million yen annually, for research and development on imported technologies, compared to 20 million yen for her indigenous technology since the year 1963. Whenever needed, she did not hesitate to take loans to meet the financial requirements of the imports of capital equipment, raw materials, etc., but rarely allowed equity participation of the foreign firms.

The favourable social environment prevailing in Japan is rarely to be noticed in other developing countries, where there is not only inadequate capital and technical expertise, but a traditional culture not quite suited to the adoption of modern science and technology. Besides this, lack of adequate number of technologists pose serious problems for the development and absorption of imported science and technology.[9] In order to reap the real advantage of the imported technology, the developing nations should be prepared to spend large amount of funds on the adaptation and further improvement of the same.

IPR vis-a-vis Transfer of Technology

India has rich experience in borrowing technologies even during her pre-independence days, mainly from the United Kingdom.[10] With the advent of independence, she has been in a position to borrow technical know-how from other advanced countries as well. Her approach in this area became more systematic since 1957. The Industrial Policy Resolution of 1956 welcomed external capital investment, with minimum control in management and with guarantees for reasonable repatriation of profits and earnings. Between 1948-65, 2,723 agreements with foreign concerns for the import of technical know-how were signed in India. The number of such agreements increased to more than 3,000 by 1971 and to about 4,000 by 1972. The important areas of such collaborations are iron and steel, fertilizers, petrochemicals, shipping, etc. This has enabled the country to develop a sound base for science and technology and use them in industries producing milk powder, vegetable protein, television sets, wood pulp, certain elements for atomic reactors, cement, sugar, chemicals, etc.[11] The best method of developing a sound technological base in the developing countries should be to pursue a course of 3 phases[12]; importing technological know-how, adapting and improving the imported technology and then promoting indigenous technology. In the initial stages, most of the developing countries propose to import know-how along with industrial plants and equipments. After developing a sound technological base, a few of such countries have been able to shift the emphasis from the importation of plants and equipments to that of technology alone.

The nations that are prepared to supply technological know-how are those of capitalist as well as socialist Europe, the United States of America, Canada, the Soviet Union, Japan and China.[13] The capitalist West has contributed to the technological growth of a number of developing countries in Latin America, Africa and Asia. The socialist countries are supplying their know-how to selected developing nations like Chile, Cuba, Algeria, North Vietnam, North Korea, India and a few others.

Choice of Appropriate Technology

Technology transfer, according to Pearson Commission, can be made

to play an important role in annihilating the disparity in the distribution of world GNP between developed and developing countries.[14] But the real problem of the latter is to make a choice of imported technology and to find out the methods of its transfer. This depends on a comprehensive survey of the actual needs of the recipient countries. The countries which are prepared to supply the know-how, should also help the recipient countries to determine the actual needs.[15] Once such needs are determined, the decisions can then be made about the appropriate technology to be transferred, because the same type of technology may not be found suitable to the different conditions prevailing in the developing countries. The highly capital-intensive and labour-saving technologies may, in fact, cause harm to developing countries like India, Pakistan, Bangladesh and Indonesia, which are in need of mostly labour-intensive devices for a warranted rate of economic growth. Sir Maurice Fiennes, the UNIDO consultant, has a great deal of discussion on the findings that ill-digested technology and inadequate capacity of absorbing it have led to 40% wastage of scarce capital investment in the developing countries.[16] If it is true, it is a matter of grave concern to the most of the developing countries, which under no circumstances, can afford wastage of this magnitude.

This wastage can, undoubtedly, be kept to the minimum, by making a proper choice of the techniques and technologies to be borrowed. The primary aim of the developing countries should be to choose whether it needs capital-intensive or labour-intensive technologies, to decide whether the whole or part of the technology should be imported and finally with equity participation or with no such participation.[17]

India is a developing country with limited capital and suffers from a low level of production and an inflationary bias. With such a serious handicap, India has to choose an appropriate technology corresponding to either of the two well-known investment criteria such as one promoting maximum social marginal productivity advocated by H.B. Chenery and others,[18] secondly, that of capital-intensity maximizing re-investment quotient, advocated by Hervey Liebenstein. The technology, either imported from other countries or developed within the nation, should be so selected as to maximize the nation's productivity within a planned period of time, so that it can help avoiding the inflationary bias, so widely and deeply affecting the life in India today.[19] A suggestion which can have popular support in India is Liebenstein's criterion, that is, the

capital-intensive techniques should be applied to the basic, key and defence industries ; whereas Chenery's criterion of social marginal productivity, that is, the labour-intensive techniques, should be applied to the remaining industries.

The danger of capital-intensive technology is that it is likely to enrich a small number of entrepreneurs gradually assuming monopoly powers in manufacturing and business, thereby accentuating the inequality between the richer and poorer sections by helping uneven distribution of national wealth and income.[20] Even in the United States of America, such sophisticated technologies have provided ample opportunities for the growth of monopolies and combinations, and has been unable to save the glut areas from poverty. The introduction of capital-intensive technologies should, therefore, be limited to certain selective sectors, as mentioned above, managed and owned by the public sector. The aim of technology in promoting maximum social welfare may be defeated, once such imported technologies fall in the hands of private entrepreneurs, whose main object is the optimisation of private net monopoly revenue. The social marginal productivity criterion suggested by Chenery need be introduced to all other sectors in order to create more employment opportunities in the labour-rich economies like that of India.

The innovators, in the Schumpeterian sense, capable of taking risks in the introduction of advanced technologies, and new output, exploring new sources of raw materials and new markets, with nation-building motives, are rarely to be found in the developing countries, where the short-sighted entrepreneurs like to invest all their resources in quick-yielding avenues and real assets.[21] It is the responsibility of the State to see that the imported technologies should, under no circumstances, accentuate the existing inequality in the distribution of national income.

The states in developing countries have also a great responsibility in creating, a scientific atmosphere and imparting scientific training and education, to one and all, so that it may enable the concerned personnel to absorb the imported technology into the existing system in an effective manner. Nearly, three decades ago, the then prime minister, Pandit Nehru, took the initiative to set up a number of national laboratories and research institutions to help the growth of technically-oriented industries in the country. Fortunately,

1	2	3
	M/s Jg Glass Industries, Poona	*Glass bottles
	M/s C.I.P.L.A.	*Cosmetics & Pharmaceuticals
	M/s Hindustan Safety Glass, Calcutta	*Safety glass
	M/s Mukand Iron & Steel, Bombay	*Steel foundry
	M/s Tata Oil Mills, Bombay	Vanaspati, soap etc.
	M/s India Pistons Ltd., Madras	Piston components
	M/s Berar Oil Industries, Bombay	*Palm oil fractioning plant.
	M/s Chemical Construction Co. New Delhi	*Hydrogenation of palm oil
	M/s Mysore Govt. Soap Factory, Bangalore	*Sandalwood soap
	M/s Phalton Sugar Works, Bombay	*Sugar factory
	M/s Chemical Construction Co., New Delhi	Fatty acid and Glycerine
	M/s Vinod Sanghi, C/o Shah & Sanghi, Bombay	Tube valves
	M/s Lakshmi Textile Exporters, Coimbatore	Textiles
	M/s Zaverchand Gaekwad (P) Ltd., Baroda	Metallic flexible tubes and hoses
	M/s Soundarajan & Co., Madras	Biscuit factory
	M/s Camlin (P) Ltd., Bombay	Stationery items
	M/s Harasha Elec. Appliance Co., New Delhi	Tubelas heating elements
	M/s Jyoti Ltd., Baroda	Pump
	M/s Saru Smelting (P) Ltd , Meerut	Flux cord, solid solder wire etc.
	M/s Universal Radiators Pvt. Ltd., Coimbatore	Radiators, oil coolers
	M/s Garware Nylons Ltd., Bombay	Nylon & Polyester yarn and fabrics
	M/s Kwality Textile Assooiation Pvt. Ltd., Polloche.	Spinning mill
	M/s Sarabhai 'M' Chemicals, Baroda.	Pharmaceuticals Plant
14. Mauritius	M/s Sidharath Jeshubhai, Ahmedabad	*Mosaic tiles & rolling shutters
	M/s Swastik Rubber, Bombay	*Rubber product industry
	M/s Orkay Group, Bombay	*Textiles
	M/s United Agencies, Bombay	Hotel projects
	M/s K.C,P. Ltd., Madras	Cement plant

1	2	3
	M/s Raymond Woollen Mills, Bombay	Readymade garments
	M/s Karamchand Premchand Ltd., Ahmedabad	Terry Towel Mfg. unit
15. Nigeria	M/s Birla Bros., Calcutta	*Engg. goods
	M/s H.L. Malhotra & Sons, Calcutta	*Razor blade factory
16. Philippines	M/s Kirloskar Oil Engines, Poona	Diesel engines
	M/s Chemical Construction Co., Ltd., New Delhi	Direct coconut processing plant
17. Singapore	M/s Teksons (P) Ltd., Bombay	*Automobile accessories
	M/s M.S. Alloy Electrodes, Bombay	Welding electrodes
	M/s G.K. Singhania, Bombay	Shipping
	M/s Chemical Construction Co. (P) Ltd., New Delhi	Mfg. of stearic acid
	M/s Ramon & Demn Ltd., Bombay	Automobiles straights
18. Tanzania	M/s Mukand Iron & Steel Works Ltd., Bombay	Mini-steel plant
19. Thailand	M/s Sacha Exporters & Investors, Bombay	*Steel mill
	M/s Birla Bros., Calcutta	*Synthetic fibre spg. unit
	M/s Gwalior Rayon Mfg. & Veg. Co., Ltd., Bombay	Viscose Staple fibre plant
	M/s Thermodyne Pvt. Ltd., Faridabad	Semi-conductors
20. Uganda	M/s Birla Jute Mfg. Co., Calcutta	*Jute mill
21. United Kingdom	M/s Birla Bros., Calcutta	*Asbestos cement products
	M/s Royal Fancy Sweet-Meat Saloon, Bombay	*Sweet-meat factory
22. U.S.A.	M/s Ghai Lamba Catering Consultants (P) Ltd., New Delhi	*Restaurant, Chicago
	M/s Ghai Lamba Catering Consultants (P) Ltd., New Delhi	*Restaurant, New York
	M/s Indo-American Electrical, Calcutta	Magnet wires
23. West Germany	M/s Kirloskar Oil Engines (P) Ltd., Poona	*Oil engines, rice milling machines etc.
	Shri N. Krishnan, Bangalore	*Hose-clips
	Shri B.A. Chandran, Madras	Non-ferrous forgings
24. Yemen Arab Republic	M/s Hindustan Tool Industries, Bombay	*Builders hardwares
25. Dubai	M/s R.M. Goculdas, Bombay	Cylinders

*In Production.

Transfer of Technology from Developed to Developing Countries

Subas C. Pati **Prahallad Panda**

No nation can think of a rapid economic growth without a sound technological base of its own. Technology revolutionalises commerce and production and adds quality to the work of the professional and trade guilds. It has, therefore, become customary for the entrepreneurs of the developing countries to import technology from the industrially advanced countries, rather than using domestic technology to build their manufacturing concerns.

The advanced countries, at present, have accumulated enough experience of passing on technological know-how and supplying industrial plants to the developing countries.[1] The supply of know-how by the advanced nations is an important factor conducive to a rapid economic growth of the nations that receive them by training skilled national personnel, who in turn would enable the developing countries to solve the engineering and scientific problems faced by their industries.

The developing countries are those which have certain common characteristics like stunted economic growth, abundance of unskilled labour and scarcity of capital, technical manpower and managerial skills.[2] These economies are mostly the suppliers of raw materials. They have missed the first industrial revolution, but now they are making all possible efforts to raise their standard of living by rapidly industrializing themselves. They have, therefore, given due importance to the role of science and technology in stimulating their programmes for industrialization. The Pearson Commission has pointed out the glaring disparities between the developed and developing countries so far as technology is concerned. The Commission has also suggested the need for technological development for solving the problems of their economic welfare, industrial exploitation and natural resources.

Role of UN Agencies

All the developing countries are now trying to acquire skill and import know-how from the developed countries which have already made advances in the field of science and technology. Technology transfer from advanced countries is now a current phrase among national planners, scientists and technocrats of what is called the Third World.[3] Technology being an important determinant of economic growth, its transfer from advanced countries has obviously received renewed interest. Imported technology, to the developing countries, has contributed to their industrial growth, strengthened their competitive ability in the world market and accelerated their technological innovations in order to achieve economic parity at international standards by progressively narrowing the existing technological gap with the developed countries.[4] The United Nations agencies are playing an important role in assisting the technology transfer from the advanced to the developing countries. Having gathered early momentum in the field of technological development, the developed countries have a moral responsibility to help the new-comers by supplying technological know-how and training their personnel so as to be able to solve their engineering and scientific problems in industrial development.

To facilitate the transfer of technology, 'Science and Technology Aid' has been proposed by the United Nations as a part of the global development aid. The U.N.'s 'Advisory Committee on the Application of Science and Technology (ACAST)' for the 'Second United Nations Development Decade' has recommended a 'World Team of Action for the Application of Science and Technology to Development.' UNIDO is taking increasing interest in helping the industrialization programmes of the developing countries with the help of technology transferred from the developed countries. And in this, they are assisted by other U.N. agencies like ILO, UNESCO and U.N.'s Regional Economic Commissions in Latin America, Africa and Asia. The U N., therefore, seems to take keen interest in developing a strong foundation of science and technology in the developing countries in order to help them build a modern industrial system.[5] They have felt the need for importing 'know-how for products and processes, design engineering and marketing expertise, engineering consultancy and management services coupled with a massive effort by the recipient countries on developing their own know-how and infra-stucture by way of R & D facilities.[6]

financial needs of laboratories have been met from time to time. These laboratories and institutes have created an army of trained scientists and specialists, prepared to help the introduction of imported technology, and at the same time develop them further in the light of local conditions. It is high time that they should help to formulate a plan of education on the basis of the special needs of the country.

The developing countries can reap great benefits from the imported technologies by using them specifically in the export-oriented industries. The international organisations like UNCTAD, UNIDO and OEA are there to help these countries in this matter, even by promoting their R & D facilities.[22]

For the successful development of imported technology, the building of a technological infrastructure, and adequate availability of trained technical manpower is essential. Indigenous R & D capability should be built to assimilate and adopt the imported technology. The nations which do not have a well-developed R & D infrastructure should send their scientists to the advanced countries to carry out basic resesarch. Their knowledge in research abroad would be helpful in building R & D infrastructure in the home country. The U.N. agencies such as UNESCO, UNIDO, WHO, FAO, etc. are there to extend their helping hands in this matter.

In order to make a proper choice of technology to be imported, a survey need be made regarding the market potential at home and abroad, price and demand conditions, ability of the market to pay, etc. A market research organization with the main function of data collection in framing R & D programmes should be set up in the recipient countries. In countries like Japan and Australia the R & D programmes were linked to the national planning policies and priorities. If technology is to be imported for the promotion of research, it should be introduced in the most profitable and commercial channels. There should be an active agency whose main task would be to supply technical imformation and services to the research managers. The research managers need be dynamic and forward looking. In India, the Government have provided 95% of the finance needed for the R & D programmes of the country; and sponsored schemes like the national laboratories which have long-range research programmes and technological planning.

It is to be admitted that even today our industries are largely depending on imported know-how. Efforts should, therefore, be made to harness the indigenous technology to the maximum possible scale and import that part of the technology which can be manageable with the available scientists and technologists. The country should try to manage with minimum of foreign participation. The growth of indigenous technology is more relevant to the developing countries as it is free from the exploitation of the advanced nations economically and politically, and further it progressively makes these nations technologically self-reliant.

The total expenditure on science and technology in India was Rs. 270 million in 1958-59; it increased to Rs. 1,360 million in 1969-70. It constituted less than 0.5% of her GNP, compared to 1 to 3.1 of the GNP in some of the advanced countries. The corresponding percentage is 1 to 2 for Europe, 3.2 for the USA and 4.3 for the USSR.[23] The CASTASIA (1969) have recommended that the developing countries should increase their R & D expenditure to 1% of their GNP by 1980, that is, by the end of the Second U. N. Development Decade. The advanced countries should also continue to assist technology programmes of the developing countries so as to increase their expenditure level, and devote at least 5% of their non-military research and development expenditure for the benefit of the developing countries.[24]

A suitable science policy can help the less developed countries to better utilise their technological capacities. This policy includes incentives for innovation, financing of technological institutions, disincentives for excessive importations, development of technological capacity through the fiscal instruments etc. The National Committee on Science and Technology is doing useful function in framing a Science and Technology plan for India, in correspondence with her Five-Year Plans.

Moreover, the developing countries like India should encourage minimum direct foreign investment as a part of their technology importation programmes. The areas of such investments are mostly restricted to the extractive industries like petroleum, plantation and mining which normally benefit the developed countries more than the developing ones. Direct foreign investment of this sort causes quick repatriation of huge dividends to the foreigners, and ultimately leads to social loss. It is the responsibility of the State to see that the industries introducing imported technology should have minimum possible idle or excess capacities.

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Development and Transfer of Indigenous Technology : Problems and Prospects

P. Soundararajan*

Ever since man changed from his nomadic way of life and started organising himself, inventions and innovations have started growing. The rate of growth of innovations, however, was dependent on the needs and exigencies that existed at a particular place at any point of time. The two World Wars gave a big boost to the development of technology in Europe and America, with the result two distinct categories of nations, viz., (i) developed, and (ii) underdeveloped (now called as developing) came into being. In the last two decades, however, the world has come much closer and in the present situation, even the developing nations have something to contribute to the body of knowledge. This paper presents some of the problems that occur in the development and transfer of technology and the prospects that lay ahead, particularly, for a developing nation like India in the years to come.

Type of Technology Required

Technology is defined as the "Science of Industrial Arts" which means it is a mixture of techniques with which man can change the environment by using the natural resources. The development of technology is essential for industrial growth, which in turn is imperative, if a nation is to raise the standard of living of its people and also keep up, if not advance, its position in the technologically advancing world. The type of technology that is required by the developing nations, therefore, varies widely when compared with that of the advanced countries. Advanced countries need technologies that are labour-saving, cost reducing, sophisticated and efficient. On the other hand most of the developing countries which still have enormous untapped natural resources suffer due to inadequate capital and lack of technical and managerial skills, though they have abundant labour force. Other factors that are peculiar to them are level of social and economic

* The views expressed in this paper are those of the author and do not reflect those of the organisation.

development, size of market, unemployment, climatic conditions, etc. These countries, therefore, need technologies which will match with their capabilities and limitations.

Sources of Technology

The sources of technology for advanced countries are :

(i) R & D institutions of big industrial establishments ;

(ii) Scientific and Industrial research laboratories of the State ; and

(iii) Research laboratories of technical colleges and universities.

Developing countries which do not have a large industrial base have to depend very much on imported technologies for their development. However, countries like India do borrow technology and innovation from the following sources :

(i) The network of national laboratories ;

(ii) Research laboratories of public sector enterprises and government departments like Railways, Defence, P & T, etc.;

(iii) Research and development laboratories of some established industries ;

(iv) Laboratories in IITs and Universities ; and

(v) In a small measure from individuals.

Transfer of Technology

It is said that the generation of world knowledge is doubling itself every 15 years, and therefore, if the world community is to benefiit by this "knowledge explosion", it is essential that the generated knowledge is disseminated quickly. This can be achieved by :

(i) Transfer of technology from the developed to the developing countries ;

(ii) Transfer of technology between developing countries ;

(iii) Transfer of technology within a developing country ; and

(iv) Transfer of technology from a developing country to developed countries.

Though much has been said and written on the ways of transfer of technology, this paper limits itself to study of the transfer of technology within a developing country like India.

Methodology of Transfer

In the above paragraphs, it has already been mentioned about the main sources of technology from which an industry or an entrepreneur can draw their requirements. In a country like India the bulk of the know-how comes from the network of national laboratories, and these are transferred to the industry/entrepreneurs through NRDC of India. The various steps involved in the process of transfer are :

1. Process assignment by CSIR and others to NRDC.
2. Preliminary study of the process by NRDC and collection of additional information, if required.
3. Process evaluation and preparation of feasibility reports—This is done either by the technical staff of NRDC or by engaging consultants, depending upon the work involved and the expertise needed.
4. Publicity through mass media—like newspaper advertisement, seminars, get-togethers, personal contacts, demonstration and circulation of preliminary technical notes.
5. Furnishing of additional information and clarifications, if any, to intending parties.
6. Discussion and finalisation of terms and conditions and issue of formal offer to the party.
7. Initial payment by the party and signing of the agreement.
8. Release of process details and demonstration of process by the laboratory concerned.

An idea regarding the number of processes referred to, and the number of processes transferred by NRDC in the last 5 years for exploitation on a commercial scale is shown below :

Number of Agreements Signed by NRDC in The Last 5 Years for Various Processes

Year	*No. of Agreements Signed*
1970-71	90
1971-72	135
1972-73	200
1973-74	238
1974-75	268

Problems Encountered

As may be seen from the above table, the performance of the NRDC in desseminating technology to industry has been satisfactory. But the transfer, however, has not been without problems. Some such problems encountered are discussed below :

(a) Even though a number of processes are referred to NRDC every year for transmission to industry, quite a number remain unsold despite the best of efforts. This problem arises out of the fact that the problems chosen for research are sometimes different from the practical needs and requirements of industry which gives an impression that they are chosen at random.

(b) Some entrepreneurs who borrow know-how do not have the necessary educational background to understand and assimilate the technology. Even if they do understand the process, they are not able to set up a plant because of their inability to design and engineer the process.

(c) Bulk of the processes available with NRDC for commercialisation are those that are developed only on a laboratory scale or at the most bench scale. Very few processes are backed up by pilot plant work. In some cases, even the pilot plants that are put up are not

pilot plants in the real sense, as the scale up factor required for commercial design based on the data available from them is very high, which makes the plant design very difficult. When such a know-how is offered to industrialists or entrepreneurs, they are rather reluctant to accept it as they fear the process may not be a success on a commercial scale.

(d) Entrepreneurs who approach NRDC for borrowing technical know-how are varied. They include industrialists, technocrats, fresh graduates, retired or retiring army and civil men, and sometimes, men with poor educational background from the rural areas. They expect that the know-how packet offered to them will consist of project report, process details, engineering design, fabrication drawings, tender specifications and even tenders from suppliers of equipments, proposals for erecting and commissioning the plants on a turn-key basis etc. Some of them expect financial particpation either in the form of a grant or a loan. Most of these people are not in a position to appoint engineers or avail the services of engineering consultants to do the scale-up, design, fabricate and erect the plant. Inability of either NRDC or the R & D institutions to give such a process package is one major problem faced while transferring technology.

(e) There is a general feeling among the prospective clients seeking the know-how from NRDC that they should get the process exclusively. They demand that the process should not be given to anybody else, once they sign an agreement with NRDC. This is because they fear that if the know-how is given to a few others, there will be unhealthy competition and they will lose their market. This fear is more predominant in those who borrow the know-how first. Their claim is that being pioneers, they do all the bull work and face the bulk of the problems in translating laboratory process to a commercial scale, whereas the subsequent licensees of NRDC cash upon their experience and expenditure. They argue therefore, that NRDC should not issue any further licenses, or even if it does, they should be given some concession with regard to the premium and royalty that is to be paid for the know-how. But, they forget that in seeking to fulfil their own interests, they are undermining the national interest. They overlook factors such as :

(i) Whether they can meet the entire demand for a particular product?

(ii) What would happen if they do not put up the plant for one reason or the other ?

(f) Another common, probably, genuine expectation from the potential licensees of NRDC, is about the guarantee on the process performance when implemented on a commercial scale. They want a guarantee from NRDC that if the process fails, the expenditure incurred by them will be compensated. While putting up such a stiff demand on NRDC, at least some parties do offer to pay a handsome know-how fee, provided the know-how is offered to them with the necessay guarantees.

(g) There are some who want every kind of assistance like market survey, feasibility reports, process know-how, grant of loan, erection of plant and even sale of the product, from NRDC. There is yet another category which does not want to pay any kind of know-how fee to NRDC. They claim that, as many of the research institutions and NRDC are government bodies, the know-how generated by them should be made available to the citizens free of cost.

(h) Some other factors which come in the way of quick transfer of technology are:

(i) element of imported raw material in the process developed ;

(ii) necessity to have some imported equipments ;

(iii) the pilot plant or laboratory set up has been dismantled, thus making demonstration difficult;

(iv) process still under development and some more work has to be done;

(v) the scientist who developed the process has resigned or gone on long leave or gone abroad.

Thus, there are many problems which do come up from time to time, making the task of the technology selling organisations difficult.

Viable Solutions

Obstacles which come in the way of technology selling organisations

are not unusual while selling "know-how" and they are quite prepared to meet them. In the NRDC of India, some steps have been taken which have proved quite effective. Some of them are discussed in subsequent paragraphs.

(a) A special proforma has been designed by NRDC to collect required information on the process referred to it. Additional information or clarifications are also obtained from the laboratories after studying the basic data furnished. Experienced engineers of the organisation visit the concerned laboratories and then prepare technical appraisals and also summary thereof for preliminary circulation. For large projects or for processes which require special expertise, the services of consultancy organisations are commissioned to evaluate the process developed by a R & D institution, and prepare a feasibility report. In the last one year, about 30 technical appraisals have been prepared by the staff of NRDC. There are quite a few reports prepared by the consultancy organisations. These reports are sold at nominal price to the prospective entrepreneurs. This approach has created a lot of confidence amongst entrepreneurs borrowing know-how from the NRDC because they are now quite sure that the data given to them, particularly, on capital investment, cost of production, etc., are more realistic than before. As the reports are good and at the same time cheap, they need not go again to consultants to get the feasibility reports done.

(b) Another step that the NRDC has taken for the development of indigenous technology is setting up of pilot plants and prototype units. This is being done in collaboration with a user industry so that once the project is a success, the process is immediately taken up for commercial exploitation. The NRDC has so far sanctioned projects worth Rs. 5.9 crores, its own contribution being Rs. 2.9 crores. Several others are in the offing. Some of the successful NRDC projects are :

(i) Lightning arrester
(ii) Integrated protein project
(iii) Pentaerythritol
(iv) Syntans
(v) Infant food
(vi) Pine Oil
(vii) SAN plastics
(viii) Dall Milling, etc.

The salient feature of this scheme is that the money given by the

NRDC for the project is refundable without interest on an agreed basis, only if the project is a success. If the project fails, NRDC writes off the expenditure incurred by it, without claiming refund from the collaborator.

It is not always possible for the NRDC to set up pilot plants for the various processes referred to it. Not only would this need huge grants from the government, but would also be time-consuming. Whereas, for some processes no pilot study would be necessary, for some others the pilot trials could be tried out with the existing facilities. For example, a coating composition to make direct copy paper has been developed and the process is available with NDRC. Instead of waiting for the NRDC to set up a pilot plant for coating the material on paper to produce the direct copy paper, some existing industrialists who are specialising in the manufacture of coated papers should come forward to take the process and make application trials with the coating machines available with them. Such a participation by existing industry, would give a great fillip to the development of indigenous technology in India. If the trials succeed, they will be the beneficiaries and if the process fails they will not lose much. Small loss, if any, could be written off against their R & D expenditure. Strangely, industries in India are reluctant to take the NRDC processes because of the fear that the project would not be a success. As the success of a process depends more upon the person who is borrowing the process than the process itself, it is certain, that if industrialists who have the infrasructure for R & D, come forward to try out the NRDC processes, most of them will prove successful.

(c) It was mentioned earlier that many entrepreneurs in India are not fully equipped to understand the technology and set up commercial plants. They depend very much on the laboratory or the NRDC for engineering and setting up the plant on a turn-key basis. Unfortunately, both the NRDC and the research institutions are not adequately equipped to do the scaling up and put up the plant on a turn-key basis for their clients. However, some effort has been made by the NRDC to offer some processes on a fully engineered basis, availing the services of consultancy organisations. Some examples are :

(i) High speed bicycle gear
(ii) Pentaerythritol
(iii) Chlorates and perchlorates
(iv) Paper from Jute sticks and other agro wastes

(v) Infant food

(vi) Protein isolate

(vii) Caffeine from tea wastes

(viii) Carboxy methyl cellulose

(ix) D.O.P. & D. P.P.

(x) Acetanilide

(xi) Electrolytic Manganese di-oxide, etc.

The NRDC hopes that in future it will be able to do some more on similar lines. If the research institutions can strengthen their engineering sections and give a design package at least for small projects, it will accelerate the pace of transfer of technology. Similarly, existing NRDC licensees who have set up factories could come forward in offering design package through the NRDC for the future licensees.

(d) The desire to take processes on an exclusive basis does not seem to be tenable. In the past, some licenses were being given both on total exclusive basis or zonal exclusive basis. Theoretically, such an arrangement showed some advantages, but in actual practice, this was not achieved. On the contrary, such type of contracting resulted in a number of processes remaining unexploited because the persons who borrowed the know-how on an exclusive basis did not put up the plant for one reason or the other (they could not arrange for finance, or they could not get the raw materials, the market conditions changed, they changed over to some other line of manufacture, or simply they lost interest), thus preventing genuinely interested parties from getting the know-how. As it was clear that granting exculsive licenses does not help either the licensee or the NRDC, a policy decision has been taken not to give exclusive licenses any more. This raises a question, what will be the limit to the number of licenses for any particular know-how ? While in principle there could be no limit, the matter will, however, be reviewed from time to time and the number determined after studying the performance of the earlier licensees the demand for the product, availability of raw materials and other factors.

(e) The demand or expectation by entrepreneurs to obtain the necessary guarantee for the processes sold by the NRDC does not seem to be unjustified. Even when we buy a product from a shop, we ask the shopkeeper whether the quality is good and whether it is durable

which is an indirect form of guarantee that we are asking for. Therefore, as buyers of know-how with the ultimate aim of investing money for setting up a plant one would definitely like to be sure that the process they are opting for would work. But unlike a product which is a finished one and can be seen, the know-how is abstract and is only an ingredient in the production of an ultimate product. So it is extremely difficult, particularly, for a selling organisation like the NRDC to give guarantee for all the processes that it is selling because there are several factors, beyond its control. Perhaps, it could offer guarantee to processes which are already established but not all. If it were to sell processes only with guarantee, then it will have to follow stiff criterion for the selection and acceptance of processes which will not only be time-consuming but would defeat the purpose for which it is set up, viz., transfer of technology. Therefore, a certain amount of calculated risk has to be necessarily taken by entrepreneurs while purchasing the know-how. The entrepreneur need not be unduly concerned over this because, if he is really capable of assimilating the technology and is also capable of bringing in the necessary inputs, the technology would definitely be a succes. And both the NRDC and the research institutions would be with him until he successfully completes the project. In order to reduce the element of risk and infuse more confidence in entrepreneurs, the NRDC (as already pointed out), has devised methods like (i) setting up pilot plants (ii) prior process evaluation, (iii) offering know-how as a package through consultancy organisations, etc. Also, the possibility of the NRDC participation in the risk capital, particularly, for big projects is being seriously thought of.

(f) A good process can become a failure if it falls in wrong hands, whereas, an ordinary process can become a success, if the person taking it has the necessary where withall. This shows the importance of the selection of entrepreneurs before a know-how is offered. Thus some personal data are collected from the entrepreneurs before a particular know-how is offered to them.

A Dig into Future

The future for indigenous technology both in India and abroad is bright. With the present trend in increasing demand for more processes, they

can be sold provided they have relevance to the actual needs of an industry or import substitution or export oriented or has something unique and is of mass consumption.

To create a dent into the foreign market, the NRDC has established many contacts with similar organisations in USA, UK, Japan and other countries. Project profiles prepared by the NRDC are being sent to the foreign agencies periodically, for information and publicity. The processes available with the NRDC (India) are now being advertised by agencies like International Licensing, London in their publication. The participation of the NRDC in the UNIDO conferences and direct visits by their senior staff to the technology selling organisations of the world, the activities of the NRDC of India, and the processes available with it for commercialisation have become known to many outside India. As a result, lot of enquiries are being received, of late, from abroad, seeking information on the processes available with the NRDC, terms for setting up projects on turn-key basis and other technical advice. A sample of technologies which have been sold to foreign parties are :

(i) Suri Transmission - West Germany
(ii) Improvements in or relating to the modification of Aluminium-based alloy—West Germany
(iii) Activated carbon—Philippines
(iv) High draught kiln—Nepal.

Negotiations are under way for the sale of the following technologies:

(i) Dry ready to wet sausage casings—Sweden, UK
(ii) Carboxy methyl cellulose—USA
(iii) Wet heat resistant leathers—USA
(iv) Dioctyl pthalate—Turkey
(v) Arc Carbon for cinematograph projectors—Srilanka.

It is observed here that offers for most of the technologies mentioned above are being sent on a turnkey basis with a tripartite collaboration viz., the NRDC, the licensee of NRDC and an engineering consultancy organisation.

Technology Transfer through International Collaboration in Research and Development

N. P. Singh G. Janaki Ram*

The concept of Technological/Research and Development collaboration between different countries is an old and established one. While technical/financial collaboration amongst industries ensures the flow of established technologies from advanced countries to developing countries, R & D collaboration among them ensures that the financial, manpower and material resources available in different countries are pooled together for development of new technologies and improvement of existing ones for the mutual benefit of the co-operating countries. The realisation of this concept of International R & D collaboration in actual practice is of great significance for developing countries, as they cannot obviously afford huge investments in R & D over prolonged periods. Further, in a country like India, which possesses the third largest pool of scientific and technical manpower in the world, creation of facilities to conduct sophisticated research in this country based on appropriate forms of international R & D tie ups can also help in alleviating the problem of unemployment among scientists and technologists to a certain extent and checking, if not altogether stopping, the much-talked about brain-drain.

In recent years, India has signed agreements for co-operation in the field of science and technology with a number of countries, specially in Europe and the Afro-Asian region, but these agreements between the Governments and the working programmes drawn up thereunder are primarily confined to the formulation and execution of joint programmes, exchange of personnel, etc., between Government-run or controlled industries, institutions and laboratories of the collaborating countries. There thus appears to be some need to evolve a policy instrument for making the benefits of international collaboration available to a large section of scientific community working in other private/public sector industries, research institutes, foundations, etc.

It is generally accepted that industrial Research, Design and Development (RDD) is best done in close proximity to the production lines. With

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this in view, Governments in developing countries have, of late, been encouraging in-house R & D work in the industries. In India, over 200 R & D departments within the industry have so far registered themselves with the Department of Science and Technology for availing of benefits consequent to such registration. Collaboration between such in-house R & D units in one country with similar units in other countries is apparently viable and would deserve to be encouraged for joint and faster development of new technologies by such industries for their mutual benefit. Further, under such an arrangement the new technologies would be 'born' in two or more co-operating countries simultaneously, and thus the problems in the field of transfer of technology as amongst the co-operating industries would be simplified.

Self-Reliance in Research and Development

In its Final Report, (12th February, 1973), the sub-group on Research and Development under the Indo-British Techological Group, sponsored by the then Ministry of Industrial Development with the objective of 'studying ways and means of increasing the self-dependence of Indian companies in research and development while ensuring the maximum benefit from the advances made by foreign collaborators and licensors', has observed as follows :

"6 (A) Steps required to be taken by Indian industry :

(viii) Indian companies with foreign equity often have the advantage of low-cost access to international technology. These companies should make use of this technology which is available to them on *favourable terms* as long as this does not inhibit the indigenous R & D effort. They should be encouraged to make technological contributions to their international group, *thereby assisting in striking a balance between the inflow and outflow of technology.*

(ix) Consideration should be given to the identification and development of R & D collaborations which are mutually beneficial to India and the U.K."

While granting approval to new foreign collaboration cases, Government

has now been imposing a standard condition that the Indian firms should set up adequate R & D facilities for absorption and adaptation of the imported technology and its further improvement. Experience so far has, however, shown that this provision has not been effective in actual practice. The reason is that this provision is self-defeating from the point of view of the Indian Industry which is interested in continuing its tie up with the foreign collaborator for not merely technological but also commercial reasons. Thus, if the Indian company sets up adequate R & D facilities and is successfully able to absorb and adapt the imported technology within the sanctioned period of foreign collaboration, it has no further case for asking for the renewal of the collaboration agreement. On the other hand, if the Indian company does not set up such R & D facilities or merely makes a 'show' of setting up such facilities and is thereby unable to absorb and adapt the imported technology fully, Government would find it difficult to refuse the renewal of the collaboration agreement, as it could lead to the stoppage or loss of production. As a consequence, Indian industries set up initially on the basis of foreign collaboration find not taking up R & D seriously to their 'advantage'. A conflict thus emerges between private interests and the interests of the country (viz. its goal of technological self-reliance). *The search for an alternative way to promote the setting up of in-house R & D facilities by the Indian Companies having foreign collaboration in co-operation with R & D cells of advanced industries in foreign countries (on a commercial basis), where necessary, therefore, appears to be imperative.*

The study of a large number of foreign collaboration cases also shows that the flow of R & D information from foreign companies to their Indian counterparts is relatively un-inhibited (and without any charges) when the foreign equity participation is more than 40 to 50 per cent. On the other hand, when the foreign equity participation is low (generally less than 40%), and in cases of purely technical collaboration, any information regarding the advances made in technology is passed on by the foreign collaborators only on the basis of some definite consideration and not otherwise. However, this method of 40% or higher foreign equity participation for acquiring R & D information may not be the most appropriate method available to indigenous companies for such purposes. Besides, it is doubtful if actual 'production technology' based on such R & D know-how would be made available by the foreign companies without insisting on some additional considerations.

Again, it has been observed that a good number of Indian companies request for extension of foreign collaboration agreements on the ground that such renewals would help them in taking advantage of the latest advances in technology in the concerned field or that the collaboration is required for the manufacture of products having different capacities, ranges, etc. or for manufacturing 'improved' versions of the old products. Such extensions of collaboration agreements have actually been allowed by the Government of India in many cases, on one of these grounds or the other, and usually these involve continuance of royalty payments to the foreign collaborator (albeit at a reduced rate) and perhaps fresh imports of capital goods, payments of lump-sum know-how fee, etc. *This only shows that most foreign companies are constantly having a 'lead' over their Indian counterparts, due to a total absence or lack of the latters' RDD capabilities and—unless the Indian Companies at some stage are prompted, enabled and even compelled to build up their own RDD competence —such continuous dependence on foreign know-how cannot be prevented.*

Keeping this aspect in view, it is strongly felt that renewals of foreign collaboration ageements in the same (or similar) line of products should give place to acceptable forms of R & D tie-ups between the collaborating companies, so as to enable the Indian Companies to

(i) absorb the 'unabsorbed'/'incremental' portions of the foreign technology, if any;

(ii) build up their own R & D capabilities in specified areas, and

(iii) undertake future developments of technology, in cooperation with the foreign collaborators, on *mutually beneficial* terms.

Such RDD collaborations, it is considered, would enable the Indian industry to keep itself abreast of the latest advancements in technology in developed countries on the one hand and minimise out-go of foreign exchange through subsequent *wholesale* imports of technology in the form of capital goods, know-how fee, recurring royalty payments, etc. on the other. This concept of RDD collaboration has been further elaborated in subsequent paragraphs.

Need for Effective Utilisation of R & D Facilities

It will be noticed that special emphasis has been placed on research,

design and development (RDD) deliberately, even though design can be considered to form a part of the development activity. In the Approach Document to the Science & Technology Plan, it has been clearly mentioned that there has not been a determined effort to utilise the capabilites already developed in the country due to the absence of active agencies to promote indigenous technology and that the communication gap between industry and industrial research laboratory remains large. What is implied in the statement is that the process of transfer of technology for industrial purposes by suitable up-scaling of the laboratory results to pilot plant and commercial scale has not gathered enough momentum, primarily, because of lack of application of engineering and design skills. Therefore, in order to complete the innovation chain from concept to commercialisation, design (as also engineering) skills have been indicated as a separate activity.

For purposes of setting up industrial scale plants, design and development collaboration at least is certainly not unknown in India. For designing our steel plants, raw materials in considerable quantities have been sent abroad to our foreign collaborators for testing, for design of process equipment and machinery, e.g. blast furnaces, coke ovens, palletisation, etc. For engineering of cement plants and sizing of machinery also raw materials have been sent to our foreign collaborators. The suggestion to organise international collaboration in applied research is only an extension of the foregoing concept with a view to get basic information and the necessary inputs for design, development and engineering of full-scale plants.

There are certain consultancy organisations and industrial plant suppliers in India who have facilities for doing detailed engineering based on the small scale experimental or pilot plant studies conducted by them. However, there have been occasions when such studies have to be conducted on a larger scale for which these organisations cannot establish their own experimental facilities for obtaining empirical or semi-empirical data for engineering plant or equipment. They have relied on foreign collaborators quite often for generation of such data which is essentially applied research.

Likewise, there can be cases where the necessary input information can be generated in this country but there may be lack of adequate design

and engineering skills for exploitation of information generated for industrial purposes. International collaboration on a limited scale for obtaining basic engineering information upon which the Indian party can do detailed engineering should be welcome in such cases. Such collaborations can promote the use of domestic technology and also eliminate costly mistakes in engineering plants. Apart from this, the Indian industry will be in a stronger position to negotiate agreements for imports of technology or complete plants when they are aware of the precise gaps in knowledge in processes or engineering. This will also prevent repetitive imports of technology from various countries or even from the same organisation in one country by different Indian entrepreneurs.

RDD Collaboration and Transfer of Technology

The Colombo and New Delhi ESCAP Conferences have recognised the problems faced by developing countries in transfer of technology from the developed countries and have recommended the establishment of a Regional Centre for Transfer of Technology for Asia and the preparation of a feasibility report for its establishment. The object of setting up this Centre is to assist all the countries in the Asian region in developing capabilities in transfer of technology, avoidance of repetitive imports of technology and laying down the most suitable methods for transfer of technology from developed to developing countries and vice-versa. This is, in effect, the recognition of the need of this region for international RDD collaboration.

Before proceeding further, it would be appropriate to consider a few examples with reference to India :

A small scale industry located in Maharashtra which is engaged in the manufacture of marine paints and associated products, has been having a Government approved R & D tie-up from 1968 with a Danish firm, a Company of international repute in the same field. The Indian Company does not have any foreign equity participation and it assists the Danish firm in evaluating and improving its products in the tropical climate as well as in the execution of sponsored R & D projects. The personnel working in the Research and Development Laboratories of the Indian Company are all Indian Scientists/Engineers and the foreign

Company meets the entire cost of the collaborative R & D Projects. Both the Indian party and the foreign 'collaborator' are *free* to exploit the results of such joint research projects commercially anywhere in the world. The Indian party is not required to pay any royalty, etc., to the foreign company for such commercial exploitation.

Another Indian firm located in Haryana has recently proposed to enter into an R & D agreement with a well-known French concern to develop technology for the manufacture of Tri-oxane and Polyacetal Resins, starting with formaldehyde as a base. Stated briefly, the arrangement envisaged is that the existing process and experimental data in possession of the two firms are to be pooled up, pilot plant trials are then to be conducted (at Indian firm's cost) in India and the designs are to be checked and the quality of end products tested in France at the foreign Company's cost. The process to be finally developed would be a 'joint' process and the ownership of patents to be obtained in India, France and other countries would be 'joint and equal'. All commercial rights, including those for the sale of technology to third parties, would for the duration of the agreement (10 years or duration of the patents, whichever period is longer) vest in the Indian Company within India and in French Company within France and all other countries. Both the Indian and French firms would be *free* to exploit the process by themselves (or through their subsidiaries) anywhere in India and the rest of the world respectively, without having to pay any fee to the other side. For sale of technology to third parties by either side, however, the benefits would be shared by both sides on a 50 : 50 basis. The phrase 'benefits' would, for this purpose, be taken to mean 'Gross receipts minus promotional expenses of the selling party, which should not exceed 10% of the receipts'. After the expiry of the agreement, either side would be free to exploit the process anywhere in the world.

Recently, the Government of India have approved a case of tie-up between an Indian Company (located in Madras) and a well-known British firm, mainly to enable the Indian Company to obtain assistance from the foreign collaborators for establishing a suitable research and development base in India. The Indian Company has had approved licensing-cum-financial collaboration arrangements with the British Company for the manufacture of brake linings and clutch facings. The extension of this collaboration had now been allowed on the ground mentioned above, for another period of 5 years, on the basis of 0.5%

royalty on internal sales and 5% royalty on exports (both subject to Indian taxes), along with enhanced foreign equity participation. It has been hoped that with adequate R & D base, the Indian party would be in a position to offer some competition to an existing foreign majority company, which has been operating in this field in the country.

Of late, a number of progressive industrial groups have also approached the Government of India to permit R & D tie-ups between certain Indian industries and industries/research institutes in some of the developed countries with a view to enable them to develop their R & D capabilities and catch up with the technological developments taking place in the industrially advanced nations. The ultimate objective, of course, is the building up of technological self-reliance, so that continuous dependence on foreign know-how may be avoided and India may become a net exporter of technology in the world technology market.

Some of the contingencies in which the suggested international R & D collaborations amongst industries may be of considerable relevance and utility in the Indian context would seem to be as follows :

(i) If we wish to have a global market for the products of our technology, R & D collaboration between industries in different countries cannot perhaps be avoided. This would specially apply to areas of various sophisticated technologies and products, which a country like India might wish to develop with an eye on the export market.

(ii) Where a foreign company wishes to sponsor R & D problems in an Indian Company/R & D Laboratory and the cost of such research projects is met through inward remittance of foreign exchange, there should be no serious objection to such an arrangement. In fact, this would further help in providing gainful employment to many of our scientists/ engineers.

(iii) Likewise, when adequate facilities for certain highly specialised kinds of research and/or development work are not available in India or where the setting up of such facilities is likely to require investment of considerable resources and time, there can perhaps be no objection in letting an Indian firm sponsor such R & D problems in a foreign concern/R & D Establishment, subject to appropriate payments. The main aspects to be considered in such cases should be whether the

R & D problems in question are of relevance to the Indian scene and whether a little out-go of foreign exchange at this juncture would have the potentiality to save a much larger out-go at a later stage on account of whole-sale import of technology.

(iv) An international R & D tie-up can also be of considerable help to an indigenous company, which is planning to develop a certain technology anew, when the development of that technology in another country is already known to be in a much advanced stage. Looking forward to the need for optimum utilisation of our scarce resources, to avoid rediscovering what has already been discovered abroad, and in order to ensure that we do not perpetually lag behind in the field of development of new technologies, it would seem worthwhile to permit the indigenous company/entrepreneur to identify and bridge the initial technology-gap through 'imports' and then get going on his own from that stage onwards. Alternatively, a continuing R & D collaborative arrangement between the two companies can also be envisaged, so as to ensure a continuous exchange of ideas, information, etc., on new developments. In the latter case, however, it will have to be ensured that both the 'partners' in 'joint' projects share the industrial property rights which would eventually accrue on a just and equitable basis.

Outright R & D payments by subsidiaries of foreign companies to their principals should not, however, be permitted, as this arrangement would serve as a disincentive for the building up of indigenous R & D capabilities.

A stage thus seems to have come when the Indian industries, specially those in the established lines of manufacture, will have to be asked and even prompted to shift from the concept of licensing arrangements and financial collaborations to co-operation in research and development. The objectives of such R & D collaborations, as stated earlier, should be the development of new or improved technologies in the desired areas at minimum cost, through deployment of our own scientific and technical manpower in as short a time as possible and also to build up our technological capabilities and to lessen the out-go foreign exchange from the country through wholesale imports of technology in the form of capital goods payment of know-how fees, royalties, etc.

In the light of the above, it would appear worthwhile for the Government

to consider formulation of suitable guidelines (listed below) for the benefit of the Indian industries that might wish to pursue R & D programmes in collaboration with foreign companies or research laboratories as the case may be.

(a) The Indian Industry should have adequate competence in the area in which it wants R & D tie-up with a foreign party, so that it can derive fullest possible advantage from such an arrangement. One could thus insist that a pre-requisite for giving permission for any international R & D collaboration would be the establishment of proper in-house R & D facilities by the Indian industry to the satisfaction of Government.

(b) While there can, in general, be no objection to an indigenous company undertaking R & D work sponsored with it by a foreign party (subject, of course, to Govenment approval), the Indian industry should also be permitted to farm out well-defined R & D problems, specially in newly emerging and sophisticated fields, for solution by a foreign company or R & D laboratory in appropriate cases.

(c) Before any research problems are allowed to be farmed out to a foreign concern/R & D set up, the concerned agency or authority should be satisfied that solutions to such problems cannot be offered within the country at a reasonable cost and within a reasonable time.

(d) R & D contributions by subsidiaries of foreign companies in India to their principals should not be allowed, except within the strict framework of the guidelines for R & D collaboration to be laid down by Government.

(e) The industries/institutions participating in an international R & D venture should generally keep themselves free to exploit the results of research in their respective countries, while exploitation in third countries could be subject to mutually agreed terms and conditions.

(f) Such collaboration agreements must preferably be on a project by project basis and no omnibus across the board R & D hook-ups need generally be allowed.

(g) All international R & D collaborations amongst industries should be based on the principle of co-operation for mutual benefit and optimal

utilisation of manpower and material resources at both the ends for the achievement of their (common) objectives.

Conclusion

While international R & D collaborative programmes on industry to industry basis executed in a spirit of mutual benefit and co-operation can effectively dispense with the need for continued or repetitive imports of technology in various fields, specially by the developing countries, there is also the possibility of misuse of these by interested companies. Possibilities exist for uncontemplated payments under the guise of R & D collaboration. It is possible, for instance, for a branch of a multinational corporation or a foreign majority company, in the guise of R & D collaboration, to try to use the scienfitic and technical manpower in developing countries as cheap labour to serve the ends of its parent organisation, without enabling the countries in which such industries are located to derive any real benefit from the collaborative programmes. Some companies may not be keen about the success of our collaborative R & D programmes to favour the desire of their subsidiaries/associated companies for exploitation elsewhere. Many foreign majority companies already functioning in the developing countries, while intensifying their & D activities through international R & D tie-ups, may later come up with requests for expansion of their activities in such countries on the basis of claims for indigenous technology. International R & D tie-ups may also open up one more channel for possible entry of multinational corporations into the economy of the developing countries. Unless adequate safeguards are provided, industries which do not already have a reasonably strong R & D base, and the countries in which they are located, cannot hope to derive, from international co-operation in research and development, all the benefits which may accrue to them in the normal course.

If, on the other hand, international R & D collaborative programmes are evolved and executed by industries in the right spirit, it should be possible to find solutions to many complex technological problems faced by mankind at minimal costs and within much shorter time spans than might otherwise be possible. Perhaps, there is need for further thinking on the subject.

Transfer of Technology from R & D Laboratories to Industry in a Developing Country

M. S. Virdi

The subject of technology transfer has aroused much interest in the recent past, as our dependence on advanced countries for technology and technical know-how is on the increase. On the other hand, the technological gap between the advanced countries and developing countries is widening with the pace of time. It is this problem which needs serious thinking and ways and means have to be found out so as to achieve self-reliance with the indigenous know-how. Some views have been expressed in this paper to facilitate development and utilisation of indigenous technologies.

Project Identification

Before any project is initiated, it is essential to prepare a complete plan of the project. In many advanced countries, expenditure upto 5% is spent on the technical and economic feasibility studies. Applied Research and Developmental projects can always be planned since the objective is known. The success in a developing country like India is more guaranteed since similar work has already been done elsewhere in the world. It is suggested that as much as six months should be spent by the scientists on the programming and feasibility studies The programme should include, status of the technology in the world, marketability, phase out of the tasks to be carried out giving the time targets, requirements of resources at various time intervals in terms of staff, equipment, pilot plant and testing facilities, space, year-wise budget, products which will be developed with targets, etc. The programme may be put to a committee of experts for discussions. After the project is well conceived and scrutinized the complete facilities and budget asked for should be provided and periodically the project could be reviewed to evaluate the progress. Though few projects may be taken up but they should be provided full financial support. It is not possible to introduce accountability unless the resources asked for are fully provided.

Identification of User

It is true that all the laboratory findings are transferable. The technology transfer becomes easier if the project has been taken up after identifying the user and need for it. Sometimes, it has been found that the need has not been assessed and the user is unknown. In many cases the know-how is passed on to persons of the industry who do not have the ability to grasp the sophistication involved and it becomes very difficult to start the production or maintain the proper quality control. Chances of success of technology transfer from research laboratory to industry are higher if the project is well identified. It is advisable to associate the user at an early stage. If the persons or the users are associated from the beginning or at a later stage depending upon the sophistication involved, the transfer process becomes comparatively easier.

In the case of sponsored projects accepted by the CSIR laboratories, there is advantage because the user is known even before the project is started. Their personnel can be associated at the appropriate stage in the development process so that when they go back to industry they can set up the production facilities and start the manufacture.

Market Analysis

One of the difficulties in technology transfer is lack of sufficient marketing data. In many of the cases it is not known as to what will be the demand of the product produced in the country. An entrepreneur who has to invest his money would like to have the demand pattern so as to decide whether he should take up this product or he may like to evaluate comparatively with other products. In fact, the exact demand of a particular product should be known when the developmental project is initiated. In many of the cases it may be found that there is not sufficient demand for a particular product after its development. This leads to infructuous expenditure on R & D. In such cases it is better to import the product. But sometimes, the demand is generated with the indigenous availability of a particular product or an instrument although its import figures may be meagre to justify undertaking of its development. To cite an example, in the case of Electrostatic Photocopying Machines, its demand used to be a few units per year because

of foreign exchange difficulties and exhorbitant price which only large business houses could afford. Now its demand has increased manifold due to its indigenous availability and low cost. Many a time, demand has to be created for a new product which is not prevalent. Accordingly, an import statistics alone does not help in arriving at a conclusion. It is very essential to set up a market analysis group which may prove very helpful in deciding whether a project should be undertaken, and after the work is successfully completed it may provide data to industry on its demand and likely consumers. This would certainly help in the utilisation of indigenously developed products.

Feasibility Studies

Another problem is the preparation of the feasibility report. Whenever a project is completed, it is very essential to prepare a feasibility report. The entrepreneur desires to know the availability of raw materials, machinery demand pattern, cost-benefit analysis or discounted cash flow, etc., before he decides to risk his capital. The banks also desire to have feasibility reports for evaluating the proposals which they would finance. At present facilities have not been geared at many laboratories/institutes to prepare the feasibility reports and such work is entrusted to firms of consultants for the major projects. The feasibility reports should be prepared for all the completed projects and a cell should be established in every laboratory for conducting market surveys and preparation of feasibility studies.

Role of Consultants

In most of the cases, the processes are developed in the laboratories on a micro level. There exists a wide gap between the process developed in the laboratory and the production process. The gap could be bridged if the design and production engineers are associated to upscale the process. A firm of consultants could be associated who have the experience in the design and fabrication of machinery and plant in that particular field. Choice of consultants should be made after looking carefully into their past achievements, qualifications of staff working with them and field of activity. In order to ensure better technology transfer, it is essential to associate engineering

consultants to carry out the design and production engineering of the pilot plants, demonstration plants, industrial units or prototype fabrications based on the indigenous know-how developed in the research laboratory. In order to build up engineering and design capabilities in the laboratories it is proposed that a design and engineering consultancy cell should be set up in each laboratory/institute. In addition to the catering to the needs of the laboratory it could render consultancy services to industry in association with the scientists within the scope of the laboratory.

Another problem of technology transfer is lack of technical competence and capacity of the industry to adopt the technology developed. Whenever know-how is transferred to the industry, training is provided to their personnel for pilot plant study of the process or making prototypes etc., in addition to know-how manual. Even after the personnel of the firm are trained, it becomes difficult for them to successfully start the production and there is every possibility that the process remains unutilised. It is suggested that industry should gear up its capacity to absorb the indigenous technology as and when developed.

The CSIR has approved a scheme wherein scientists associated with development of the process could be deputed for six months to work at the premises of the industry (licencees) to set up plants, offshoot their production problems and establish quality control. Recently, NPL scientists have visited the plants of the licencees and have helped them to start production. The point emphasized here is that the system will not only be useful to industries, but scientists would also be benefited. They would learn from practical experience the problems faced on the shop floor, which can be dealt with more effectively when they develop another product in the laboratory.

Import of Appropriate Technology

One of the major obstacles in the growth of indigenous technology is the import of technology when indigenous technology has been developed already or it is under development. It has been observed where foreign technology has been imported on one pretext or the other, when the proven indigenous technology is available and the Indian firms are producing the material for the past several years on the ground that

major share of the production will be exported while the remaining share will be consumed in the domestic market. In such ventures the production capacity is so large that the component of production for domestic market itself becomes larger than the production capacity of small units utilising the indigenous know-how. This mars the interests of these manufacturers because of reputed trade names of their competitors. It is suggested that whenever licenses are granted to boost the exports, 100% of their production capacity should be exported. The Government should not import the technology wherein substantial effort is being put. There has to be inter-relationship between the policies for the import of technology and those of its indigenous development. It should be decided at the national level as to what technologies should be imported and what technologies should be developed indigenously. For instance, the foreign know-how has been permitted when the ferrite products developed by the NPL are being produced for the past several years. In fact, the NPL has been the pioneer to set up ferrite industry in the country. Such import of technologies creates problems in the transfer of laboratory know-how. It is not dearth of talent in the country, but only mobilisation of resources and collaborative efforts between scientists and technologists which is necessary for developing indigenous know-how.

In conclusion, it is suggested that entrepreneurs, who agree to help the development and utilisation of indigenous know-how, should be encouraged by giving of incentives in return for the risk taken by them. The incentive could be providing partly risk capital, performance guarantees, preferential treatment in import of essential capital equipment and raw materials, loans by financial institutions at concessional terms, etc. The indigenous technology could be better utilised by adopting such measures.

Transnational Corporations, Trade and Development

Thomas Ganiatsos*

The unprecedented spread of transnational corporations[1] in the last twenty-five years is altering traditional relationships in the world economy. In the following pages an attempt is made to review some recent evidence of the extent and importance of their activities in developing economies, to analyze those of their features that may condition their economic impact in those countries and to consider how their operations have affected the balance of payments.

Scope and Importance in Developing Countries

The inflow of private foreign direct investment to developing countries came to $3.2 billion in 1970 and $5.8 billion in 1973, representing nearly 28 percent of the total flow of financial resources that they received from developed market economy countries and multilateral institutions in the latter year.[2] The accumulated stock of foreign investment has been unevenly distributed both among regions and between countries within regions, as can be seen from Table 1. Although Latin America has been receiving a declining share of the total flow, manufacturing investment there was $71 per capita compared to $51 per capita in West Asia, $5 in South and East Asia and $22 in Africa.

Approximately a third of the accumulated direct investment in developing countries has been in petroleum and almost one half in the extractive sector as a whole. Manufacturing accounts for 30 percent of the total

* The views expressed in this paper do not necessarily reflect those of the UNCTAD secretariat.

1 The term "transnational" throughout this paper is used to refer to any corporation producing output in more than one country.

2 Calculated from Organization for Economic Cooperation and Development, *Development Cooperation 1974, Review*, Paris, November, 1974. The above figures exclude Southern European countries.

Thomas Ganiatsos

over 200 of them have sales in excess of $1 billion.

The technological prowess of transnational enterprises is impressive. In the United States they account for 52 percent of total private expenditures on research and development, of which only 6 percent occurs overseas.[9] Of the $2,760 million in overseas receipts of royalties and fees for the transfer of technology by United States firms in 1972, it is estimated that between 85 to 90 percent went to transnational corporations.[10] Moreover, three-quarters of the above sum came from affiliated firms, confirming the view that the inherent loss of control over licensed technology makes large firms unwilling to license technology to unaffiliated firms except where foreign regulations or market conditions make export or investment unattractive or impossible.

The internationalization of production, resulting from overseas investment, does not in any way appear to have been diminishing the role of transnational enterprises in world trade. Together with their majority-owned affiliates, United States parent companies' share of all world exports and world manufacturing exports was about one quarter ($73 billion) and one fifth ($39 billion), respectively in 1970, having increased slightly from 1966.[11] For the United States alone they accounted for about 62 percent of manufactured exports and 34 percent of manufactured imports in 1970.[12] Of even greater significance is the fact that out of total United States transnational corporation-related exports, almost half were intra-company exports.[13]

The concentration of a substantial portion of world trade in the hands of a small number of transnational enterprises brings into question the

9. But the figure of 52 percent becomes 80 percent if the highly research oriented aerospace and electronics industries in which TNC, are less important are excluded. Committee on Finance, United States Senate, *Implications of Multinational Firms for World Trade and Investment and for U.S. Trade and Labour,* United States Government Printing Office, Washington, 1973, p. 557.

10. *Ibid.*, p. 600 and United States Department of Commerce, *Survey of Current Business*, December 1973, p. 14.

11. Committee on Finance, United States Senate, *op. cit.* pp. 279-280.

12. *Ibid.* p. 322. A related estimate for the United Kingdom in 1966 indicates that 22 percent of that country's exports were accounted for by intra-firm sales. *Board of Trade Journal,* August 16, 1968.

13. Committee on Finance, United States Senate, *op. cit.* p. 319

relevance of traditional trade theory which is based on the assumption of competitive market determination of values. This is particularly true for that part of trade which is intra-firm trade and which "depends only indirectly on market demand, and can respond rather quickly to command decisions about sourcing and supply to customers that TNC managements may choose to make."[14]

Paralleling the growing concentration of transnational corporations in the world economy is a trend toward consolidation of internal decision-making authority within a hierarchical structure which delegates day-to-day matters to a periphery of operating subsidiaries, coordinative functions to a middle layer of regional or continental divisions and high-level global strategy to the board rooms of the parent companies situated in the principal financial centres, New York, London, Tokyo, Paris, Frankfurt, etc.[15] Implied in the increased centralization of decision-making is a unified approach to the management of the corporation's financial resources so as to maximize over-all profits. Central to this strategy is a system of accounting and money management which allocates expenses and revenues and raises funds over different parts of the organization in such a way as to minimize its over-all exposure to the risks of currency fluctuations, high taxes, credit restrictions, political instability and undesired dividend payments.[16] The greater the importance of interaffiliate exchanges of goods and services in the total volume of trade, the greater the rationale for such an approach.

Distribution of Benefits

It is clear from the preceding discussion that there does not exist an atomistic market setting in the international economy such that maximiza-

14. *Ibid.* p. 314. For a detailed discussion of these issues, see S. Lall, "Transfer-Pricing by Multinational Manufacturing Firms," *Oxford Bulletin of Economics and Statistics,* August 1973, pp. 173-195.

15. One cannot dismiss *a priori* the possibility, based on location theory, that the next ten or twenty years may witness a scenario in which the entire non-socialist part of the world economy is organized along such a pattern and managed from these centres by an exclusive, highly-paid corporate elite. See testimony of Stephen Hymer in *Summary of the Hearings Before the Group of Eminent Persons to Study the Impact of Multinational Corporations on Development and on International Relations,* (United Nations Publication, Sales No. E.74.II.A.9).

16. For a detailed discussion of operating policies regarding control and finance in United States-based transnationals, see S. M. Robbins and R. B. Stobaugh, *Money in the Multinational Enterprise : A Study of Financial Policy,* Basic Books, New York, 1973.

The results of this and similar aggregate studies are difficult to interpret because of the complexity of assumptions required. However, they do show that the terms and conditions under which collaboration with transnational corporations is accepted or invited need to be carefully scrutinized in developing countries in conjunction with consideration of alternatives to such collaboration. A number of practices by transnational corporations tend to reduce the size of balance of payments benefits as well as the contribution (if any) to economic development.

First, despite their considerable control over financial assets, there is a well known tendency for transnationals, particularly, in the manufacturing sector, to rely on sources outside of the home country for their financial needs (85 per cent in the case of United States firms). A substantial part of this financing comes out of local borrowing and internally generated funds (via depreciation and retained earnings) of the overseas affiliates, thus limiting the foreign savings contribution and possibly diminishing the financial resources available to productive local enterprise.[22]

Secondly, the arrangements for the transfer of technology by these corporations to developing countries—either through their own affiliates or through foreign businesses, frequently include restrictions on exports and the requirement that imported intermediates and other inputs be purchased from the parent or technology-supplying firm. In a recent study analysing 2,640 contracts for the transfer of technology in 12 countries, the incidence of such restrictions was shown to be quite significant, though their presence tended to be somewhat lower in countries having taken measures to control them.[23]

The existence of restrictive practices need not be formalised in written contracts. Informal arrangements between parent firms and the

22 See Committee on Finance, United States Senate, *op. cit,* p. 38 and *Review of International Trade and Development 1973, op. cit,* Chapter 3.

23 The percentages of sampled contracts in which export restrictions were found for various dates during the sixties were as follows :

Argentina 28%, Bolivia 83%, Chile 90%, Colombia 79%, Ecuador 75%, Ethiopia 71%. India 43%, and 47% (2 dates), Israel 11% and 67% (2 dates), Mexico 97%, Peru 99%, Philippines 32% and Spain 38%.

The incidence of tie-in restrictions (not separately shown but grouped together with limitations on output) ranged from 5 percent in Spain to 86 percent in Ethiopia. Summarized in 'The Role of the patent system in the transfer of technology to developing countries.' TD/B/AC.11/9), p. 49.

subsidiaries they control may achieve the same results. These arrangements are partly reflected in the significant volume of trade with overseas affiliates noted previously. Whether the trade is with affiliated firms or tied to the purchase of technology by unaffiliated firms, it provides a powerful instrument to the transnational corporation for extracting concealed monopoly profits from the developing country. Transfer pricing, therefore, is a *third* way in which balance of payments benefits may be depressed—either through over-charging for imported machinery and intermediates or through under-pricing of exports. Systematic data on the extent of this practice is still lacking. However, price comparisons for a limited number of product groups that have been made in Colombia, Chile, Ethiopia, Ecuador, Ghana, Iran, Peru and Spain show overpricing on some items to be as high as 300 percent.[24] Stated rates of return on direct investment, though commonly reported to be lower in developing than in developed countries, greatly understate actual rates of return for some companies.[25]

Although there are many reasons why a firm will engage in overpricing of imported intermediates and capital goods, the necessary condition for this to occur has been the establishment of tariff structures in some developing countries which provide high levels of effective protection to finished goods and correspondingly high potential monopolistic rates of return. Criticisms of this policy (as well as of the interrelated policy of generous tax holidays) imply that the foreign investor faces a given predetermined tariff structure, and in so far as this has attracted import-substituting foreign investments with adverse effects on the balance of payments, the developing countries have themselves to blame. To some extent, however, tariffs are a variable rather than a datum to the foreign

24 See 'Policies relating to technology of the countries of the Andean Pact, their foundations; A study by the Junta del Acuerdo de Cartagena,' (TD/107) 29 December 1971, pp. 16-17; TD/B/AC. 11/21, *op. cit,* pp. 56-59; 'Major issues arising from the transfer of technology: A case study of Spain' (TD/B/AC. 11/17), p. 51; Ghassen Salehkhou, *Commercialization of Technology in Developing Countries: Transfer of Pharmaceutical Technology to Iran,* Ph.D dissertation, New School for Social Research, New York, April 1974, pp. 192-211; and *Tax Treaties Between Developed and Developing Countries, Fourth Report,* (United Nations Publication, Sales No. E. 73, XVI) p. 143.

25. A calculation of declared profits plus royalty payments for 13 foreign-owned Colombian manufactuting firms averaged 13.1 percent of net worth for the years 1966-1970 compared with 52 percent when over-pricing on initial-firm imports was taken into account. Daniel Chudnovsky, *Foreign Manufacturing firms' behaviour in Colombia: A study of the influences of technology, advertising and financing upon profitability 1966-70,* Ph.D dissertation, Oxford University, 1973 cited in Keith Griffin, 'The International Transmission of Inequality,' *World Development,* March 1974, p. 14.

investor—a variable whose value is fixed during the course of bargaining and negotiations between the foreign enterprise and the host government. In these circumstances, the more powerful participant—typically the foreign investor, is able to influence the outcome in his favour.[26]

While there is less information available on the extent to which transfer pricing takes the form of undervaluation of the subsidiary's exports to its parent, the potential loss to developing countries in foreign exchange—particularly in industries based on the processing of primary products or in the assembly of manufactured goods within a vertically-integrated corporate structure, may be quite large and needs to be investigated. A recent case in Ethiopia came to the attention of the government only after a foreign-owned company wanted to expand its operations in the wake of a decade of losses amounting to nearly 14 times the original equity contribution. "The losses appeared improbable for the additional reason that the price of the commodity in question had shown a steady upward trend in the world market. Accordingly, a study was undertaken which showed that on conservative assumptions, the company was undervaluing its exports by 150 percent."[27] This type of practice may also be prejudicial to the country of the parent company by permitting evasion of tariffs. In the United States it led to an increase of $2.5 million in fiscal-1974 in the budget of the fraud unit of the Customs Service.[28] Unfortunately, few developing country governments have either the resources or the trained manpower to undertake comparable surveillance.

Because of the extensive control that transnational corporations exercise over world manufacturing markets, it is sometimes felt that association with them represents an avenue for export expansion. Indeed, limited

26 In Ethiopia it has been reported that '..... tariff guarantees constituted an integral part of the majority of agreements involving direct foreign investment; in some cases the investment and the technology transfer were made conditional upon such guarantees. Moreover, in the determination of tariff rates the Government has tended to rely heavily on data provided by the foreign firm itself.' (TD/B/AC/.11/21), *op. cit.* p. 20. See also International Labour Organization, *Employment Incomes and Equality : A Strategy for Increasing Employment in Kenya.* Geneva 1972, p. 439.

27 TD/B/AC. 11/21m *ibid.*, p. 57. Other instances in the same country are also cited in this study. Similar practices have been reported in Ghana, pertaining to a subsidiary exporting cocoa for processing to its parent in *Tax Treaties Between Developed and Developing Countries, op. cit.*, p. 112; and in Mexico and Singapore pertaining to intrafirm manufacturing exports, as reported by G.C. Hill, 'Customs Service Hits Multinational Firm for Export Violations : the Mexican Connection,' *Wall Street Journal,* November 6, 1974, p. 1.

28 G.C. Hill, *op. cit*, p. 1.

information on their export performance in developing countries does appear to indicate that although the exports of foreign-owned companies have been low in relation to their total sales, these exports do appear to account for a significant and growing proportion of total developing country exports of manufactured goods.[29] However, it has also been observed that for the most part the products exported have either involved light processing of local raw materials or the assembly of imported components.[30] Hence, in value-added terms the role of transnational firms in exports manufactures need not be more important than that of locally-owned firms.

A recent econometric analysis of 257 firms in Latin American countries provides further insight into the export behaviour of transnational corporations.[31] The results showed that firms with 90 per cent or more foreign equity exported substantially more to Latin America (but not to the rest of the world) than other firms but that there was no significant difference between joint ventures (defined as 10 to 90 per cent foreign-owned) and firms that were 90 percent or more domestically-owned. More importantly, the study indicated that firms selling predominantly to other units of the same parent company exported substantially less on the average to Latin American countries than firms exporting predominantly to unrelated buyers, and that the exports to the rest of the world of the two sets of firms did not differ significantly.[32] These results add further weight to the suspicion that the growing share of world trade between related affiliates of transnational corporations may be adversely affecting the balance of payments of developing countries.

Summary and Conclusions

The inflow of private foreign investment to developing countries rose to

29 *Review of International Trade and Development 1973,* ch. 3, *op. cit.,*

30 *Ibid.* See also B. I. Cohen, "Comparative Behaviour of Foreign and Domestic Firms," *The Review of Economics and Statistics,* May 1973, pp. 190-197, for an analysis based on South Korean firms.

31 The sample, drawn from Argentina, Brazil, Ecuador, Mexico, Paraguay, Peru, Uruguay and Venezuela, accounted for 25 per cent of the total exports of these countries combined in the period 1965-69. R. Muller and R. D. Morgenstern, 'Multinational Corporations and Balance of Payments Impacts in LDCs : An Econometric Analysis of Export Behaviour," *Kyklos,* Vol. XXVII, Fasc. 2, 1974, pp. 305-321.

32 The methodology, which is explained in the study, explicitly allowed for the effects of other variables including total sales, country of export origin, industry and productivity.

$ 5.8 billion in 1973, or nearly 28 per cent of all financial resource flows received from developed market economy countries and multilateral institutions. The political environment for transnational corporations in developing countries is influenced by the fact that one or two source countries typically account for half or more of the total stock of capital in each developing country. Because of the small, fragmented markets in these countries, it is not uncommon to observe whole industries in the manufacturing sector dominated by foreign capital. Adding to the concentration of foreign ownership is a persisting tendency by transnational firms to prefer majority or 100 per cent control and to enter a market by acquiring existing local enterprises rather than by creating new ones.

The awesome implications of the transnational corporations, both in terms of their importance in the world economy and in terms of their relations with developing countries, are partly reflected in statistics showing that some 200 of them have annual sales exceeding $1 billion. It is also seen in the oligopolistic markets in which they operate, in the relatively small number of such enterprises that are able to supply or control the lion's share of direct foreign investment and technology, in their considerable share of world trade, much of which is intrafirm and does not go through the market, and in their increasingly global perspective brought about by a hierarchical internal decision-making structure.

In the setting described above there exists no invisible hand of competition to insure that maximisation of global rates of return by the transnational corporation approximates to maximisation of the welfare of the countries in which they operate. Scattered evidence both on the over-all impact and on balance of payments effects of foreign investment increasingly suggests that these are often negative for the host country. At least three types of practices by transnational corporations tend to diminish their contribution to the balance of payment receipts of developing countries. These include the tendency to rely on sources of finance within the host country, the imposition of formal and informal restrictions on exports and sources of supply for their affiliates and independent licensees, and the over-pricing of exports to or under-pricing of imports from these enterprises.

Because of the extensive control that transnational corporations exercise over world manufacturing markets, it is sometimes felt that association

with them represents an avenue for export expansion. While this may be true in particular cases, the existence of export restrictions and under-pricing of exports mentioned in the preceding paragraph would certainly suggest that alternatives to such association should be given first priority. This conclusion is also strengthened by evidence of the low value-added of exports going through such channels and by the results of a recent econometric study of the comparative behaviour of a sample of 257 firms from eight Latin American countries, accounting for 25 per cent of the manufactured exports of those countries.

While this chapter has mainly considered the balance of payments effects of transnational corporations, it is clear that their impact spans virtually all areas of economic and social development. It is not surprising, therefore, that the Programme of Action on the establishment of a New International Economic Order addresses the problems which they pose in at least three sections dealing, respectively, with "Transfer of Technology", "Regulation and Control over the Activities of Transnational Corporations" and "Assistance in the Exercise of Permanent Sovereignty of States over Natural Resources". A variety of measures are envisaged. However, they all can be said to share the same two-fold objective : an improvement of the ability of each developing country to bargain effectively with transnational corporations on at least an equal footing and to pursue, if it wishes, national development policies involving alternatives to the transnational corporation.

Concrete action has already begun or is under way at various levels. It includes *inter alia :* at the national level, the steps taken by oil-producing countries and by some copper-producing countries to gain an increased share of the income derived from their natural resources and the enactment by Mexico and Argentina of new legislation regulating foreign investment and the transfer of technology ; at the regional level, Resolution 24 of the Junta del Acuerdo de Cartagena setting forth a common treatment for foreign capital, trade marks, patents, licensing agreements and royalties ; and at the international level, the possible adoption of a code of conduct on the transfer of technology, the possible revision of the international patent system, and the establishment of a permanent machinery to deal with transnational corporations within the United Nations framework.

Table 1 : Distribution of stock of foreign direct investment by DAC countries in developing countries, 1972

Regions, countries and territories[1]	*Stock of foreign capital end-1972*		*Foreign capital per capita US dollars*	*Present share in foreign capital by main investor country, 1967*
	US dollars (million)	*Percentage of area total %*		
1	2	3	4	5
Total, All Areas	48126	100.0	25	US. 50.4
Latin America	25835	100.0	92	US. 63.8
Brazil	6150	23.8	62	US. 35.6
Venezuela	3700	14.3	337	US. 73.1
Mexico	2650	10.3	51	US. 76.4
Argentina	2300	8.9	96	US. 55.8
British West Indies[2]	1800	7.0	1765	US. 42.2
Panama	1650	6.4	1086	US. 90.8
Jamaica	1100	4.3	573	US. 70.7
Trinidad and Tobago	1100	4.3	1048	US. 75.8
Colombia	910	3.5	40	US. 86.2
Peru	880	3.4	61	US. 84.4
Nerherlands Antilles	800	3.1	3478	US. 36.2
Chile	765	3.0	76	US. 91.3
Ecuador	350	1.4	54	US. 58.5
Dominican Republic	315	1.2	73	US. 81.1
Honduras	200	0.8	74	US. 97.7
Guatemala	190	0.7	35	US. 84.4
Costa Rica	185	0.7	101	US. 89.3
Guyana	135	0.5	180	Canada 41.0
Surinam	120	0.5	286	US. 56.7
El Salvador	100	0.4	27	US. 58.1
Nicaragua	85	0.3	43	US. 63.9
Uruguay	80	0.3	27	US. 71.5
Bolivia	75	0.3	14	US. 82.9
Haiti	55	0.2	11	US. 56.6
Belize	50	0.2	385	UK. 70.2
Paraguay	45	0.2	17	US. 57.6
French Antilles[3]	35	0.1	51	France 71.7
French Guiana	10	0.0	167	France 100.0

(*Table 1 Contd.*)

1	2	3	4	5
Africa	9404	100.0	28	UK. 30.0
Nigeria	2100	22.3	36	UK. 53.8
Libya	1560	16.6	78000	US. 77.7
Zaire	620	6.6	27	Belgium 87.8
Gabon	375	4.0	735	France 73.4
Liberia	360	3.8	224	US. 57.8
Ghana	360	3.8	40	UK. 59.1
Ivory Coast	340	3.6	75	France 80.0
Southern Rohdesia	315	3.3	55	UK. 88.3
Zambia	300	3.2	68	UK. 79.6
Angola	290	3.1	50	UK. 48.6
Algeria	250	2.7	16	France 71.7
Morocco	250	2.7	16	France 45.2
Kenya	235	2.5	19	UK. 78.8
Cameroon	210	2.2	35	France 75.1
Senegal	210	2.2	51	France 87.4
Tunisia	200	2.1	38	France 39.2
Guinea	175	1.8	43	US. 38.5
Mauritania	150	1.6	123	France 68.8
Mozambique	125	1.3	15	UK. 50.1
Egypt	100	1.1	3	U.S. 70.7
Congo	100	1.1	102	France 83.4
Madagascar	95	1.0	14	France 76.5
Sierra Leone	75	0.8	29	UK. 84.4
Ethiopia	70	0.7	3	France 43.7
Togo	65	0.7	31	France 56.6
U.R. of Tanzania	65	0.7	5	UK. 46.7
Malawi	55	0.6	12	UK. 92.7
Central African Rep.	50	0.5	30	France 91.8
Botswana	35	0.4	56	UK. 88.0
Niger	35	0.4	8	France 95.7
Swaziland	35	0.4	81	UK. 96.6
Sudan	35	0.4	2	UK. 74.9
Uganda	30	0.3	3	UK. 48.1
Dahomey	25	0.3	9	France 57.0
Chad	20	0.2	5	France 80.4

Table 1 (Contd.)

1	2	3	4	5
Burundi	18	0.2	5	Belgium 84.5
Upper Volta	18	0.2	3	France 75.3
Rwanda	17	0.2	4	Belgium 86.8
Somalia	15	0.2	5	Italy 83.3
Mali	8	0.1	2	France 76.9
Territory Afars and Issas	6	0.1	60	France 90.9
Gambia	5	0.0	13	UK. 87.0
Lesotho	2	0.0	2	UK. 60.0
West Asia	4051	100.0	55	US. 57.3
Saudi Arabia	1050	25.9	128	US. 90.4
Iran	1000	24.7	33	US. 45.1
Kuwait	725	17.9	863	US. 54.4
United Arab Emirates	250	6.2	1250	—[5]
Iraq	185	4.6	18	UK. 37.5
Israel	180	4.4	58	US. 59.8
Bahrein	170	4.2	773	US. 91.8
Muscat and Oman	110	2.7	157	Neth. 52.1
Lebanon	110	2.7	37	US. 54.5
Qatar	100	2.5	1250	UK. 40.5
Yemen, Arab Rep. of[4]	80	2.0	14	—
Syria	35	0.9	5	US. 56.8
Cyprus	30	0.7	46	—
Jordan	25	0.6	10	US. 75.0
Aden and Yemen People's Democratic Rep.	1	0.0	1	UK. 100.0
South and South East Asia[6]	8836	100.0	7	UK. 41.5
India	1660	18.8	3	UK. 64.6
Indonesia	1200	13.6	10	US. 73.2
Malaysia	1000	11.3	3846	UK. 74.3
Philippines	870	9.8	22	US. 88.4
Hong Kong	670	7.6	164	UK. 41.4
Thailand	490	5.5	14	US. 40.2
Pakistan	485	5.5	8	UK. 59.0
Singapore	485	5.5	226	UK. 33.8
Papua—New Guinea	435	4.9	167	—

Table 1 (Contd.)

1	2	3	4	5
Korea, Rep. of	360	4.1	11	US. 92.3
Brunei	190	2.2	1357	Neth. 56.1
Viet-nam, Rep. of	180	2.0	9	France 65.7
Sri Lanka	130	1.5	10	UK. 95.1
Khamer Rep.	85	1.0	11	France 88.2
New Caledonia	85	1.0	708	France 91.4
Bangladesh	55	0.6	1	—
Afghanistan	16	0.2	1	US. 54.2
Burma	10	0.1	0	UK. 92.8
Laos	8	0.1	3	France, US. 36.6
Nepal	5	0.1	0	US. 50.0

Notes : [1] Countries and territories are arranged within regions in descending order of state of foreign capital.

[2] Includes Leeward and Windward Islands, Bahamas, Barbados and Bermuda.

[3] Martinique and Guadelupe.

[4] 1971 data.

[5] Abu Dhabi . . . . U.K. 51.2%; Dubai . . . . U.S. 46.2%.

[6] Including Oceania.

Sources : Development Assistance Directorate, Organisation for Economic Cooperation and Development, *Stock of Private Direct Investments by D.A.C. Countries in Developing Countries—End 1967*, Paris, 1972

—End 1972, Paris, 1974

United Nations, *Monthly Bulletin of Statistics*, October 1974.

Table 2: Manufacturing Subsidiaries in Developing Countries of 396 Transnational Corporations : Characteristics of Ownership and Methods of Affiliation

	Subsidiaries of 187 transnational corporations[1] based in the United States		*Subsidiaries of 209 transnational corporations based elsewhere than United States[2]*		*Total*	
	Number	*Percentage*	*Number*	*Percentage*	*Number*	*Percentage*
Ownership characteristic[3]						
Wholly owned	669	42.2	323	19.1	992	30.3
Majority-owned	258	16.3	377	22.3	635	19.4
Minority-owned	450	28.4	649	38.4	1099	33.6
Not classified	207	13.1	340	20.1	547	16.7
Total	1584	100.0	1689	100.0	3273	100.0
Methods of affiliation						
Acquired as going business	870	54.9	991	58.7	1861	56.9
Newly created	567	35.8	476	28.2	1043	31.9
Not classified	147	9.3	222	13.1	369	11.3
Total	1584	100.0	1689	100.0	3273	100.0

Source : Industrial Development Survey : Special issue for the Second General Conference of UNIDO, (United Nations Publication Sales No. E. 74.II.B. 14), p. 194.

[1] Data cover period to 1968.

[2] Data cover period to 1970.

[3] At time of establishment.

Agricultural Technology Transfer

Robert E. Evenson

A simple view of the transfer of technology from one region to another involves a sequence in which new technology is produced and is then diffused or adopted by producers. Typically producers in one or more regions will adopt the technology ahead of producers in other regions. Thus the term "transfer" is applied to adoption patterns and is often treated as implying something more than simple adoption in which producers "screen" alternative technologies and select profit maximizing technologies (subject to constraints).

Simple Technology Diffusion

Some useful insights can be gained into the more general process of technology transfer by considering features of simple diffusion. Suppose that an initial equilibrium exists in which farm firms have selected from among a wide range of alternatives those technologies which are profit maximizing. It is observed first that producers in agriculture will almost certainly not be utilizing identical technologies in equilibrium. It is one of the corner-stones of production and cost theory that firms facing different factor prices will not choose the same technologies. They will be at different points on the isoquant. It is probably true that some parts of the technology set will be quite similar but firms will select technologies to minimize costs and this means that they will differ in some respects in production technology unless, of course, it is impossible to substitute one factor for another.

This same principle applies to environmental factors other than prices. Even if all farmers in an Indian district faced the same output and factor prices (they do not) they almost certainly would not select identical technologies for producing a particular crop such as wheat. The reason for this is that they face different environments with respect to soil and climate factors. And most agricultural technology is very *sensitive* to these factors. It is not unusual to see many varieties of the same crop being planted in small regions. This is because the varieties differ with respect to their relative superiority under differing environments.

An equilibrium is thus characterized by the utilization of technologies which are suited to, or "tailored' to, environmental "niches". (In the following section, the incentives to develop such tailored technology is discussed).

Now consider the development of some relevant new technology, say a variety of wheat. The new technology in the initial stages has some uncertainty about it. In particular, there will be uncertainty about the range of existing technologies which are now economically *inferior* to it (i. e., have higher average costs per unit output in equilibrium). It is a rare technology indeed which turns out to render all existing technologies inferior to it. This is so, because of the fact that agricultural technology is tailored to environmental niches and improvements are likewise tailored. Only truly extraordinary new technologies such as the early "Mexican" wheat varieties introduced to North India in the mid 1960's render existing technology inferior over a wide range of environmental conditions. (It might be noted here that extension workers and researchers with vested interest in the diffusion of technology usually greatly over-estimate the extent of superiority of new technology).

The process of diffusion of this new technology is fundamentally a matter of the economics of learning and experimenting by farmers. Farmers have an incentive to experiment with new technologies as long as they are being produced. This involves "screening" or "scanning" communications of several types for information about new technologies and on farm testing and experimentation. Farmers differ considerably in their ability to systematically screen and experiment and information supply agencies such as extension workers and farm supply agents (fertilizer, insecticides, etc.) differ in terms of the degree and quality of information provided for farmers to screen.

The result of this behaviour will produce certain diffusion patterns. These patterns will be related both to farmer characteristics such as age, schooling, size of farm and availability of family labour and to environmental factors. For given enviromental condltions, many studies purport to show correlations with farmer characteristics and rates of adoption of technology. These studies are often faulty on two grounds. First, they often do not really control for changing environmental conditions and secondly, they often provide little in the way of a theoretical foundation for their correlations. They tend to focus on the obvious cases where

the new technology is superior to the many cases and neglect them, whereas the farmer screening and experimentation show that it is not.

For the cases of obvious superiority, one can take the findings of these studies as showing that education creates screening and experimenting capability in producers and that larger farms have incentives to do more screening and experimenting. It is also clear that the greater the economic superiority of the new technology, the less screening and experimenting is required to determine whether adoption is profitable.

In diffusion studies which do not specifically take environmental factors into account, quite erroneous and spurious relationships can be obtained. Very often the failure of farmers to even devote resources to screening and experimentation is simply due to the fact that there is a very slim chance that the new technology is really superior in his niche. And producers who have not enjoyed appreciable new technology for a long period of time are unlikely to devote many resources to look for it.

Transfer Process : Diffusion of Knowledge

Simple technology diffusion patterns are determined both by farmer characteristics and by the sensitivity of technology to environmental factors. They involve only simple screening and experimenting. Transfer involves a "disclosure" effect, followed by adaptive research. It too is limited by environmental conditions. Thus, patterns of technology transfer will depend on farmer characteristies, environmental characteristics and *research effort* directed to the production of closely related technology. We first note that for technology transfer, as opposed to technology diffusion it is required that research capability be developed which has the objective of producing new technology suited to different environmental conditions. Some of this research capability will reside in inventive farmers and blacksmiths. Historically, most farm inventions and plant and animal improvements were made (at a slow pace) by men and women without scientific or engineering training. Most new biological technologies today do require scientific training and, to a lesser degree, engineering training is required for mechanical technology development. So what is really being talked about is public sector agricultural experiment stations and private input supply industries.

Now consider the transfer process. A new technology is developed. It is a superior technology only in a limited number of environmental niches and in those niches a simple diffusion process will be initiated. The technology, however, also provides a disclosure of knowledge to researchers consumed with these and "nearby" niches which may enable them to make a related discovery. The case of genetic material, for example, has such an effect. A breeder may select a cold tolerant variety which is suited to certain niches, but he or other breeders will upon disclosure of the success in breeding the first variety be able to redesign their own breeding programme (perhaps by using the cold tolerant variety as a parent) to produce cold tolerant varieties adapted to other niches.

Strictly speaking, technology is not transferred, it is only diffused. The transfer is of knowledge which forms a "building block" in further technology development. Such knowledge is diffused in varying form and by different means of communication. Some knowledge is disclosed by the characteristics of the machine or other form of tangible embodiment of the technology. Some must be communicated in abstract form as in patent claims or scientific papers. In agriculture, particularly in the biological sciences, much knowledge is diffused through genetic material.

From the perspective of the researcher with the objective of developing new technology there are two primary sources of new knowledge of relevance to his task. One is disclosed by the development of new technology, and the other is by new knowledge which is not actual technology. It is the former, which is being considered to be a part of technology transfer. The latter might be termed as knowledge transfer. Of course, researchers may also benefit from acquiring knowledge which is not new in the sense meant here.

The nature of the screening and experimenting undertaken by the researcher is basicallysimilar to that undertaken by the producer. It differs in degree, however, requiring finer skills and more in-depth understanding of the physical and biological phenomena involved. if the skills of the researcher have not been acquired by significant numbers of people and institutions have not been developed to enable efficient research conduct in a region, that region will be unable to benefit from technology transfer. It will only have the option of technology diffusion.

Studies of Agricultural Technology Transfer

In contrast to the many studies of technology diffusion within small geographic regions, very few studies of international technology diffusion or of international technology transfer have been undertaken. A study of the history of varietal transfer in sugarcane (Evenson, Houck and Ruttan, 1969) Illustrates many of the features of technology transfer discussed here.

In the sequence of major developments in sugarcane varietal transfer, the earliest improved varieties were produced in a small set of experiment stations which were established prior to 1900 As the first new varieties were discovered in the stations in Java and Barbados in the British West Indies, (and India, Mauritius, and Hawaii somewhat later) they were actually diffused quite rapidly to producers in many parts of the world. The simple screening activities of the cane growers proved inadequate in most countries, however. The new varieties were susceptible to diseases in many new environments and as a consequence, producers were forced to abandon them and return to the traditional varieties.

In fact, the screening activity ultimately required very systematic field testing, and understanding of the various cane diseases and the development of methods of testing varieties to determine disease resistance. Sugarcane producers generally did not have the skills required to undertake this type of screening. In many countries (e.g. South Africa) the widespread incidence of diseases associated with new varieties led the growers to completely ban the growing of the new varieties in the interest of controlling disease in the native varieties. The incentives to establish experiment stations in every country was now based on two objectives. Not only could the stations undretake a varietal research programme, but they could also undertake the screening which had proven to be too difficult for the growers.

In the early 1900's, a number of experiment stations in South Africa, Mexico, Agrentina and Australia and several other countries were established to pursue these objectives. They were generally successful in doing so. During the 1920's and 1930's these stations performed an important screening function. They screened varieties suited to the environmental conditions faced by their growers and facilitated diffusion of the new varietal technology internationally. Their research

programmes in agronomy and cane breeding were also dependent on their ability to screen national and international genetic material and genetic and agronomic knowledge from other countries. The leading experiment stations (particularly, those in Java and India) then produced a new set of interspecific hybrid varieties in the 1920's and 1930's which were rapidly diffused to countries with screening capability. By the late 1930's and the 1940's the cane breeding programmes of the new domestic varieties which were developed and adapted specifically to domestic environmental conditions proved to be superior to the internationally available varieties. The indigenous research programmes thus facilitated the transfer of the technology developed in Java and India.

The sugarcane experience in the 1930's was a forerunner of the modern "green revolution" wheat and rice varieties. As with the interspecific sugarcane hybrids of the 1920's and 1930's the dwarf wheat hybrids from CIMMYT and the dwarf rice varieties developed at IRRI and elsewhere were initially diffused over wide environmental conditions. That diffusion was closely related to the research capacity of the countries which borrowed the new technology. Furthermore, there was significant knowledge transfer through the adaptive reseach of the borrowing countries.

A study of productivity in wheat and maize (Kislev and Evenson, 1973) was one of the first to explicitly deal with environmental factors. The basic procedure utilized in the study was to first define geo-climate regions. The classification of Papadakis (1966) was modified to the purpose. The model of the study then postulated a relationship between yield changes over time in a country and the stock of research capital (a measure of research intensity) both in the country and in similar regions in other countries. Thus the model postulated that a country could indeed benefit from (or borrow) research done in the other countries, but only if the environments were sufficiently similar.

The study concluded that a high degree of complementarity existed between research capability and the extent to which a country actually borrows technology or knowledge. In fact, the implication of the data was that in both wheat and maize production, if the borrowing country did not have indigenous research capability, it realized or borrowed, only a tiny fraction of the gains possible with research

capability. The marginal gains to the country conducting research were approximately as high from the facilitation of borrowing as from the discovery of technology suited to the country itself.

A further study of productivity in cereal grains production (Evenson, 1974) was based on a similar model, but with somewhat more detailed data. The model was more flexible regarding the complementarity between research in different countries. The model also incorporated the recent high-yielding varieties discoveries as semi-exogenous factors. The conclusions reached in this study were :

(1) That indigenous research activity complemented borrowable research at low levels, but was a net substitute at high levels.

(2) Environmental factors matter, both in the diffusion of technology and in the diffusion of knowledge or transfer of technology (albeit to a lesser extent). Very little knowledge diffusion across major climate regions takes place. In cereal grains the diffusion from developed to developing countries has been almost nil.

(3) That the green revolution high-yielding varieties represented a departure from the normal pattern of technology discovery, but only temporarily. Today the high-yielding varieties are as much the product of national research systems as of the international centers.

(4) That investment in research in developing countries yields a higher payoff than in the developed countries, and that research devoted to discovering new knowledge is probably of higher economic value than adaptive research.

(5) That the "typical" investing country appropriates a relatively small share of the total gains from research in the developing countries. A country without research capacity realizes very little benefit from the research of neighbours, however.

We are only beginning the systematic study of the technology transfer process. These studies have only begun to identify the complexities of the process. It is important, however, that we develop improved conceptualization and improved empirical base for designing policies to facilitate both technology diffusion and technology transfer.

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Implementing Appropriate Technology Programmes

Ram K. Vepa

There has been considerable discussion in the last decade on the need for Appropriate Technology to stimulate faster economic growth in developing countries. Propounded originally by Dr. Schumacher as "Intermediate" technology to correspond to the stage of development of these countries, the concept is now seen to have a much wider scope in many areas of national life. In order, however, that the stigma of second rate technology does not apply today—which makes it unacceptable to countries that still carry memories of colonial legacy—it has been re-designated as "appropriate" technology, to conform more closely to its basic theme that technology should be relevant or appropriate to the environment in which it operates.

Appropriate Technology *vis-a-vis* Developing Countries

Many countries, both in the developing and developed countries, have been actively working in this area. India was one of the first to recognise the need for it ; in the draft outline of the Fourth Plan issued in 1969, a specific reference was made to the need for adopting this approach to many problems. An Appropriate Technology Cell was set up in 1971 under the Ministry of Industry, and although, the efforts of this organisation have been considerably handicapped due to lack of resources and personnel, it has served to stimulate interest amongst a wide variety of personnel and initiate work in a number of areas by bringing together workers from diverse disciplines. In Indonesia, the Bandung Institute of Technology, in collaboration with the East-West Centre, Hawaii, have been operating a programme to identify areas which are suitable for the development of appropriate technology. The Korean Institute of Science and Technology has also been doing some useful work in this direction. In many African countries, there has been interest in this programme which has been undertaken with international assistance. An Intermediate Technology Development Group (ITDG) founded by Dr. Schumacher himself has been working in the countries of Africa, developing new techniques and implements which are considered suitable for those countries. The Volunteers for International Technical

Assistance (VITA) which is a non-profit organisation in United States is also setting up affiliate units in other countries such as Philippines in order to encourage transfer of technology on a person-to-person level. International organisations like UNIDO, ILO and FAO have shown growing interest in this concept. The UNIDO has set up an Appropriate Choice of Equipment (ACE) programme which advises clients in developing countries on the choice of appropriate equipment, while the ILO has been operating an Appropriate Technology Centre in Tanzania for some time.

Despite all the above efforts, there is still incomplete appreciation and understanding of the way Appropriate Technology needs to be implemented. While, conceptually it has been accepted as being of significance to developing countries, there is inadequate understanding of the manner in which appropriate technology needs to be practised. Few countries have had the courage as yet to integrate this concept closely into their day to day policies. It still seems as an idea which is fit to be discussed at Seminars and Conferences but does not have an immediate practical relevance. Policy makers in developing countries are still somewhat unsure themselves to be able to go ahead with boldness and vision with programmes based on appropriate technology. The reasons for this diffidence are many, some of which are discussed here.

(*i*) *Criteria of Appropriateness :* One of the basic difficulties about appropriate technology which most people have is the purely semantic one : how does one determine which technology is appropriate ? What are the basic criteria to be applied in judging appropriate technology ? Can this characteristic be quantified ? To answer these questions by merely saying that appropriate technology is that which is "appropriate to the country or society concerned is merely to indulge in tautology. There is need for quantifying parameters or indicators which would determine, to some extent at least, the degree of appropriateness of a particular technology to the conditions in a society. This is a matter for economists and administrators to work together so as to arrive at simple criteria which could be applied to any particular technology to determine its appropriateness. Perhaps, the employment provided by the technology or the value added by the worker or the total productivity of the operation may be indices which could provide some idea whether a particular technology is appropriate or not. In the ultimate analysis, the

whole concept of appropriate technology is significant only because it is expected to optimise the use of resources, both human and material, but this characteristic must be quantified into a single index of appropriateness which could be applied by the administrator and the policy makers at all levels when faced with an actual choice. Unless such an attempt at quantification is made, appropriate technology will remain a beautiful "idea" but difficult to practise.

(*ii*) *Availability of Know-how :* Another important bottle-neck in the wider application of appropriate technology is lack of adequate information on the availability of know-how. It must be confessed that since this problem is peculiar to the developing countries, not much work has been done, or will be done in future, in the developed countries. It is for the developing countries themselves, assisted by interested international organisations, to undertake the major technological thrust that will expand the horizons of appropriate technology. It should not always be regarded that this is scientifically or technologically speaking a minor effort. On the contrary, it might involve the application of some of the latest scientific principles to arrive at the most suitable technology for a particular country. It will, therefore, require the combined efforts of a variety of disciplines in science itself and should be considered as a major priority for any first class research institution.

Unfortunately, in most countries the scientific effort is largely patterned on that which is being done in the advanced countries. Partly, this comes out of a vague feeling that such a programme is modern and helps to "keep up with the Joneses". Partly, it comes out of the familiarity of the top scientific personnel with the work being done in these countries. Whatever the reason, it is time for technologists in developing countries to be reminded, as Lord Blackett once did, that there is no greater or more urgent tasks for these persons than to attend to the problems that lie in their countries, practically in their backyards. "In most parts of Asia", said the distinguished Nobel laureate, "the problem really is to devise new technologies which make manpower more efficient without much capital expenditure." There is, therefore, need for undertaking more intensive technological research into the problems of the developing countries, which may sometimes seem somewhat less glamorous or exciting at a time when the scientific world is preoccupied with space shots and landing on the moon. But in their ultimate result such work is bound to have much greater impact on

the growth of the country than problems which are of no immediate relevance. As Julius Nyerere, the wise leader of Tanzania has said, "while other countries aim to reach the moon, we must aim, for the time being, to reach the village".

(*iii*) *Ready Information :* Even where technology is available, there is not always adequate data on it to be applied readily. In fact, one of the major tasks of any international organisation is to operate a "data bank" which can collect information on the developments that have already taken place in many of the less advanced countries. This could then, in turn, be fed to other developing countries which are placed in a similar situation. Such sharing of experience amongst the developing countries themselves is likely to be more meaningful and more beneficial than the sharing of knowledge with the more advanced countries who are so far ahead that their research is of no immediate significance to the problems of the developing world. What happens in India or Philippines may be more relevant to other countries of Asia and Africa, than the developments in USA, U.K. or even Japan.

The Small Industries Extension Training Institute at Hyderabad is operating a documentation centre for small industry, including appropriate technology and their quarterly bulletin provides information on developments in this field. The Vaikuntlal Mehta Smarak Trust, a non-profit organisation at Bombay also publishes an abstract survey every quarter on appropriate technology. Such efforts would need to be organised on a wider footing so as to embrace various sectors which are of importance to appropriate technology. The data so obtained at the national level can be pooled together at the international level for suitable exchange of information. The Intermediate Technology Development Group in U.K. publishes a monthly Bulletin under the title *Appropriate Technology,* providing a useful forum for sharing of information. Similarly, the *News Letter* and other literature published by VITA also gives information on the work being done in institutions and laboratories around the world. There is, however, need for a more systematic and organised effort to collect information so that technologists and policy makers become aware of the choices available to them, limited as they are. Very often the lack of such information is proving, particularly, a big handicap for building appropriate technology into specific programmes.

(*iv*) *Indigenous Manufacturing Capacity :* Even if a particular product is

developed in the laboratory, it needs to be produced on a large scale if it is to have a mass application. Unfortunately, the fabricating and design capabilities available in the developing countries are not always adequate for this purpose. The large scale sector in these countries is based primarily on techniques and processes developed in the Western world, since much of the industry has been set up in collaboration with leading manufacturers in these countries. There is, therefore, a reluctance to undertake fabrication of the comparatively simpler developments that are envisaged in appropriate technology.

The ITDG, had compiled a catalogue some years back, entitled 'Tools for Progress', giving details of simple equipment and implements which are available on a commercial scale for users in developing countries. It may, perhaps be useful for some of the State promotional organisations such as the Industrial Development Corporations or the State Agro-industries Corporations to take up this work and produce on a large scale improved implements and equipment which can be distributed widely in the rural and semi-urban areas of the country. Unless such a manufacturing capacity is developed, mere development of a technology in the laboratory is not likely to produce the desired impact. This is one of the key weaknesses in the developing countries where the work in the laboratory does not have an immediate relevance to the industrial growth of the country. This can be bridged only by the State promotional organisations which have been set up in every part of the country and which can take up production on a large scale of items that are suitable to the conditions in their own State.

(v) Administrative Procedures : Another bottleneck in the widespread application of appropriate technology is the outdated administrative procedures which continue to hold sway. In the building and road construction, for instance, the long-established Public Works Department has procedures which are based on the principle of the "lowest tender", other things being equal. The rules themselves are not too rigid and do provide for the acceptance of a tender which is higher than the lowest, if there are tangible benefits which flow from the acceptance of such a tender. Unfortunately, few administrators, particularly, at the middle levels are willing to take the responsibility for chosing a tender which is higher than the lowest; most often, they accept a tender which uses the most machinery, ignoring another which is likely to employ more labour and less machinery. It is the latter that will produce in the long run

results with a higher social benefit to the community but the administrators feel helpless in the matter since the rules, they say, make it almost obligatory for them to accept the lowest tender.

It may, perhaps be necessary in this connection to quantify an index which would provide a measure of the social benefits, appropriate technology can provide to a community. Such a measure could depend upon the quantum of appropriateness which has been discussed above. Alternatively, as has been done in the case of Small Industry, it may be possible to have a rough and ready index which could be used to give weightage to appropriate technology against those which are less appropriate. In the case of the small scale industry, it has been stipulated that any product made in that sector should be given weightage upto 15% in deciding a purchase tender; a similar quantification of the social benefit of appropriate technology may make it possible for such a technology to be used on a much wider scale.

(*vi*) *Cultural Orientation :* It has already been stated above that one of the important problems is the cultural orientation of the technologists and policy makers. Most technologists have been schooled in Western universities, and are, therefore, reluctant to work on programmes which to them seem less than the best. Similarly, policy makers are so tuned to Western concepts that the idea of employing a semi-modren technology seems to them to smack of a colonial feeling. There is need for a greater recognition that in the circumstances prevailing in the developing countries the most modern is not always the best and that the most appropriate could well deliver the goods better than what generally passes as the most modern technology.

Perhaps as years go by and policy makers and technologists in these countries acquire self-confidence, it will be possible for them to break away from the strangle-hold of Western ideas and concepts which prevail in many developing countries. It is for this reason that even in India, which is certainly one of the most developed of the developing countries, there is a hesitation to employ processes tried in the laboratory; the Vertical Shaft Kiln Cement Plant, for instance, which has been developed at Jorhat in Assam is yet to find a practical application, although conditions in the North East Region itself are suitable for this purpose. But to take such a decision involves self-confidence on the part of the technologists themselves and boldness on the part of policy makers, both of whom

tend to feel inhibited due to the 'Western' orientation in their attitudes.

(*vii*) *Inadequate Rural Bias :* Part of the difficulty is the fact that rural problems do not always get the attention they deserve at high policy-making levels. Most scientists and technologists are urban oriented and hence have inadequate understanding and appreciation of the problems of the rural areas. The same is the case with the administrators except those who have had some familiarity in dealing with the people in the country-side. But even in their case, such an experience comes almost at the beginning of one's career and, subsequently, there is hardly any opportunity for the officers to 'recharge' their understanding of rural problems. Perhaps, as has been done in the case of Castro's Cuba or Mao's China, it may be desirable to insist that every public official—whether a scientist, technologist or an administrator—should work for a minimum period of two weeks every year in a village so that there is a renewed understanding of the problems and the parameters of the rural areas. It is only through such knowledge that one can arrive at techniques and processes which are more relevant to such areas than to the purely urban regions in which most of the scientists and administrators live.

(*viii*) *Foreign Technology :* The many collaborations which indigenous industry in developing countries has made with foreign companies has lead to the markets in these countries being familiar with brand names and products of the western world. Names such as Coca Cola, Ovaltine, Horlicks or more recently the Japanese brand such as National, Cannon, Honda, and Sony have become household words all over the world. It becomes, therefore, doubly difficult for indigenous groups to break into this monopoly of the foreign industry collaborating with indigenous groups within the country. India has taken a stand in recent years that even where foreign collaboration is agreed to, it should be based only on advanced technology and that brand names, particularly, for consumer goods would not be allowed in the internal market. It is necessary that greater vigilance is exercised in regard to import of foreign technology so that markets within the developing countries are not completely monopolised by such interests.

Only China has had the courage in the last two decades to build appropriate technology into their programmes, although it is not so called by their policy makers. China has followed in agriculture a policy of what they call 'semi-mechanisation', which uses improved implements without

going over to large scale mechanisation. In their irrigation programmes, they have used large number of people to build vast irrigation projects as well as flood control dams. In industry they have consistently employed the "walking on two legs theory", whereby both the small and large industries are expected to contribute to the national life. In recent months, however, there has been a tendency in that country to break away from these concepts and to concentrate more and more on high technology areas. This again is the result of the fact that using appropriate technology, the country has been able to come up to a certain level of economic growth which, in turn, enables it to take appropriate technology to a higher level. Even the much publicised "backyard furnaces" of the mid-fifties which were being ridiculed by Western technologists and the press are now seen, in retrospect, as having made possible the production of steel which could be utilised for low grade applications; with steel production running today at about 25 million tonnes, China seems to have no more use for such furnances and has switched over to large scale steel plants. The application of appropriate technology, therefore, requires a policy of pragmatism and flexibility and a willingness to concede that different conditions may require different solutions and techniques.

Conclusion

The fact that India is a vast and diversified country offers excellent opportunities to technologists and policy makers to try different 'solutions' within the country and acquire valuable experience which can be employed in other parts of the country. Appropriate technology requires a bold and pragmatic approach to the problems as well as a significant modification of existing attitudes and procedures. It is only then that it can produce the desired impact on economic growth of the community; otherwise, it is likely to remain as a 'hardy annual' for discussions at seminars and meetings but seem to be of little consequence in devising practical solutions to the problems of developing countries. With its technical skills and manufacturing capabilities, India can well be a pace setter in this field and an "exporter" of appropriate technology to the third world.

Appropriate Technology for India

M.S. Iyengar

The task of technology is to bring about social change. The introduction of the plough transformed the society from hunting to agriculture. The food surpluses resulting from agriculture and the solution of the connected problems provided the basis for specialisation of labour, writing, city, social classes, the state and civilization as we know it. It also was responsible for the first great population explosion in human history. The stirrup and the horse-shoe made feudalism possible. The compass led to the discovery of sea routes to India and eventually to the colonial era. The discovery of the steam engine coupled with the capital accumulated from the plunder from the colonies resulted in the Industrial Revolution. Atomic energy, electronics, space satellite, cybernation are now transforming the affluent societies into post-industrial societies.

Historically, technology created new resources or helped to exploit the traditional ones, but in most instances it tended to be tied down to its physical resource base. Major industrial centres were built around coal-iron ore belts. The advent in chemistry and progress in transport has made most of the industries "leg-free". A notable example is Japan which without its own iron and coal resources has become an exporter of steel. Availability of superior technology—and not the location of raw materials—has become the principal factor in the emergence of new industrial centres and the economic viability of nations and regions.

Integrative Effect of Technology

The independence of technology from resource base has resulted in two levels of integration. One level is the integration of human activity and spatial unit into one global geo-technical system.

The advanced industrial societies are highly inter-related technologically and politically. The communication satellite promises to envelop the developing regions also and integrate them with the developed world.

The other level is the large-scale integration which is proceeding in science and technology itself. The combination of computer, satellite and atmospheric sciences open up new vistas for weather prediction and modification. The combination of electronics and chemistry, chemistry and biochemistry is producing synergistic breakthroughs in the life sciences.

All these things are making technology complex, costly and global. Even in such conventional itmes as transformers for power network, the economics of scale is pushing producers into co-operation or merger. Even giants like Siemens and Telefunken are forced to join hands in the heavy electrical engineering field. Complex technology demands system approach. With increase in the scale of operation, the commitment of time and money become inflexible. It also calls for specialised manpower and complex business organisation and industrial planning. Not only the enterprise needs to exercise control over what is sold but also over what is supplied. The larger the scale of operation, the larger would be the time taken for its completion. Therefore, sophisticated methods of planning, including technological forecastings have to be adopted.

Science-based Industry

India has tended to model its development on the Western pattern of industrial growth. If it is to follow this logic to its natural conclusion, it will have to make its science and technology much more sophisticated and opt for science-based industries. For instance, like Japan, it will have to shift from the throw-away industries like coal, paper and pulp, non-ferrous metal, agricultural products to third stage industrialisation like automobile, precision tools, large scale construction equipment, computer, electronics etc. In that sense, our attempts in harnessing of atomic energy for peaceful purposes and launching of Aryabhatta in space are in the right direction. Nuclear agro-industrial centres for de-salination of water for irrigation purposes with large-scale production of chemicals, fertilizers and metals from sea water and air could provide to millions of people new sources of food and equipment. Space satellite could facilitate discovery of new mineral resources and generate economic activities in geographical regions hitherto considered uneconomical. In August, India will be launching an experiment to provide

audio-visual television programme through space satellite to 2,500 villages. This would demonstrate that a satellite-based TV network could be built and made operational in about 4 years. To construct a comparable conventional TV net-work would take perhaps as long as two or three decades and the cost would be twice as great. Education/communication through space satellite, therefore, becomes 'appropriate' to Indian conditions. Adoption and reliance on electronics also is 'appropriate'. Adoption of large-scale integration in place of thermionic valves or transistor could increase the performance of radio receivers and make them more accessible to the common man. Option for developing micro-computers in preference to traditional computers again would be appropriate because the latter would tend to decrease the cost by several-fold and make it available for a multiplicity of uses.

One of the imperatives of technology, however, is that it tends to eliminate manpower. This, in a developing country like India would mean more unemployment. The last 28 years of industrial development has indicated that industrialisation and increase in Gross National Product does not automatically increase the standard of living. In fact, the disparity between the rich and the poor has widened considerably. Consumerism leads to higher import content and increase in the production of such goods aggravates rather than alleviate the problem of balance of payment. It is in this context that the approach to the Fifth Plan worked out by the Planning Commission becomes relevant. The approach analyses two possible patterns of growth. The first is based on the perpetuation of the present patterns of distribution of income and of consumption expenditure and the second upon a radical redistribution of consumption expenditure in favour of 30% of the population below the proverty line. The first approach leads to preservation of a dual society and the second to a reduction in inequalities.

Appropriate Technology

The magnitude of the problem faced by India can be appreciated from the following. By the turn of the century, the population would have doubled and the food production would have increased 2.5 times; the clothing requirements would have increased to 25 million metres involving an expenditure of Rs. 8,000 crores. Power consumption would

have to be increased to 214 million kilowatts and steel production to 75 million tonnes and even if this is done, India would still continue to have all the disparities of the present day reality. India would, therefore, have to not only opt for sophisticated technology and industry but also simultaneously opt for appropriate technologies, i.e. technologies which are more labour and less capital intensive and which could be made operational within a short period utilising local talent and local raw materials. Such industries will have to be low-energy based. The arguments in their favour are:

(i) Low capital and capacity to utilise abundantly available labour;

(ii) Capital-intensive technologies become efficient only when operated on large scale but the market is small and more in favour of scale-down ;

(iii) The divisible nature of the investment is in favour of small units ;

(iv) They can spread easily and increase links with the rest of the economy more readily than a few large units in isolated areas;

(v) Because of their labour-intensive nature, appropriate technologies can ensure more wider spread of benefits of growth;

(vi) The low capital and low gestation period can make for a high rate of growth in the economy with no drain on foreign exchange ;

(vii) They make more ready use of local raw materials and their operations meet with less maintenance problems.

The arguments against them are :

(i) Labour intensive technologies tie down the capital longer and take longer time to mature.

(ii) They demand more enterepreneurial skills which are scarce.

(iii) They make a non-human use of human beings.

Notwithstanding these valid criticisms, the fact remains that appropriate technologies can bring about social changes more rapidly in the rural areas with less time, energy and effort than can capital-intensive technologies. In any case, their role is transitory and relevant only till such time as the economy takes off.

The following examples illustrate the possibilities of adopting alternative technology :

(*1*) *Mini Cement Plant.* The Indian Cement Co. started production of cement in 1914 with a capital perhaps not exceeding Rs. 100,000. The time taken by them to go into production was not more than six months. Today, the installation of a 5,000 tonnes-per-day capacity jumbo kiln will call for a minimum investment of Rs. 450 million, the time taken for its installation being not less than 2 years. Operation of such a plant wolud call for specialised manpower and a complex business organisation with control not only over the market but also over uninterrupted supply of power, raw materials and specialised skills. These conditions do not exist at present in India. Although, in the past, cement industry had installed bigger capacity units, the performance during the last few years has shown that the installed capacity utilised, which in 1968 was 94%, has been gradually decreasing and during the first half of 1974, it decreased to 69% mainly due to the deterioration in the power and raw material supply. The price of cement has been increasing correspondingly. The investment cost has increased from Rs. 101 per annual tonne in 1957 to as much as Rs. 600 in 1974. While in theory, installation of jumbo rotary kiln would be more economical, in actual practice it will lead to a decrease in productivity and increase in cost of installation and production. Also, for a large country like India where consumer centres are distributed over long distance, what is saved as initial capital cost would largely be negated by long haulage cost of the finished product. The alternative would be the installation of several mini vertical shaft kiln cement plants, for which the technology is indigenously available. These kilns can be operated continuously, having the following features :

(i) The feed is in the form of uniform nodules ;

(ii) Since the raw meal has the fuel interground, fuel efficiency is high ;

(iii) Clinker formation which is mainly a sintering operation, is confined to the top portion of the kiln ;

(iv) The lower portion of the kiln acts as a heat exchanger where the sensible heat of the clinker is recovered by the air ;

(v) Air for combustion is supplied through rotary grate at the bottom of the kiln by a blower ;

(vi) The clinker discharge is controlled by the rotary grate ;

(vii) The clinker obtained are porous and involve less energy in grinding.

The capital investment for a 600-tonne per annum plant would be only Rs. 2 lakhs. The investment per annual tonne is less than half that for a conventional rotary kiln. The strategy, therefore, could be :

(i) Encourage installation of cement kilns of 1 to 3-tonne per day capacity and mobilise local skills of artisans and craftsmen. The kilns could be batch kilns with induced draft, but having nodulized feed.

(ii) Encourage the installation of 100 and 200-tonne capacity mini cement plant, based on modern Vertical Shaft Kilns.

(iii) Revive and modernise construction, without Portland cement.

(2) *Production of Building Bricks :* The conventional brick making industry utilises special type of soil which can be obtained only by removing top soil from agricultural fields. The brick formed will have to be fired in a kiln, utilising coal or oil. All this increases the cost of production. For instance, a *2-crore-a-year* plant for manufacture of bricks in a modern factory would involve investment of Rs. 50 lakhs or so, out of which the cosf of land alone would be Rs. 10 lakhs.

An alternative appropriate technology could utilise the residue left by burning paddy husk as the starting material. The paddy husk ash is admixed with lime and converted into bricks. After 24 hours curing, the bricks are ready for use. They do not need any fuel or kiln for their manufacture. These bricks can be manufactured in a decentralised manner at the village level.

(3) *Production of Industrial Oxygen :* At the present time, industrial oxygen is produced by liquefaction of air using high pressure compressors which are still imported. Also, they make heavy demands on power. An alternative appropriate technology could utilise molecular sieves for production of oxygen on a small scale. Alternatively, the old process of production of oxygen from barium peroxide can be revived. In this process, barium oxide is heated to a particular temperature to convert it to barium peroxide and then maintained at another temperature to facilitate the breakdown of the latter into oxygen and oxide. The oxide could be recycled. This process was abandoned in favour of liquefaction of air, but under Indian conditions like shortage of high power and shortage of pressure cylinders and equipment, one could resort to this method of production of oxygen.

(4) *Production of Calcium Carbide :* Most of the modern methods of production resort to using electric furnaces involving heavy expenditure on power. The alternative method could be to admix charcoal with limestone, nodulise the mix and feed the same into a modified blast furnace utilising enriched air. Calcium carbide could be obtained in molten form. Such plants could be constructed even on a small scale of half a tonne per day capacity with low investments.

(5) *Dry Battery Cell Production :* The Central Electro-Chemical Research Institute, Karaikudi is offering the know-how for manufacture of 1.8 million cells per annum by employing about 40 workers. 33 such production units employ a total 1,650 workers to produce nearly 60 million cells per annum. A corresponding size unit in the organised sector would employ only 1/5th the number of labour.

(6) *Newcomen-Watt Pumps :* Rural electrification has received the attention of Government. The distribution cost, however, becomes costly and uneconomical in relation to power offtake. China is reported to have developed a multi-purpose small horse-power portable diesel pump which the farmer carries to the field and uses not only for pumping water but also for operating other agricultural implements.

It may be worthwhile to revive the early Newcomen-Watt steam engine and use it for pumping water. The advantage would be that these pumps could be made to operate by burning the readily available agricultural waste.

(7) *Micro-scale Industries :* One of the alternatives for accelerating the pace of industrialisation could be to think of micro-scale industries employing not more than Rs. 20,000. Such industries should be simple and should be able to ensure a high return so that the accrued capital could be reploughed to multiply their number. The product to be made or raw materials to be used will naturally have to be thought of as complementary to the existing, small, medium, or large-scale industries. One example of such an industry is manufacture of water filter candle. One of the biggest problems in rural India is the supply of portable water. Candle filter could be manufactured from the indigenously available clay, utilising the local potter's skill. Burnt clay admixed with clay, saw dust and silver nitrate could be utilised as raw material. Presence of silver in traces in the candle ensures bacteria free water. Manufacture of 100 filters per day will not involve an expenditure of more than Rs. 10,000. The cost of each filter would not be more than Rs. 4.

Another example of micro-scale industry could be the manufacture of paper twine for the Cable Industry. The machine would not cost more than Rs. 5,000 and the product which is at present imported should sell at Rs. 30 per kilogram. Several products for use in the Chemical Industry could also be manufactured on micro-scale. Some of them are Silica Gel and Palladium Catalyst.

The above examples only illustrate the possibilities that appropriate technology offers for innovation. Several more can be thought of. What is needed is the mobilisation of the talents in our research and technological institutions and utilise them to develop several appropriate technologies. These technologies cannot be developed in isolation. They would also have to utilise the local artisans and craftsmen, for it should not be forgotten that the first Industrial Revolution was ushered in not by the scientists and technologists but by artisans and craftsmen. It is only through following a 'walking on two legs approach' that we can transform India.

Fiscal Policy and Appropriate Technology

Anand P. Gupta*

Research work on issues concerning the relationship between fiscal policy and appropriate technology has not received the kind of attention it deserves. The importance of such work can hardly be overstressed at a time when the employment problem has turned ugly in many countries and when every effort is being made to find ways of dealing with this problem in an effective manner. This article[1] looks at the employment implications of some of the fiscal measures and makes an attempt to explore ways in which the instrument of fiscal policy can make a significant and lasting contribution to the promotion of appropriate technology in India.

Concept of Appropriate Technology

Let us begin by asking the question, "what is appropriate technology?" While we recognise that this is not a simple question, we believe that an attempt can be made to define appropriate technology in terms of the resource endowments of a country. That is, an appropriate technology is a technology which requires that factor ratio which coincides as much as possible with the factor ratio that the country is endowed with. Thus, in the context of a country like ours which suffers from inadequacy of foreign exchange and where the employment problem has assumed rather staggeringly large proportions, appropriate technology may be defined as that technology which is based on locally-available material resources and which favours the employment of unskilled workers in large numbers. If one goes by this definition of appropriate technology, he can find many examples of the use of inappropriate technology in India.

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1. The article draws on the paper "Public Finance and Employment : The Indian Case", prepared by the author for presentation at the XXXI Congress of the International Institute of Public Finance, Nice, September 8-12, 1975.

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above, and cover a period of twelve years, 1961-62 to 1972-73. Data for the years 1961-62 to 1965-66 relate to 1,333 companies, those for the years 1966-67 to 1970-71 to 1,501 companies and those for 1971-72 and 1972-73 to 1,650 companies. These companies have covered, in terms of paid-up capital, about 80 per cent of all the non-government, non-financial public limited companies in India.

Tax incidence has been defined as the percentage of tax provision to profits before tax. For the years 1961-62 to 1970-71, the percentage relates to all the companies covered in the Reserve Bank of India's studies referred to above,[5] but for the years 1971-72 and 1972-73 the percentage relates to profit-making compantes only. As regards labour intensity, it has been defined as the percentage of wage cost to value of production.[6] It may be noted that the Reserve Bank of India data on wage cost relate to both salary earners and wage earners and no break-up of the data is available to show the relative changes in the shares received by these two groups of income earners.[7]

A striking feature of the trends in tax incidence and labour intensity is that while the average labour intensity of the private corporate sector in India has declined, industries with lower-than-average labour intensity have enjoyed considerably larger relief in tax incidence than industries with higher-than-average labour intensity : Total reduction in tax incidence of industries with lower-than-average

5. Measurement of tax incidence in terms of percentage of tax provision to profits before tax of *all* companies suffers from certain limitations. For a discussion of these limitations, see author's "Burden of Taxation on Corporate Sector." *The Financial Express* (Bombay), July 21, 1973.

6. This may not sound like an ideal way of defining labour intensity in a country like India in which the objective of employment policy is simply that of increasing the numbers employed. But limitations of data availability did not permit us to use a more satisfactory definition.

7. Evidence [illegible] from other sources [illegible]

What is wrose, one can find evidence to show that even public policy has played an important role in the growth of inappropriate technologies: It has not only tolerated such technologies, but has even deliberately favoured their adoption through various means.[2] Tax policy is a case in point. The tax system in India has provided and continues to provide a number of incentives to stimulate industrial development in the country.[3] The use of tax incentives for the purpose of encouraging industrial development rests essentially on the premise that the conterral of tax benefits will induce domestic or foreign industrialists either to initiate activities which they would not otherwise undertake or to expand their activities in already existing enterprises. While development of certain industries is a desirable objective, what is questionable is the design of the tax incentives used to achieve this objective. A careful review of the relevant literature shows that these incentives have been designed in such a manner that generally they not only lack selectivity but the tax benefit associated with them varies in proportion to the amount of investment in a capital asset. When calculating this benefit, no consideration is given to the number of workers employed, or to the quantum of locally or indigenously available inputs or raw materials used in the production of the capital asset. These incentives have operated (and continue to operate) in an environment in which interest rates at which finance has been made available to industry have been maintained at artificially low levels and in which interest has been allowed as an item of expense for tax purposes.[4] The implications of such a combination of policy factors for technology adoption are obvious: By reducing considerably the tax liability and thereby improving the net (after-tax) profitability, or by reducing the

Tax Incidence and Labour Intensity
1961-62 to 1972-73

(*Percent*)

Industry		*1961 —62*	*1962 —63*	*1963 —64*	*1964 —65*	*1965 —66*	*1966 —67*	*1967 —68*	*1968 —69*	*1969 —70*	*1970 —71*	*1971 —72*	*1972 —73*
Coal mining	TI			39.0									
	LI			54.6									
Cotton textiles	TI												28.7
	LI												20.5
Jute textiles	TI											29.5	24.0
	TI											22.4	25.4
Woollen textiles	TI								37.2		31.3		
	LI								23.1		15.0		
Iron and steel	TI	2.46	20.8	30.2				29.5	31.6				—
	LI	19.9	19.5	19.3				23.9	23.1				26.4
Aluminium	TI						16.9	29.0	23.6	4.6	0.1	13.7	
	LI						11.3	12.0	12.2	10.9	10.5	10.9	
Other non-ferrous metals	TI								23.9	24.0	22.7		
	LI								12.1	8.9	8.4		
Motor Vehicles	TI						30.0	30.0	38.3				
	LI						12.3	13.5	13.9				
Foundries and Engg. workshops	TI						29.2			25.7	18.5		
	LI						17.9			19.9	17.9		
Basic industrial chemicals	TI		41.3									29.6	26.8
	LI		11.4									9.1	9.5
Cement	TI					37.7			29.7	23.3	20.4		33.2
	LI					14.6			13.6	12.3	11.7		12.7
Paper and paper products	TI			34.3	40.5	19.5	30.2	38.1	22.5	15.6	30.2	23.3	24.0
	LI			14.7	15.4	15.7	15.5	16.0	15.6	14.8	15.1	14.5	15.8
Elec. generation and supply	TI	25.0	33.1	37.3	40.4	21.3	30.5	21.5	22.3	22.8	33.1		
	LI	10.2	9.1	7.9	8.3	8.9	9.4	9.8	9.5	8.8	8.9		
Shipping	TI			29.1	11.8	2.8	9.3	5.6	15.4	4.4	10.0	7.2	11.0
	LI			15.1	16.3	16.4	15.8	14.6	14.2	13.7	13.0	13.0	13.8
All industries	TI	43.7	52.3	51.0	50.5	51.0	47.8	49.4	49.5	43.7	45.9	41.5	43.3
	LI	16.9	16.9	16.7	17.0	17.1	15.9	16.4	16.4	15.9	15.6	15,1	15.6

TI = Tax Incidence LI = Labour Intensity

Note : The data presented in this table are confined to those cases in respect of which tax incidence works out to at least ten percentage points lower than average tax incidence in a year.

Source : Data from "Finances of Indian Joint Stock Companies, 1965-66", *Reserve*

labour intensity works out to roughly 3.89 times the reduction in tax incidence relevant to industries with higher-than-average labour intensity.[8] Clearly, the way corporation tax policy has operated in India, it has tended to induce distortions which have favoured the employment of capital, with the result that the labour intensity of industrial output has suffered a decline.[9] This can hardly be regarded as consistent with the objective of promoting appropriate technology in a country like ours. We feel a situation of this kind should not be allowed to continue and, therefore, suggest (a) complete withdrawal of all fiscal incentives related to the employment of capital, and (b) complete disallowance of interest as expenditure for tax purposes. These measures, by raising the effective price of capital, should have the effect of influencing the factor-mix in favour of labour.

The above measures should be combined with a deliberate fiscal effort aimed at re-ordering of investment and production priorities with a view to increase the output of goods of mass consumption. A policy measure which deserves consideration for achieving this result is a substantial reduction in the incidence of corporation tax on industries producing specified mass consumption goods. If these goods are in adequate supply, prices can be expected to remain reasonably stable and, as a consequence, beneficial effects may be expected not only on employment but even on income distribution.

An attempt should also be made to explore the possibility of reducing the incidence of excise duties and other indirect taxes on goods of mass consumption. Whatever data are available suggest that the incidence of taxation on at least some of these goods has registered an almost persistent increase. This has tended to cause upward pressures on the cost of living for the working population, which in turn have exerted a perceptible influence on money wage levels. The net result has been a distortion between the relative factor prices—a distortion which has favoured capital-intensive rather than labour-intensive production.[10] In view of these considerations, any reduction

8. As between companies in an industry, this means considerably larger tax benefit to the companies with a relatively high proportion of capital in their factor-mix.

9. This is consistent with a recent Government of India estimate according to which the share of workers' wages in the value added by manufacture fell from 38.5. to 33.7 per cent in the decade 1960-1970.

10. It must be noted that fiscal factors represent only one set of factors which have induced

the rich.[16] But we must hasten to state that these adverse effects are almost certain to be more than offset by the positive gains which are likely to accrue as a result of any significant reduction in inequality. These gains can be expected to accrue because of (a) decline in imports, (b) increase in exports as a result of decline in domestic consumption of certain products which have good demand in world markets, and (c) changes in the pattern of growth rates of output, with output of labour-intensive products growing at a faster rate. To these should be added the gains resulting from reduction in foreign exchange leakages. These leakages, involving considerable amount of foreign exchange, have taken various forms, such as smuggling,[17] expenditure by Indian tourists abroad and outflow of foreign exchange in the forms of royalties, technical fees, head office expenses, project remittances, etc.

No empirical estimates are available of the magnitude of the hypothesised effects which reduction in inequality would have on employment (and other aggregates) in India, but in view of the considerations noted above it appears to us that a potential does exist for improving labour intensity through income redistribution as well. Fiscal policy can be of help in realising this potential, but our country's experience so far with the use of this policy for re-distributing incomes does not justify any ground for optimism. A recent study of the incidence of taxes collected by the central government shows that while the rich pay a considerably higher proportion of these taxes than what the poor pay, the composition of tax incidence on the rich is such that their pattern of consumption remains largely unaffected.[18] To put it differently, as the incomes of the rich have recorded considerable gains and as the

16. Not all the goods consumed by the rich are capital-intensive. Indeed, it has been argued that as the relatively well-to-do consmue labour-intensive personal services and elaborate handicraft products, increasing the degree of inequality may have a more favourable impact upon employment levels. For analyses along these lines, see D. G. M. Dosser, "Tax Incidence and Growth", *Economic Journal,* September 1961; and Paul Strassmann, "Economic Growth and Income Distribution", *The Quarterly Journal of Economics*, 1956.

17. The large scale smuggling of luxury goods which takes place in India (according to an estimate, goods worth at least Rupees 400 crores were smuggled into the country between September 1973 and January 1974) merely reflects the gross inequalities in the distribution of disposable incomes in the country. With a dent on these inequalities, a noticeable decline in smuggling should follow, thus making additional foreign exchange resources available for priority development activities.

18. Anand P Gupta, "The Rich, the Poor and the Taxes They Pay in India : A Study of Central Government Taxes and Their Impact on Income Distribution", World Employment Programme Research, Income Distribution and Employment Programme, Working Paper Number 12 (Geneva : International Labour Office, January 1975).

system of direct taxes has failed to mobilise an increasing proportion of these incomes, the resulting increases in disposable incomes have been so large that increases in commodity prices resulting from indirect taxes have by and large failed to cause noticeable shifts in the consumption patterns of the rich people.[19]

This means that if fiscal policy has to play an effective role in realising the potential which in our opinion exists for improving labour intensity through income re-distribution, certain changes of a far-reaching nature will be absolutely necessary. Part of the thrust of these changes will have to be on shifting the structure of taxation in favour of direct taxes. Such a shift would not only be of help in reducing inequalities in the distribution of disposable incomes, but can also be expected to improve the effectiveness of indirect taxes in influencing desirable changes in consumption patterns.

A careful survey of the present situation suggests that a good part of the success in this area will depend upon what those who are responsible for the administration of the tax system do to curb the rapidly growing menace of tax evasion. A measure of the extent of tax evasion is provided by the near constancy of the ratio of individual incomes assessed for tax purposes to national income. In a country like ours in which national income at current prices has risen rather rapidly in recent years and in which inequalities in the distribution of incomes have tended to widen,[20] one would have expected this ratio to rise, but at least partly[21] because of the widespread practices of non-reporting and under-reporting of taxable incomes the ratio has remained practically unchanged: It stood at 6.74 in 1970-71 as against 6.66 in 1960-61.

It may be noted that while improvements in tax administration are absolutely essential for bringing about any meaningful shifts in the

19. In a number of cases substantial increases in indirect taxes have only promoted smuggling—a situation which, as noted earlier, merely reflects gross inequalities in the distribution of disposable incomes.

20. For a recent survey of trends in income distribution in India, see Pranab K. Bardhan., "The Pattern of Income Distribution in India : A Review", *Sankhya : The Indian Journal of Statistics*, Series C, Volume 36, Parts 2 and 4, June and December 1974 pp. 103-38.

21. Partly, because changes in the ratio of income assessed for tax purposes to national income may also be caused by (a) changes in the effective exemption limit for income tax purposes, (b) changes in provisions relating to the grant of various exemptions, reliefs, deductions and rebates, and (c) changes in the quality of tax administration.

to a considerable degree upon the extent to which such measures are complemented by other policy actions of the development authorities. This is true because the latter, in operating the devices influencing the relative prices of capital and labour, can determine how much of the potential improvement in labour intensity will actually be realised. For practical purposes, it is indeed significant that perverse behaviour of certain key variables can choke off the positive effect of the above measures on labour intensity, thus negating the best of one set of policy intentions.

Second, a bold effort will also have to be made to create conditions which are most favourable for the consumption of labour-intensive output and which are inimical to the consumption of capital-intensive products. Fiscal policy can be of significant help in creating these conditions by directing the prevailing income distribution towards the consumption of relatively more labour-intensive products, as also by reducing inequalities in such a manner that the resulting pattern of income distribution is conducive to the consumption of a more labour-intensive output-mix.

The recent developments give an indication of the ruling Congress Party's determination to make a real move from a socialist platform to a socialist reality. We welcome these developments, but feel that a lot more will have to be done. Let us hope that those in power will rise fully to the occasion and take measures which not only remove the biases towards capital-intensive technologies but also influence the factor-mix and the output-mix in such a manner that the end result of a truly labour-intensive economy is achieved.

Transfer of Sponge Iron Production Technology from Laboratory to Industry

V. A. Altekar **V. S. Sampath**

Sponge iron is a product of solid state reduction of iron ore lumps, pellets or fines. Sponge iron so produced contains most of the original iron oxide in the form of metallic iron. It also contains the impurities like silica, alumina, etc. which are originally present in the ore, in the same form, as they are not reduced under the conditions obtaining in the production of the sponge metal.

The sponge iron is a highly metallised product which may contain metallised iron to the extent of 85% to 95%. It is, therefore, obvious that the purer the original ore, the higher the grade of the resulting sponge iron.

Sponge iron has several advantages as a melting stock over steel scrap, viz.,

(i) it is an excellent melting stock for mini-steel plants;

(ii) it provides a graded and uniform feed stock;

(iii) the physical size enables its application for continuous feeding to the electric arc furnace for steel making;

(iv) it offers higher productivity;

(v) it lowers power consumption;

(vi) it can form a convenient addition to the L.D. converter as a coolant.

The technology of direct reduction has the following major advantages :

(i) Direct reduction for sponge iron production can be a source of primary steel making facility when integrated with electric arc

melting furnace and continuous casting. The concept of mini steel plant can be achieved by such an integrated unit.

(ii) The direct reduction units with capacities ranging from 30,000 ton per annum to 300,000 ton per annum can be economically established, involving relatively very low capital investment unlike the conventional blast furnace, coke ovens, B.O.F. complex which have to be several times larger in size to be economical. The investment requirement for sponge iron plant is about Rs. 1,000 per annual ton for installed capacity only.

(iii) Direct reduction units can be based on non-coking coals and established at various regions where good grade iron ores are located, whereas blast furnace technology depends on selective raw materials and metallurgical grade coal.

Relevance of the Direct Reduction Technology Under Indian Conditions

The technology has great significance to the conditions obtaining in the country. India has large resources of iron ores of good grade and non-coking coals spread widely throughout the country, while coking coal deposits are limited and occur within a rather narrow geographical region. The following factors contribute to the concept of mini steel plants based on sponge iron :

(i) High capital cost involved in the establishment of steel plants based on blast furance technology.

(ii) Non-availability of suitable grade of coking coals.

(iii) Substitution of scrap which is becoming scarce and thereby retarding the rapid development of mini steel plants based on scrap steel.

(iv) Regional development of the steel making capacity in wider areas of the country to remove the imbalance in the industrial development of those regions.

Apart from these, sponge iron has several advantages over scrap steel as melting stock.

Sponge Iron Production Technology

There are several direct reduction processes, but till recently, only three of the processes were commercially operated with good success. A number of plants have been established based on these technologies. Basically, they can be classified into two broad groups, viz., those based on solid reductants and those based on gaseous reductants.

It has been observed that the direct reduction technology based on gaseous reduction have attained a better measure of success due to their continued trouble-free operation over fairly protracted periods. As for those based on solid reductants, the problems relating to design and engineering had been the major problem holding back the progress of those processes. Every day the gap is getting narrowed down with new innovations.

India has to depend more on the technologies based on solid reductants as we have an abundance of non-coking coal and lignite. We have rather limited resources of natural gas and, although, of late some promising areas have been located, they need to be fully assessed and developed for exploitation.

The National Metallurgical Laboratory, keeping in view all these aspects, launched a multi-directional approach to evolve a suitable technology for adoption in the country, based on the indigenous sources of raw materials. The various investigations under active progress can be briefly classified as :

(i) Rotary kiln reduction based on coal,
(ii) Vertical shaft furnace based on coal,
(iii) Vertical shaft furnace based on naphtha,
(iv) Vertical shaft furnace based on coal gasification.

Among the various approaches, considerable progress has been made on the process based on rotary kiln reduction, and this technology is now under transfer to the industry.

In 1970, an existing rotary kiln of size 10 metres long and 0.9 metre inside diameter which was primarily used for drying, calcining,

and pre-hardening of pellets etc. was modified to suit the production of sponge iron. Initial trials were very encouraging and high degree of metallisation, over 90% was achieved. While testing a new sample of ore and coal from a different source, the results were rather disappointing in that it gave a metallisation of only 70% and also affected the smooth operation of the kiln, resulting in the abrupt closure of the campaign.

It then became necessary to study the characteristics of the raw meterials and suitably match them for optimum reduction in the kiln. A number of iron ore samples from various sources were studied and successful campaigns were run with iron ore and coal deposits from Donimalai, Kiriburu, Bailadila, Surajgarh, Barpada, Ghugus, Singareni, Bellarpur, Talchar, Rampur, Samla etc., where production rates of 3-4 tonnes of sponge iron per day were achieved. It has been established by several campaigns that metallisation may vary from ore to ore and range between 85%-95%.

To optimise conditions for trials on larger scale, continuous improvements and modifications of the original kiln were effected and this in itself has generated a good knowledge about design aspects to enable the laboratory to undertake design of mini sponge iron plants of capacities ranging from 30,000 to 50,000 tonnes per year.

Several hundreds of tonnes of sponge iron were produced from the experimental kiln. The sponge iron so produced has been successfully employed for steel making in industrial electric arc furnaces.

Transfer of Technology to Industry

To convince itself and gain complete confidence of the technology developed, the laboratory carried out several campaigns by arranging to obtain raw material samples of varied characteristics from different regions. This approach had to be initiated to take care of the possible problems that may arise out of the vagaries in the nature of the raw material resources.

The laboratory carried out persistent and patient work involving several extensive trials and produced sponge iron on tonnage lots. Several state

sector projects on the pilot-plant trials for sponge iron production based on their local raw materials were undertaken such as from APIDC, IDCOL, etc. Sponge iron melting trials were initially conducted in a 0.8 tonne capacity electric arc furnace unit in the laboratory. Based on the success of these trials the laboratory initiated correspondence with the HSL-Bhilai and the HEC-Ranchi.

Tonnage lots of sponge iron produced at the NML were transported to these plants to carry out inplant trials in their large sized electric arc furnaces. These trials were very successful and created considerable confidence in translating it for commercial purposes.

The laboratory has also prepared a technical fesasibility report for the establishment of sponge iron production units in the country with capacity of 30,000 tonnes per year.

A proposal was also made to the ministry of Steel and Mines for funding a project. Similar proposals were also made to NCST. The laboratory had been very persistently trying to identify a customer who could finance this project to enable the process to take deep roots in the country and assist the existing and projected mini-steel plants.

Unfortunately, there has been considerable delay in obtaining a favourable response from either the steel ministry or the NCST.

In the meantime, the laboratory started tapping other alternatives. The potentiality of the technology and the socio-economic importance of the project were highlighted on various platforms so that the technology is not allowed to rest on the way-side, loosing its vitality.

The laboratory did not have the necessary finances to go ahead in a big way on its own and had to seek the help of an entrepreneur. In the end, an entrepreneur, M/s. Andhra Cement Co., Vijayawada, Andhra Pradesh, was identified who commanded certain infrastructure facilities. The company had an old cement kiln 45 metres long, which was placed at the disposal of the NML in January, 1974. The kiln was examined and it was found that it needed many modifications.

A team of scientists, embodying various disciplines of the laboratory visited the plant and necessary design modifications were drawn out and

sent to the firm. The kiln was modified in a record time and no load tests were carried out in January, 1975 under the supervision of the NML scientists. Further, modifications were again suggested in the light of the performance of the blank run of the kiln. After the completion of the final modifications, the rotary kiln was got ready for regular test trials in March, 1975.

In the mean time, the raw materials to be tested were evaluated in the laboratory in all respects to optimise the operational parameters for rotary kiln trials.

The unit was commissioned fully and regular campaigns were initiated. The results have been very encouraging and metallisation between 85-90% has been achieved. Under highly optimum conditions metallisation over 90% has also been achieved.

The experience gained by the NML scientists in the design and commissioning of this prototype-cum-demonstration unit will greatly help in establishing similar units or even larger units in various regions of the country.

The entire plant can now be fabricated within the country, involving no foreign exchange. A plant with a capacity of 100 tonnes-per-day is likely to cost around Rs. 300 lakhs. It is estimated that in a 100-tonnes-per-day capacity plant which is logistically located, the cost of production per tonne of sponge iron would be in the range of Rs. 350 to Rs. 400. The whole technology developed right from its bench scale to its present status of a prototype unit has given the concerned scientists the unique experience of how to make a dent in the industry from the stage of an embryo of project which has great potentialities.

It has also very well exemplified the fact that success is sure to come to those who are tenacious and have great perseverance. It has also demonstrated the fact that in India entreprenuership exists that is willing to put faith in indigenous technology and to take risk if required.

Building with Plastics : Prospects for Regional Collaboration

O. P. Ratra

Housing experts the world over are engaged in offering solutions to ease growing housing demand. These include, low-cost housing through pre-fabrication and industrialised building techniques, use of new and traditional building materials, as also their potential availability through conversion of industrial and agricultural wastes, and the plastics-based materials of more recent origin.

Building materials, as is well known, constitute an important factor influencing the total building costs, which in turn are rising rapidly, as against the consumer price indices. Wages tend to rise more rapidly than the cost of building materials. In other words, housing is becoming more costly in relation to other goods and services.

In the wake of expanding house building activities in developing countries, the increased production and availability of building materials have attained greater importance at national levels. It is an established fact that the traditional building materials fall short of their supplies, and at times, performance too, in view of the technological developments in the building industry.

Search for New Building Materials

In the search for new and economical building materials, major research and developmental efforts have been directed to plastics, in industrially advanced countries. The growth of world plastics industry has been enormous, from little over 3 million tonnes in 1955 to 43 million tonnes in 1973; by 1980 it is expected to touch 96-million tonne mark. And by 2000, it is estimated that synthetic products (thermo-plastics, lacquer raw materials, adhesives, synthetic fibres etc.) will account for about 78% of world consumption of structural materials, while, metals will represent only 19%. Today, plastics are next only to metals in the *per-capita* consumption of materials in the world.

To date, more than 200 plastics building systems—prototypes of all-plastics houses—have been designed and erected in major plastics producing countries. An International show for plastics houses was held at Lueddenshied, Federal Republic of Germany, in 1971. With a few exceptions, not many of these systems had actually been built and used as houses, as these were not found to be economical. However, these systems served as useful developmental efforts, and provided ready solutions for structures required for holiday homes, camping shelters, exhibition halls, sports arenas, as also for emergency housing. A variety of designs and architectural features have been evolved, and many of these have made use of glass-fibre re-inforced polyester resin, PVC extruded profiles, sandwich panels, and air-supported structures based on plastic-coated fabrics made of synthetic fibres—such concepts have been developed from the familiar inflatable structures and offer new and interesting solutions for roofing large areas, such as shopping centres and the like.

During the last two decades, the world plastics industry has concentrated its resources in exploiting potentialities of plastics for the building industry. Estimates to the effect that over 25% of the world production of plastics goes into various building applications, that the building materials market for plastics constitute around 5% in value, and building industry is the major consumer of plastics in the world, have not been uncommon in the published literature. If we carefully analyse the consumption figures for plastics in building in developed countries, we arrive at a conclusion that these indicate plastics applications for a range of individual building components/products, and the reason for their increased utilization is cited in favour of preferential adoption or substitution, or more appropriately, to upgrade the utilities and services in the building industry.

Since the latter months of 1973, the scope for expansion and diversification of the plastics industry has been questioned in various national and international forums, in view of the dramatic increases in price of crude oil. It is a known fact that hardly 3% of the crude refined in the world today is used for petro-chemicals.

There has been world-wide inflation. As a result, the pattern of consumption of plastics is one area that has been seriously affected. This obviously calls for re-assessment of the concept of dependence of

plastics industry on petro-chemicals, and the competitive position of plastics in relation to other industrial raw materials. However it has been observed that there has been substantial corresponding increase in the prices of traditional industrial raw materials. In general, it is found that the increases for finished plastics products are in most cases of the same order as those of competitive finished products made from other materials. It must be borne in mind that although plastics compete with traditional materials on price basis, their technical performance also has relevance in their overall acceptability. Because of lower density of plastics in relation to other raw materials, together with the less labour-intensive processing necessary for production of finished components, plastics have remained competitive, despite the fact that overall increase in their raw material cost has been greater than that for other materials.

Why Build with Plastics ?

The bulk of traditional materials are produced with a minimum of conversion efforts. The production of sophisticated materials like plastics, had necessitated the importation of manufacture and applications technology for developing countries. Among the several qualities which have favoured plastics in the manufacture of building components are their adaptability to mass production techniques in a variety of shapes and profiles to very close tolerances, light-weight, high strength-to-weight ratio, corrosion resistance, built-in-colour, light transmission, and ease of manipulation into components of any specific design. In terms of their applications in the building industry, plastics as new materials have certain limitations also, under actual conditions of use. In the early days of development of these applications, there have been charges and counter-charges by the building industry that plastics industry had been working in isolation of the user requirements, designing components without any consideration of the fact that the material properties of plastics were much different from those of traditional materials. There had been frequent failures of building applications in plastics, and as a result, plastics industry has gradually appreciated the basic requirements of the building industry and have been engaged in experimentation and perfection of a number of useful building applications.

A demand for increased use of plastics in general, and more recently, for a number of building applications has been created in developing countries. India, the Republic of Korea, Iran, Pakistan, the Philippines, Brazil, Chile, and Mexico, are some of the countries where plastics raw materials production has been established. Processing facilities for plastics into a range of end products, exist almost in all the developing countries. The average *per-capita* consumption of these materials in developing regions is between 0.2 to 1 Kg. The *per-capita* consumption in Latin America is around 4.74 Kg. It is estimated that by 1980, the consumption of major thermo-plastics in the developing countries in Africa, Asia, the Far East, Latin America, and the Middle-East would be around 4.90 million tonnes and this would hardly mean 5% share in total world production of plastics.

The following building applications in plastics have appeared in developing countries :

> Electrical fittings and fixtures, paints and varnishes and related surface coatings, water-proofing and damp-proof coarse materials, sanitary fittings and fixtures, bath-tubs and rooflight sheets in GRP, flushing cisterns in high impact polystyrene, thermal and sound insulation materials, water-stops and corrugated roofing-sheets in PVC; pipes and fittings for cold water services, soil-waste and underground systems, decorative laminates; wall-cladding and panelling in PVC and polystyrene; floor and wall coverings in PVC, nylon carpets, and adhesives for wood-based panel industry.

Noticeable changes, recently, have been the availability of high density polyethylene woven fabric, and PVC coated nylon fabric, which could be suitably used for designing emergency shelters, air-supported structures for exhibition halls.

Limitations of Plastics Building Products

The consumer acceptance of any new product is an important aspect of study. It is more so in the case of plastics building products being advocated for the developing countries. Developing countries require to encourage only need-based building applications in plastics, keeping in view the user requirements of the local building industry. The outright

acceptance of the use of plastics in the building industry based on the experience of industrially advanced countries has at times posed several inhibitions in promoting the use of plastics in the building industry in developing countries. Factors such as overlooking the socio-economic and climatic conditions and the absence of standard/performance specifications for plastics under conditions of use have also hindered the growth of the building applications in plastics.

The use of plastics building products exposed to extreme weather conditions, cold or hot and humid, has certain limitations, and if these are not taken care of while selecting the suitable plastics material for the required building application, including the choice of additives and colours, the product may lead to ultimate failure in performance. Efforts are being made by the plastics manufacturers and the research institutes in advanced countries to standardise formulations of plastics materials for products to be used under different conditions, but the problem still persists. The situation calls for a systematic study of these in developing countries based on local requirements and experience.

There is no denying the fact that plastics are basically 'delicate' materials to handle, vis-a-vis the traditional building materials, in building applications. Plastics do perform better in certain respects as against the conventional materials; however, their handling and installation on constructions site, require education and training of the users, and the tradesman in the building industry. After proper installation, the user, as a resident of the house is faced with equally critical situation of being guided with the term 'plastics' *versus* metal or wood, and their respective performance under conditions of use. This necessitates re-orientation of the user habits for owners of the houses incorporating plastics products in their design. The users in developed countries were faced with similar situations in the early stages of development of building applications in plastics. Over the years, learning from their initial failures, and improving upon the products, their experience has shown, that plastics are useful in upgrading the utilities and services in the bulding industry. On the other hand, many developing countries are still beginners, both in the manufacture and the use of plastics building products, and their local experience and failures will help them learn better for the requirements of the building industry. This is a gradual process, and the developing countries cannot afford to adopt these new materials and applications technology as fast as expected of them.

Prospects for Regional Collaboration

By 1980, it appears that countries in almost all the developing regions would claim to have their indigenous production of plastics raw materials. Petroleum producing countries in Africa and the Middle-East are already set out for industrialization and diversification, and the petro-chemicals-based plastics industry is one such field, likely to be exploited. Coupled with this, would be the local demand for housing, basic, low-cost, and other institutional and commercial buildings, and the fact that imported building materials/components represent between 60-70% of the total value of imports in the Middle-East and African countries. The need for diversification of the plastics industry to supplement local building materials production would be pertinent. Keeping these facts in view, and user requirements of the local building industry in respect of socio-economic and climatic conditions, it would be opportune to learn from the experience in this field from advanced countries, and it would be more appropriate to learn from the failures and the experiences of developing countries which are gradually approaching the status of 'developed countries'. In other words, the regional collaboration among developing countries for exchange of local knowledge and experience in the manufacture and applications technology of plastics in building would be desirable and useful. Regional collaboration in the field of development and promotion of the use of plastics in the building industry holds out good prospects of being advocated among developing countries. Developing countries which have built up expertise in the manufacture of plastics building products and their applications under local conditions, could exchange experience based on the local requirements and extend the same to less developing countries which are planning to establish plastics industries. This could take the form of exchange of technical know-how, and case-histories of manufacture and use; exports of plastics building products; formation of regional working groups, organisation of regional seminars, training courses, meetings; publication of technical reports on developments of mutual interest; and also undertaking applications development research programme region-wise by promoting only need-based applications in plastics, and studying their performance requirements under local conditions.

Since plastics are relatively new building materials, there are still reservations in developing countries on the part of architects, engineers and builders, in adopting or specifying these, especially in the absence

of sufficient quality control and standardisation both in manufacture and use. Technical bulletins under the titles 'Plastics in Building', 'Building with Plastics' and 'Architectural Plastics' are periodically issued by trade, professional, building research and development organisations. Further, seminars and training courses have helped bridge communications gap. The building research and development organisations in developing countries, in association with the local plastics industry need to encourage and undertake such activities.

Developing countries can ill-afford to invest large sums of money in undertaking research and development activities in the use of plastics in building. Certain aspects of the problem are required to be studeid locally and for this purpose, regional requirements and experience could be pooled at one source and work initiated through the research and development facilities existing in developing countries. The regional collaborative practice already exists for a number of scientific and technical fields, except, perhaps, for the plastics industry. The work towards plastics in building is to be co-ordinated regionally, and if not initiated already, the same is required to be undertaken on the regional experience. Applications development is time-consuming and costly and plastics products must be evaluated on their own merits.

Performance-Oriented Approach

The routine testing and standardisation of new building products including those based on plastics which are inadequately supported by local experience in manufacture and use, have invariably been found to be a failure in performance. The current concept of performance-in-use through research-oriented investigations, technical assessment and evaluation of new building products and techniques, first introduced in France under the name 'Agrement System' (now knows as ' vis technique') and later in the UK and other European countries has proved to be very useful for the building industry for adopting innovations in materials and construction techniques. Such a practice has also helped in making plastics acceptable for a number of building applications. The proposition of introducing 'Agrement systems' in developing regions/ countries appears to be promising since there is an awareness of adopting new building materials and construction techniques in relation to the development and promotion of improved building technology to meet the

growing housing demand. In view of this, the need to establish 'Agrement systems' country-wise or region-wise among developing countries, utilising the locally available testing and evaluation facilities can hardly be over-emphasized. Such a practice would infuse a sense of confidence while adopting building products and construction techniques, from one country to the other, in a region, and facilitate the spread and growth of innovations in the building industry including those based on plastics.

Research and development work are fundamental for successful introduction of new building products and techniques. With the pace of development in plastics materials technology – structural PVC and polystyrene foams, and plastics-composites in advanced countries and their diversification into building applications, the developing countries need to assess and evaluate these from time to time to determine their suitability for adoption in the local building industry.

The frequent *caution* that plastics are prone to fire hazards, and produce thereby toxic fumes and that their outdoor performance under tropical conditions is rarely satisfactory, and always questionable, has prompted the plastics industry to undertake development work in plastics-composites technology. Such developments are required to be undertaken in developing countries, advocating the use of plastics in conjunction with traditional building materials, industrial and agricultural wastes.

Role of Indian Technology

India holds a prominent position among developing countries in the manufacture of plastics raw materials and their applications. All the major thermo-plastics and thermo-setting resins are produced in India. In regard to processing equipment, while most developing nations have generally relied on imports from industrialised countries, Indian plastics industry has already developed an indigenous capability by means of joint ventures or licences from international manufacturers. Besides, a large number of machinery manufacturers have come up in almost every major town in the country, primarily engaged in designing and engineering small capacity machines, hand-operated or semi-automatic. The whole range of injection moulding, blow-moulding, vacuum forming machines, extruders and hydraulic presses are manufactured and cater to the requirements of the plastics industry.

Tool-making facilities have long been recognised as key to the development of the industry. Several large-scale processors have their own tooling operations. An institute for Plastics Engineering & Tools (CIPET) has been established with United Nations' assistance, at Madras since 1968. The Institute is well equipped and offers facilities for training of operators in mould making and mould design, both to the Indian plastics industry, and others from developing countries.

Though the current resin production facilities are in the private sector, the public sector is expected to play an important role in future, when the Indian Petro-chemicals Corporation Ltd (IPCL) complex goes into full operation by 1977. It will make available about 1,40,000 tonnes/year of thermo-plastics-low-density PE, polypropylene, polystyrene, and copolymers, nylon, and acrylics. An Applications Development Research Centre is also planned by IPCL at Baroda.

Commensurate with the planned petrochemicals-based resin production since 1968, the Indian plastics industry is poised for production target of 500,000 tonnes of various plastics raw materials by 1980, and this would amount to one-fourth share of total resin production among developing countries in Asia and the Pacific region.

The industry has developed a remarkable range of products for consumer and industrial applications including packaging, electrical and electronics and building construction. Building applications have been growing rapidly. Production of rigid PVC pipes for electrical conduits and cold water services which exceeded 10,000 tonnes in 1974, is likely to double during 1975. Other building applications like PVC floor and wall coverings, flushing cisterns in high-impact polystyrene, a whole range of sanitary fittings and fixtures in polyethylene, ABS and polypropylene, are presently accepted with confidence by the building industry. List of plastics building products currently produced and marketed in India is given in Annexture 1. Building applications under development include, PVC soil/waste, rainwater and underground drainage piping systems, overhead water storage tanks in polyethylene, and GRP; door and window-frames in PVC-resin wood-flour composites.

The National Buildings Organisation in the Ministry of Works and Housing has been responsible for evaluating and recommending development and promotion of building applications in plastics, and maintains well-

equipped 'Plastics-in-Building' information service for the benefit of engineers, architects, builders and would-be-entrepreneurs. The NBO has been appreciative of judicious use of plastics in building and promotion of need-based applications, keeping in view their performance requirements under local conditions of use. While the question of achieving economy in cost of construction is kept in view, the technical performance of plastics in building applications is not overlooked, as plastics should be studied on their own merits.

The NBO has been seized of the urgency of initiating Applications Development Research Programme on the use of plastics in building, and has recently taken up this work with the active co-operation and participation of resin manufacturers, Indian Petrochemicals Corporation Ltd, Central Institute of Plastics Engineering & Tools, and Building Research and Development institutions. In its efforts to extend its activities in the field through developing countries, NBO in collaboration with UNIDO has been engaged from time to time in propagating the judicious development and promotion of plastics in the building industry. As a result of these efforts, and NBO's active participation in UNIDO's activities, a seminar and training programme on plastics in building—are being planned by UNIDO, scheduled for Jan-March 1976 at New Delhi, for the benefit of developing countries. This will be the first of its kind initiated by UNIDO for developing countries and NBO's involvement and contributions, with the active participation of the Indian plastics industry, would go a long way towards increasing the utilization of plasics in the building industry in developing countries.

In the fields of exports, the performance of the plastics industry has been commendable. During 1974-75, the rigid PVC pipes for electrical conduits and cold water services fetched Rs. 2 crores through exports to Middle-East countries. Besides, a sizeable quanitity of electrical fittings and fixtures are regular/plastics products of exports.

Conclusion

Under bilateral Technical Co-operation Programmes or through the assistance of international agencies like the United Nations Industrial Development Organization (UNIDO), developing countries could benefit from the available experience in the manufacture and applications

development technology in respect of plastics building applications in India.

Though the concept of low-cost housing by building with plastics may not be achieved directly, there are evidences of successful experience in upgrading the utilities and services in the building industry through use and diversification of plastics in building applications. The comparative economy coupled with the technical performance are to be simultaneously advocated, while promoting building with plastics. Keeping in view the availability of raw materials, and the local requirements, socio-economic and climatic conditions, the following need-based building applications are suggested for mass-introduction and diversification through regional collaboration among developing countries:

1. For rural and urban water supplies, soil/waste, rainwater and underground drainage systems. Piping systems in Rigid PVC, high-density polyethylene, as replacements to costly GI/CI pipes.

2. Sanitary fittings and fixtures, like water taps, stop-cocks, showers, basin and sink wastes, gratings, syphons, float valves and balls, in polyethylene, polypropylene, and ABS; as replacements to costly and scarce non-ferrous metal fittings.

3. Flushing cisterns in high-impact polystyrene/polyprophylene; overhead water storage tanks in polyethylene/GRP.

4. Door and window-frames, and shutters in plastics-composites, (like PVC resin-wood-flour or polypropylene-wood-flour composites) structural polystyrene or PVC foam.

5. Cladding panels in thermosetting concrete i.e., industrial wastes like stone dust/gravel/fly-ash in conjunction with polyester resins.

6. Economic roofing sheets using waste polyethylene lined paper bags.

7. Emergency housing using high-density polyethylene woven fabric.

Annexure I

List of Plastics Building Products Currently Produced and Marketed in India

1. Surface coatings, paints and varnishes
2. Resin-bonded wood based panels
3. A range of electrical fittings and fixtures
4. Electrical conduits in PVC and PE
5. Pipes and fittings in rigid PVC and PE, including taps, showers, basin and sink wastes, wastes traps, float valves and balls etc. in polyethylene and polypropylene
6. Decorative laminates for surfacing furniture and panelling
7. PVC asbestos floor tiles
8. PVC coated wall paper, polystyrene wall panels etc.
9. PVC extruded profiles for panelling, partitions, shutters, louvers
10. PVC handrails, curtain rails and staircase nosings
11. Epoxy resin floor toppings for industrial floors
12. Rooflight sheets in GRP
13. Glazing and partition decorative panels in GRP
14. Polyethylene film for water-proofing and damp-proof course
15. Bath tubs in GRP
16. Concrete formers in GRP
17. Overhead water storage tanks in GRP
18. Flushing cisterns in High-impact polystyrene
19. Thermal and sound insulation material-expanded PS
20. Water-stops in PVC
21. False-ceiling panels in GRP, high-impact, and expanded PS
22. Window stays and fasteners in PP
23. WC seats in PF and UF, PS
24. PVC leather cloth (including foam PVC)

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Development Strategy for Electronics Industry: Ensuring Success of Technology Innovation*

A. Parthasarathi

The Bhabha Committee covered, in its path-breaking Report, a number of aspects of the development of a balanced electronics industry. These ranged from the volume and pattern of expected demand, to the magnitude and time phasing of investment in productive capacity needed to meet such a demand, to the strategy for developing in the shortest possible time a self-reliant base of manufacturing knowhow, to the manner in which production at various tiers of the industry should be organised, and the manpower needs for research, design development and manufacture. However, without doubt, pride of place has been given to the need for freeing the industry from its acute dependence on foreign sources of technology. The means for achieving this goal was repeatedly emphasised in myriad different ways throughout the Report, viz., a major commitment of resources to the generation of manufacturing knowhow through indigenous design and development (D & D), both within and outside production plants. The committee had a very convincing rationale for according such priority to indigenous D & D, as the following extracts taken from different sections of the Report indicate :

"The process of manufacturing equipment under licence has built into it a natural tendency towards obsolescence. Licences are normally sought to be obtained only for equipment which has been well tried out in use, and which has therefore been in production for at least some years. Another two years lapse after the licence has been obtained before indigenous production starts. In the fast-moving field of electronics this automatically means that the equipment which will be produced in the country will be at least five years out of date."

"Moreover, foreign collaborators often change their models, with the result that the components required for production of equipment under licence become difficult to obtain when their production in the country of origin is discontinued. Consequently, the indigenous industry will often be forced to stock large

*Reproduced from *Economic and Political Weekly*, Review of Management, Vol. V. No. 48, Nov. 28, 1970.

quantities of components to maintain the production of equipment under licence and for repairs."

"A serious and undesirable feature of the present situation is that foreign collaborators often dictate the sources of procurement [of components] themselves. This is accepted as the Indian manufacturer does not possess enough design expertise, even after paying for knowhow, to be able to adapt equipment designs to use components available indigenously or in the world market at competitive prices. This largely annuls whatever reductions in cost and in foreign dependence are apparently achieved by going in for foreign collaborations."

Taking its cue from the Bhabha Committee, the Electronics Committee has concentrated its attention, during the three and a half years of its existence, on placing contracts on laboratories, universities and companies for developing, what I shall for the moment call, 'know-how'. As of today the Committee has placed some 18 such contracts. The outlay on these contracts during the first year of actual finding, viz., 1969, has been around Rs. 33 lakhs while that in the coming year is about Rs. 1 crore. However, before the Electronics Committee came on the scene, and indeed even after, government agencies with major interests in electronics such as the Department of Atomic Energy (DAE), the Defence Research and Development Organisation (DRDO) and the Council of Scientific and Industrial Research (CSIR) had undertaken a number of D & D projects with their own funds oriented towards agency specific goals. Unfortunately, no data is available on the total number of D & D projects under way in the country as a whole, the problems they are tackling and the resources that have been utilised by them.[1] It is, however, possible to make a 'guesstimate' that during 1969 the total national outlay on electronics D & D was of the order of about Rs. 6 crores and that the number of scientists and engineers (but not supporting staff) engaged on it, again on an optimistic basis, was of the order of 7,000. These figures may be compared, in order to get some perspective, with the Rs 3 crores and 6,334 scientists and engineers, assessed as being engaged in electronics R & D in 1966.[2]

The question arises : have any of these projects reached the stage where even pilot plant or prototype production, utilising the knowhow generated by them, have been established ? It is a matter of regret that, as far as those supported by the Electronics

Committee are concerned, none except two can make such a claim to what is often used as a criterion of 'successful' D & D. The corresponding figures for projects undertaken as a result of decision taken at the agency level are unfortunately not known. It is, however, possible to secure an overall national estimate from a consideration of the proportion of electronics output,other than of radio receivers which is based on locally developed knowhow. I have computed this to be 40 per cent for the year 1966 (about Rs. 6 crores in absolute value) and 22 per cent for the year 1968.[3]

"Improvement' at such a pace in the aspect of the electronics industry to which the Bhabha Committee attached pride of place can hardly be taken as satisfactory. We are, therefore, forced to examine the fundamental reasons for such a failure.

As might be expected there is much disagreement as to what these reasons are. According to one school, the basic cause of such a low 'success rate' level for indigenous D & D is the abysmally low *absolute* of national expenditure on the activity. This school points out, in support of its contention, that had the growth pattern of D & D resources outlay recommended by the Bhabha Committee been really followed, the country should today be spending about Rs. 17 crores[4] on such activity instead of the Rs. 6 crores mentioned earlier. This school subscribes, if unconsciously, to the Freeman thesis[5] that, D & D, whether at the level of the laboratory, the company or the nation, is a 'threshold level phenomenon, with the result that unless 'an absolute minimum' amount of resources are invested in the effort, no results whatever will result. Of course, they are unable to indicate what this 'minimum' should be or, more importantly, what criteria should be applied to determine its magnitude. Consequently, there is a tendency to argue that whatever the minimum might be, our present outlays are so far below it that, for the time being at least, the 'sky is the limit' for increases in D & D outlays on electronics.

The second school argues that the pace of change in electronics is so great and the technology with which we started our effort at planned development of the industry in 1966 so far behind that in the industrialised countries that we should cease to be concerned about the adequacy or otherwise of our domestic D & D effort. We should instead, it is argued, "follow the Japanese road" and rely overwhelmingly on transfusions of manufacturing technology from abroad. Persons belonging to this

school cite in support of their argument the very fact that so much of our present electronics production is based on technology imported from abroad and so little utilises that generated locally.

Need for Technological Innovation as a Total Process

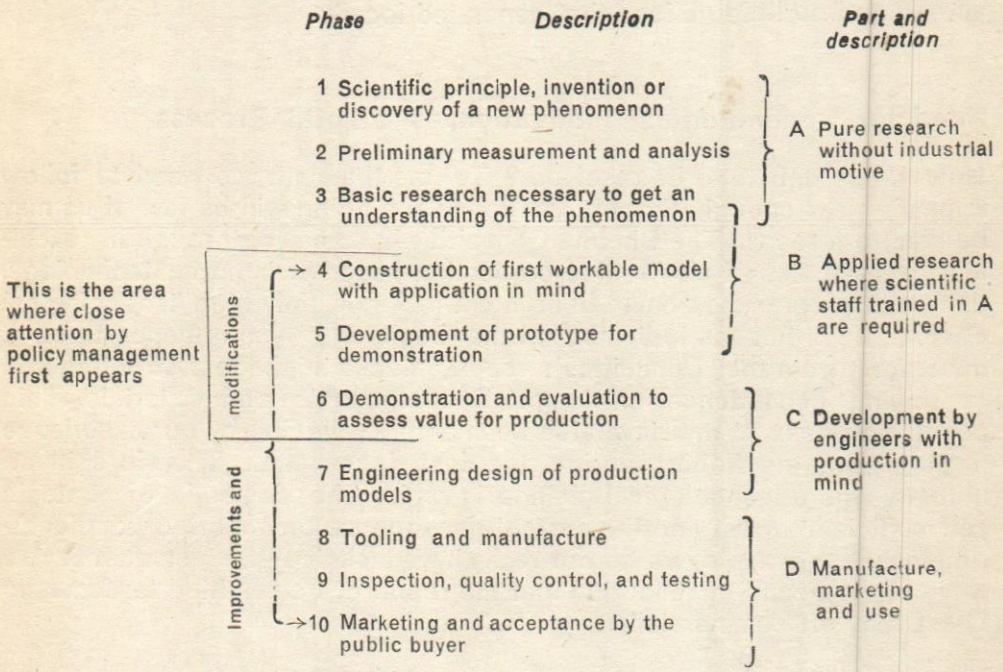
How is this debate to be resolved ? To me the path we need to follow appears clear enough, though how rough the going will be few of us may be able to foresee. The Bhabha Committee has shown, through its excellent case studies of electronics production based on imported technology, that such programmes have built into them not only high technological obsolescence but, as indicated at the beginning of this paper through quotations from the Committee's report, also a high cost structure and continuing dependence on imported components and materials. This conclusion has, in my view, also been amply validated by our experience in developing electronics during the last four years. Therefore, in an industry where technological change is rapid, the demands of strategic self-sufficiency great and the current dependence on imported manufacturing technology acute, we do not really have a choice—we just must devise ways and means of ensuring that the resources committed to domestic D & D pay off commercially.

If we are to have any chance at all to achieve this goal it is imperative that we accept the need for a fundamental change in the conceptual framework, the institutional forms and the executive procedures within which we have been attempting to pursue R & D in electronics. Such a change must arise primarily from the recognition that, in fact, the arguments of both these schools really miss the central issue, *viz*, that neither the mere performance of what we have been terming D & D nor the mere setting up of manufacturing activity using imported technology is a sufficient condition for sucess. The focus has to shift to conceptualising, institutionalising and implementing technological innovation in electronics as a total process.

The Innovation Chain

Technological innovation may be defined as the process by which knowledge on how to produce a product not available in a given

Chart 1 : **Technical Progress Chart Research Through Development to Use**



market, or how to improve the performance of an existing product, reduce its production cost or market and distribute it more efficiently, is made a reality. It is only during the last five years or so that even the industrialised countries have come to understand in operational terms, how technological innovation occurs. The process can be visualised conceptually in terms of a simple model of a chain made up of a number of links. This is shown in Chart 1. It will be seen that there are some 10 links in the chain, each of which constitutes a specific type of activity. Such a model brings home to us immediately that what the Bhabha Committee has called D & D is not a self-contained and self-sufficient activity but only one part of the innovation process. It therefore follows that even 'successful' D & D—and I shall come later to how 'success' in D & D might be assessed—will be of absolutely no value in an economic sense, unless it is both preceded and followed up by a number of other steps, closely interrelated with it.

Let us now examine the model shown in Chart 1 a little more carefully. I would, however, like to preface such an examination with a word of caution, *viz*, that the model has been borrowed from an industrialised country and so it may not be completely appropriate to the conditions prevailing here. It will be seen that the model has been so structured as to enable each activity in the chain to be associated with the kinds of manpower needed to undertake it, the goal such manpower is working towards and the institutional setting in which the work is to be carried out. Part A covers basic research, undertaken usually in academic institutions and, to some extent, in government laboratories, by scientific staff who are leaders in some specialised field, and aimed not at making any particular invention but at the advancement of basic scientific knowledge. Part B spans the gap between basic research and engineering design, which we often call Development. The kind of personnel required here are largely those with scientific backgrounds acquired from participating in Part A activity, but also include some engineers. The activity undertaken is often as complex as that tackled in Part A, but is more directed at producing a new product or process in the short term. Part C is a stage manned almost completely by engineers whose sole aim is to get products and processes 'ready' for production. The final part D deals with the (supposedly) well understood activity of industrial production, marketing, sales and after-sales service.

Implications for Policy Making

We can now draw several important deductions from the innovation chain delineated above, which are relevant to policy making. These are:

(1) Innovation is inextricably concerned with interfaces—technical, economic, institutional and behavioural—and it is on the identification of such interfaces and on ensuring smooth and effective flow of information and action across each of them, that successful innovation largely depends.

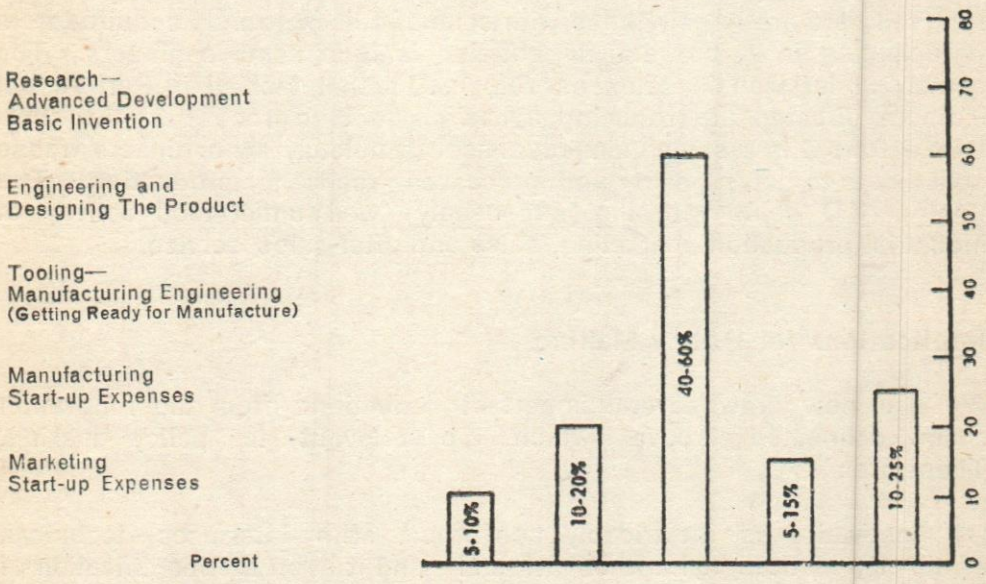
(2) The fact that administrative control over each section in the chain frequently lies in different hands makes such interfaces often 'no-man's lands'. This requires that, at least in the early stages of the development of an industry like electronics, the innovation process as a whole

must be conceived, planned and executed by a single overriding managerial authority.

(3) The activities in the chain are by and large sequential in occurrence but overlap considerably on all the three counts mentioned in (1) as well as in regard to time. This provides some scope for undertaking activities in parallel also, thereby shortening total innovation lead time.

(4) Each activity will take a certain minimum amount of time, no matter how large an investment in men and money is made on it.

Chart 2 : **Typical Distribution of Costs in Successful Product Innovations**



(5) The time-phasing of the various activities in the chain plays a crucial role in ensuring that the innovation is successful.

(6) There is a 'Resource Threshold' in terms of annual outlay on men, equipment and materials for each segment of the chain which must be crossed if the project is to move to the next segment in any finite time interval.

(7) The magnitude of such threshold level resources required to complete each activity is far from uniform across the chain, but will generally increase as one moves towards the final stages of the chain.

(8) While the ratio between resource requirements for various stages in the chain will vary from product to product, studies have shown that in a majority of cases the distribution of costs across the chain is typically as shown in Chart 2.

(9) The kinds of training and aptitudes that the manpower deployed in each of these stages must have varied considerably, particularly in regard to specialisation. The development of manpower must therefore be undertaken keeping in mind the nature of the activity which each type of professional is to be deployed on.

Causes for Our Failure

Once we have accepted the concept of the innovation chain, recognised its inherent characteristics and perceived their implications for technological policy, it is relatively easy to see why the resources the Electronics Committee and the departments with interest in electronics have been committing to research, design and development have not succeeded in giving us a broader and deeper base of manufacturing knowhow.

First, while the innovation chain concept is known to policy makers in a theoretical way, no attempt has been made to use it in real life decision-making. Moreover, at the so-called operational level of managers in industry and project leaders in D & D laboratories, there is often a lack of awareness of even the existence of such a chain. As a consequence, the fact that interface problems are bound to come up at some stage in the development of what starts off as a D & D project in a laboratory has, time and again, been recognised only when the laboratory claims it has completed its task but no manufacturing unit is willing to undertake commercial production, or the user denies that his needs have been met.

Secondly, the features of the institutional structure available to us in this country for producing technological innovation, viz., physical

separation of institutions responsible for various stages in the chain, lack of the most rudimentary information system on needs, production programmes underway, development projects in progress, etc., militate strongly against essential prerequisites for successful innovation.

Thirdly, much of the success of technological innovation and, more narrowly, of goal-directed D & D, depends critically on our having the ability to make demand forecasts with increasing accuracy. I might stress that by this I do not mean such assessments as the money value of the requirements of computers over the decade 1970–80 ! Demand forecasts in such terms are useless operationally. To provide an important input to promoting technological innovation, demand assessments will have to be reduced to product-specific terms. Such demand forecasting is difficult, and calls for the use of sophisticated statistical techniques. But the fact that for at least 60 per cent of the electronics needed over the coming decade, government will be the sole purchaser, should make things much easier. It must be emphasised, however, that equally important as having such a forecast at all is its availability sufficiently far in advance of the time when the product is first needed, to enable not merely D & D but also the remaining stages in the chain to have adequate lead time. Far too often in the development of electronics during the last four years has the demand forecasting effort started, or the demand made available to the Electronics Committee by the concerned government user, only when an offer for import of technology has been received from a foreign company or, worse still, when clearances for the import of the product itself are being sought. Thus development of use–directed domestic technology is repeatedly pre-empted.

Fourthly, both industrial units and laboratories in electronics are extremely weak in production engineering capacity, and indeed persons trained in the design, development and engineering of production machinery, jigs, tools and fixtures are extremely small in number. This has proved to be a major bottle-neck in ensuring that process know-how or product design, once proven on the laboratory scale, i. e., brought upto stage 6 in the innovation chain, can be carried forward to the next two stages, viz., engineering of production protoypes and designing and fabricating of equipment enabling volume production. A typical example is provided by the case of silicon, where the mono–crystalline

silicon pilot plants at both SSPL and Electronics Corporation of India Limited (ECIL) are being equipped almost completely with imported production machinery.

Fifthly, the very fact that the overwhelming bulk of our electronics output today is based on foreign technical collaboration has prevented manufacturers from having to face the difficulties of true technological innovation. Under a collaboration agreement the foreign company usually provides the following inputs :

(a) full complement of production equipment :

(b) detailed plant layout and either written instructions or its own personnel for installing and commissioning production machinery;

(c) details of production process, with blue-prints, production drawings, testing and approving procedures;

(d) bill of materials for product;

(e) training at their plant of our staff who are to supervise production and the testing and control of quality, volume, etc.,

(f) training of workers for various operations through the deputation of one of their foremen or equivalent production operatives to this country; and,

(g) consultancy services to overcome teething troubles.

These inputs correspond to a considerable transfer of resources, but only those related to stages 8, 9 and 10 of the innovation chain. This does not mean, of course, that the collaborator did not himself go through earlier stages in the chain, particularly from 4 onwards. But that experience is never communicated in the transfer process, even implicitly. Consequently, when presented with Indian technology which has only come as far as stages 5 or 6 the manufacturer is reluctant to commit the men, money and intellectual and managerial resources needed for him to learn how these stages are performed. This is particularly so when he is sure that he can continue to rely on 'packaged' technology from abroad on a continuing basis.

Essential Elements in a New Strategy

How then should one proceed if the electronics industry is to move out of this unsatisfactory state of affairs in regard to technological innovation? To be sure there is no unique formula, as different detailed strategies will have to be evolved and applied products ranging from computers to microwave communication systems and electronic materials. It is possible, however, to identify in the light of our experience hitherto a set of initiatives which an apex body like the Electronics Committee or a proposed National Electronics Development Board can take immediately to set things right.

First and foremost, such an apex body and, within their delegated spheres of responsibility, the government agencies, must see themselves as very much more than disbursers of funds for D & D. The apex body, in particular, should assume the global role of 'manager of technological innovation' in electronics.

To fix our ideas let us consider the case of a Sophisticated Electronic Test Instrument on which a D & D laboratory wishes to work and for which it approaches the national apex body for support. Here the paramount factor shaping the product chosen—its technical specifications, the process involved in its production and its end use—is the amount of information available to the D & D group (on both technical and commercial aspects) and the group's technical competence and interest. Were the D & D activity a self-contained one, the provision of such inputs might be deemed adequate for evaluatory decision making. But given the innovation chain, they are not. The apex body would therefore have to pose and secure answers to a whole range of wider questions, such as :

(a) what is the market for the product and how is it likely to develop in the future ?

(b) what are the criteria by which the technical success of the project will be assessed and by whom ?

(c) does the terminal stage of the project as defined by these criteria constitute an institutional interface in the chain ?

(d) assuming success, what forward action should the apex body or

others take to prepare for smooth transfer of technology across such an interface ?

(e) specifically, how much would the resources in men, money and time be to ensure that such transfer is supported at above the threshold level and is therefore likely to 'succeed' ?

(f) what would be the exact operational nature of the responsibilities of the two institutions of either side of the interface, e. g., a research laboratory and a pilot plant to be set up in a manufacturing unit ?

However, even the issues covered by these questions will, in many cases, not take one far enough. Particularly, in situations of the kind which face us in the country, viz., where a large part of the need for development-intensive electronics products is meant for government users, the apex body will have to go further down the chain than even the manufacturer and establish direct links with the user. There will then be a need to manage the transfer of technology (now as embodied in a product) across the producer-user interface. The questions to be posed will be different in substance but similar in character to those listed earlier. User acceptance will then have to be formalised appropriately. Only when all this has been done, can the 'innovation management authority' evaluate the adequacy or otherwise of the D & D project proposal which is all that it has in front of it to begin with. I think it is fair to say that such conceptual clarity, care and industry by a team of persons with a mix of technical, economic, legal and managerial skills has yet to be committed in the development and exploitation of indigenous electronics technology, whether by the Electronics Committee or indeed by any of the agencies. Thus, seeing that all existing projects are subjected to such an examination is a matter of the highest priority.

Secondly, a detailed review of professional electronics needs during the 70's and a forecast of the expected growth in consumer electronics products over the same period must be undertaken, at whatever cost in terms of men and money. Then, working in consultation with the professional electronics users, the apex body must draw up a list of priority products, the need for which must be met through indigenous technological innovation. Ranking these products in terms of their importance as judged by such criteria as strategic need, volume of requirements, and attainable technological sophistication, the apex body

should make the specifications of the products, the time phasing of their need and the design concepts to be used, known to both D & D laboratories and manufacturing companies. It should take the further initiative to establish, formalise and make mutually intelligible the responsibilities of these two institutions and of the users, in a multilateral co-operative endeavour not just of know-how generation, production or use, but of innovation. In this way the D & D institution, the manufacturing unit and the user will all be held accountable.

Thirdly, a major effort of analysis, decision-making and, above all, working in the field with manufacturing units in the engineering and machine-tool industry must be launched, to ensure that at least the plant and equipment required to produce the electronic components and materials needed for the industry during the 70's is fabricated and instrumented domestically. Unless this is done and done fast, more and more of our effort at earlier stages in the innovation chain will come to nought and the now familiar situation of process technology being imported even in cases where it has been successfully proven to the user, because the overseas companies supplying the plant and machinery required make the import of the process technology itself a condition for the supply of plant, will continue.

Fourthly, the apex body and the government agencies with major responsibilities in electronics have to build up on a most urgent basis 'technological innovation teams' whose full-time responsibility would be to structure, promote and manage the innovation chain in electronics. The members of these teams should be trained in a wide range of analytical skills ranging from demand and technological forecasting, to cost-benfit analysis, PERT, and other elements of programme planning and management. Their most important requirement, however, is to be able to work in the field, locating the interfaces and matching the activities straddling them.

As emphasised earlier, it is practically impossible to design a successful strategy for technological innovation on a global basis, particularly when, as in an industry like electronics, we have to deal with products ranging from specialised materials to large integrated systems. The five inputs discussed earlier must, therefore, be regarded as necessary but not always sufficient conditions for success. The range of factors to be included in any particular instance can only by decided

through carrying out, at both the national and the agency levels, a series of real life case studies on technological transfer and innovation.

It is in pursuance of this conviction that the Electronics Board of the Department of Atomic Energy has been undertaking such a case study during the last six months. The experiment involves a set of Microwave Test Instruments 'developed' by the Tata Institute of Fundamental Research. These Instruments had been brought to the stage of pilot plant production at the Institute by the time the matter of their commercialisation came to the attention of the apex body in this case, viz., the Electronics Board. The task before the Board was, therefore, to successfully carry out all the remaining activities in the chain. The experiment is still in progress and therefore no conclusive results can be given at this stage. However, many useful insights have been acquired and particularly difficult interface problems identified.

Conclusion

The need to 'produce' technological innovation poses a fundamental challenge for the development of our electronics industry, viz., to learn the behavioural, institutional, technical, economic and managerial intricacies of this process and apply the understanding so acquired in the policy making and executive arenas, or give up the resolve to develop an autonomous industry altogether.

Notes

1. However, see Brigadier K K Mehta's panel statement at the National Conference on Electronics held in Bombay in March 1970 (NCE-6) in which he has given a figure of Rs. 3 11 crores as the R & D outlay during 1969 on the 4 electronics laboratories in the DRDO.
2. "R & D Activities in Electronics" in "Electronics Information Potential in India", INSDOC, New Delhi, 1967.
3. See my panel statement at the National Conference on Electronics (NCE-7).
4. This figure is computed on the basis that :
   (a) the national D & D outlay in 1964 was Rs 4 crores ;
   (b) that starting from such a base level, attainment of an annual outlay of Rs 75 crores on D & D (excluding long range basic research) requires a compound growth rate of 34 per cent ; and
   (c) that at such a growth rate the outlay anticipated should be Rs 17.4 crores in 1969.
5. C Freeman : "Research and Development in Electronic Capital Goods". *National Institute Economic Review*, London, April 1965.

Exotic Technology and Performance of the Indian Economy : Key Areas of Failure

V. S. Mahajan

Quite often the exotic technology is blamed for the poor performance in a developing economy. This, one feels, is an unjust charge and needs to be repudiated. One can hardly think of a country which starts from a scratch. In the beginning every country has to borrow technology from some other (advanced) country for changing the traditional mode of production. History well supports this. Great Britain In the 17th century borrowed technology and skills from the Continental Europe ; and the Continental Europe, in return, borrowed liberally from Great Britain in the 18th century. This shows the circularity and feedback of technology. The USA borrowed liberally from Great Britain and the Continent in the 19th century (especially during the early period); and in the 20th century the USA has emerged as the world's largest workshop of technology and has been feeding the world market. Japan borrowed from the USA and the West in the latter part of the 19th and early parts of the 20th century, and Japan has now emerged as an important feeder of technology to many countries.

India, in the middle of the 20th century (especially in the 1950's and early 1960's), has been borrowing substantially from the USA and Western Europe (though earlier she was mainly dependent on Britain because of her political ties). From the latter part of the 1960's, India has been leaning on the Socialist countries (mainly the USSR) for the transfer of technology. It is because of continuous flow of exotic technology that India has been able to accumulate capital (especially in basic and capital industries) during the last over two decades at a rate it was never done in the past. It would have been unimaginable for her to produce steel, machinery, equipment, components and parts, and intermediate goods (including fertilizers, cement, chemicals) but for her having a liberal access to technology from the advanced countries. Thus the contribution of the exotic technology in her recent growth has been substantial.

This at the same time does not mean that India has made the best possible use of the exotic technology. In fact it is this part of technology that needs further probing, i.e., why India has failed to make an

optimal use of technology. It is not that imported technology is bad, but the fault generally lies in making an appropriate use of such technology. One has to pose questions such as : Does the exotic technology help to speed up the rate of local development ? Does it help to train local people so that in due course of time they could independently operate such technology ? More importantly, how far the imported technology is adapted to the conditions obtained in the importing country ? For instance, a developing country may be having abundance of mostly unskilled labour force and shortage of capital, while the exotic technology is developed under a different set of factor situation (scarcity of labour and abundance of capital). Thus to obtain appropriate results such technology would have to be adapted to suit the factor situation in a developing economy.

Adaptation of Exotic Technology

It is felt that the problem of adaptation of exotic technology to the conditions obtained in a developing country is of fundamental importance. Again the historical experience lends full support. The Industrial Revolution in Great Britain in the 17th and 18th centuries was the result of her people's ability to adapt exotic technology to the emergent national and international situation. The development of steam power became the main focus for the development of railways and steamships which enabled Britain to gain supremacy in international commerce over other countries. Putting it slightly differently, the development of steam power (which had its immediate impact on the development of coal mining) would not have gone very far if there was not sufficient feed-back in the shape of development of machinery and transport sectors (the main users of steam power in those days). Thus it goes to the credit of the British technicians that they were able to adapt new techniques of productions for accelerating their growth rate. In the 19th century, the USA was able to make far-reaching changes in both farm and industrial techniques and thus has emerged as the world's richest country in the 20th century. Japan which had borrowed the technology from the USA in the initial stages of her development had found that such technology was not suitable to her local conditions. For instance, she found that the machinery developed for big-sized farms was not at all suitable for her small-sized farms. It was also found that when Japan had employed foreign farm technicians in the

earlier part of her development, they were not acquainted with local conditions. It was through persistent effort and zeal of the local people (especially the administration) and giving time and sufficient incentives to foreign technicians that soon it became possible to develop new techniques suitable for the Japanese farms, and also because of efficient farm extension programmes, these techniques gained countrywide popularity. Japan also made a remarkable adaptation in industrial techniques and developed techniques which could suit her factor situation (abundance of cheap labour and shortage of capital). If today Japan is the world's best organised and developed country for small industries, it is in no small degree due to the ability of her people to develop suitable means of production after thoroughly mastering the imported techniques.

Recently China has shown how a backward country, containing the world's largest population and possessing limited natural resources and capital could forge ahead of all developing countries through sheer determination and ability of her people to adapt exotic techniques to their local conditions. It is well known that for the first ten years of her development, after the founding of the Republic (in 1949), China was exclusively dependent upon Russia for technology and technicians. However, she used this opportunity for the maximum assimilation of the new technology and for training her people in new methods of production. In fact, such was the rate of assimilation of exotic technology that after 1960, there was no need for the foreign technicians in the country and they were sent back. By the middle of the 1960's, China was depending upon her own technicians for the operation and maintenance of all imported plants. Not only this, simultaneously her technicians were busy developing alternative techniques of production which could suit local conditions, i.e., developed techniques which could meet the need of small farmers and scattered rural population which formed nearly 80 per cent of her total working population.

Let us give a concrete example. It was found that while large (exotic) cement plants were all right for feeding urban areas, these were ill-suited for feeding the needs of rural areas. And if industry was to be decentralised—which was the only way to contain population in rural areas and avoid their shifting to already overcrowded urban areas—rural areas should have a sufficient quantity of cement for the construction of small industrial complexes as well as for building rural houses,

farm buildings, schools and community centres. Thus, through continuous effort the Chinese technicians were able to develop small-sized cement plants which could be set up in rural areas without difficulty and which used local inputs. In fact, it is said that at present over half of the total cement produced in China comes from these small plants and the rest from the big-sized plants. This is an isolated example showing how an important basic item like cement is produced in China and how it has helped to speed up construction in rural areas as well as made life of the rural population more comfortable and happier.

Performance of Exotic Technology in India

Unfortunately in India, despite 25 years of planned development, it has not been possible to develop technology to suit her own conditions In other words, India has failed to develop alternative techniques which could have helped her to accelerate production and employment. The development of suitable technology in the farm sector which could adequately meet the requirements of small farmers is still a far cry ; e.g. while India has emerged as the world's important manufacturer of tractors, these tractors continue to be prototypes of Western tractors and the country has failed to develop small tractors (or even hand power tillers) which could cater to the needs of small households.

India happens to be the world's second rice grower (and rice also happens to be the staple diet for the majority of her population), but the yield per hectare continues to be very low. This shows that her farm scientists have failed to develop high-yielding varieties in rice as well as technology suitable for rice cultivation. In electric power, India still depends heavily on the outmoded equipment which also has a high import content. Much of the present power crisis could have been averted if the country had developed her power equipment, especially of the type which could cater to the needs of the rural population.

In the industrial sector, the situation is equally gloomy. Most of the equipment in basic and heavy industry is of complicated nature. Despite years of functioning, these plants continue to be dependent on foreign technicians for their operation and maintenance. Further, most of these plants operate below capacity, thereby entailing a huge waste to the

national exchequer. Thanks to the present communication and marketing facilities, basic goods are only available in urban areas and not in rural areas, though 80 per cent of India's population lives in rural areas. This partly explains the paradox that while India has a huge domestic market most of the plants continue to operate below capacity Further, the domestic market is so scattered that it could be approached effectively through the development of new techniques of production which could help de-centralisation of means of production. We have already considered earlier how China has de-centralised the production of a basic industry (cement), through developing small-sized plants. Unfortunately, India has done nothing of this type. Cement consumption in this country is confined to urban areas and rural areas generally do not get it. Under this situation, it would be no more than wishful thinking to develop the rural sector.

Thus, the conclusion is inescapable that while India has borrowed exotic technology heavily over the last two and a half decades, she has yet to adapt this technology to her own conditions. There is no self-reliance in technology. Rather in this matter the country is very heavily dependent upon Western and Socialist countries. That such dependence is not a healthy sign (i.e. exotic technology is not suitable to India's conditions) is reflected in the poor performance of the economy—one important indicator of this is that the country has had just half the growth rate in national income than what has been planned under various Plans. Not only this, the decennial average growth rate (in constant prices) is unfortunately declining. Thus, if India is to have the minimum of 5 per cent growth rate—which is not ambitious either—it would have to adapt suitably the exotic technology to suit her factor situation. This would need political will and concerted effort of both technicians and administrators.

Readers' Page

In January-March 1975 issue of PRODUCTIVITY, K. Kasturi, in his paper "Small-Scale Industries : Too Much of Feather-bedding ?" has accused the small entrepreneurs of becoming "a much-pampered lot". He says, "but the peculiarities of our support system only encourage the infant to remain infant, clamouring for increased support all the time. Under an ideal system, one would expect the small industrial units to benefit from the props offered, grow in strength and cease to look for support". (Page 412)

I have only to point out to Dr. James J. Berna's book "Industrial Entrepreneurship in Madras State" and to the comment of Eugene Staley : "This proves that it is at least possible for small-scale industry in India to serve as a seedbed for medium scale industry, and it justifies further the efforts being made by government of India to provide small-scale manufacturers with better opportunities for access to modern technical and managerial knowledge and to the financial and other requisites for growth".

Mr. Kasturi is unduly concerned with official patronage to small industry.

—Amarjeet Singh,
New Delhi.

Book Reviews

PERT and CPM Principles and Application

L.S. Srinath, 2nd Edition

East-West Press, 1975, Rs. 25.00

Reviewed by Rakesh Kumar*

Any student of management can hardly quote a few Indian books in the field of management he can be proud of. 'PERT and CPM Principles and Applications' is one such book written by L. S. Srinath, Prof. of Mechanical Sciences, Indian Institute of Sciences, Bangalore. The second edition of this book appears to be more presentable in its present get up and format. Two more chapters have been added, one on 'Linear Programming and Critical Path Scheduling' and the other on 'Problem Formulation for Computation'. Other new features include the division, with modifications of the original chapter nine into two chapters namely, Resource Allocation, and Management and Network Analysis.

Mr. Srinath has mentioned in the preface, 'the technique of PERT and CPM are being extensively used to solve not only phenomenal problems, such as those connected with missiles and space travel, but also simpler problems costing only a few hundred dollars. The objective of this book is to explain what PERT and CPM are and how they can be profitably used to solve such management problems'.

The book meets its objective partially as it does explain what PERT & CPM are and how to solve problems costing only a few hundred dollars, but it is silent about the applications of PERT in phenomenal problems. PERT and CPM techniques of drawing networks have been methodically discussed. All aspects of computation on networks have been covered including time estimates, costs and resource levelling The book also contains a brief write up on the various statistical principles used for computing various parameters on networks. In all, there are twelve chapters and each is accompanied by a set of problems for practice. The solutions too are given at the end. The book, in its present form, is a comprehensive text and there exists scope for introducing some real case example. While going through this book whereas one gathers information about the network techniques, one remains ignorant about the problems encountered in planning and execution of projects in the field.

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It is, therefore, suggested that in the next edition of this book, some case studies with special reference to India from the field on application of PERT may be introduced. This will make the book more practical-oriented.

Computers have proved very useful in PERTING big projects and package programmes are available. This book has altogether omitted to discuss the application of computers in PERT. While the introduction of chapters on Linear Programming and Critical Path Scheduling and Problem Formulation for Computation is a step in this direction there is a need to lay emphasis on computer applications without which PERT could not have gained the importance it enjoys today.

In short, Srinath's book is an excellent introduction to the techniques of PERT and CPM. The book can serve as text-book for the students of management science. It is useful for anyone who wants to acquire basic understanding of PERT and CPM techniques, be he a project engineer, planning manager or any other executive.

Fundamentals of Business Organisation and Management

Y.K. Bhushan

Sultan Chand & Sons, Delhi, 1975

Reviewed by Dr. G.R.S. Rao,*

This publication (8th edition) coming from an author with wide experience, is primarily addressed to the student community and on that score, has been subsidised by the Government of India.

The text-book approach is fairly reflected in the coverage of topics which include Business System, Business Ownership and Size, Company Management, Business and its Environment, Principles of Management, Production Function of Management, Personnel Function of Management, Marketing Function of Management, and, Financial Function of Manage-

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ment, in as many parts—which are grouped into two volumes.

The first part sets the problems and prospects of business, what may be called the 'National-Political' perspective which constitutes the environment within which business organizations operate. However, viewed in the context that is primarily meant to serve the student community, a glaring vaccum in coverage appears to be the absence in the theme of the volume a cross-cultural perspective – role, philosophy and structure of business organizations in capitalist, socialist and other shades of social systems. Treatment of the problem in a cross-cultural context would enable the readers to appreciate not only the emergence of the wide range of theories, but also an of the divergence among the available body of theories. Whereas such a cross-cultural perspective provides a rationale for specific approaches and policies, the absence of such a perspective makes knowledge of particular approaches.

This cross-cultural perspective is also essential for students in the context of growing strength of multi-national corporations, which necessarily have to take divergent and often conflicting socio-economic system and cultural contexts.

A distinctive feature of the publication is that the material presented in the book merely end up with a review of the body of theories but also fairly elaborately covers policy. The advantage of such a coverage would have been enhanced had the author also covered and explained with the aid of examples and dates the wide range of divergence in actual practices.

The language is simple and direct and the print is good, although not without its quota of printer's devil.

The basic limitation, however, is with regard to heavy reliance on theoretical base which is alien to the Indian context, and absence of an explanation of the consequent incongruence. Absence of an attempt to review the Indian situation vis-a-vis the incongruity exposes, at least in part, the student community to distortions in perception and appreciation of the subject matter in a proper and broader perspective. However, this is a problem that is common to most of the publications—the present one is no exception.

Planning, Development and Economic Policy in India

V.S. Mahajan

Kalyani Publishers, Delhi, pp. xvi +340, Rs. 36.00

Reviewed by C.V. Rao*

The subject of economic planning for a moderate rate of economic development for any nation depends mainly on the policies adopted by them. But this is not the end in itself. Clear-cut objectives, judicious selection of priorities, line of action, their implementation, overcoming the bottle-necks in an effective manner, and more importantly, stepping up the rate of growth of productivity in a variety of sectors do contribute positively towards an accelarated rate of growth of the economy.

We, in India have had enough experience of plans and planning models since independence. More so, every plan was ambitious at the start and ended up with more negative points than plus points, thereby presenting a gloomy picture. Unfortunately, none of the Five-Year Plans in India, have been able to fulfil the objectives laid down from time to time. Though the nature of disappointment hardly varied, the degree of gloominess varied from plan to plan.

There are many writings to date to assess the success and failure of Five-Year Plans critically, and the book under review is also one of those which has added something for researchers to chew for some time. Without saying it explicitly, Mahajan has adopted an inter-disciplinary approach, but does not clearly state how development takes place and what are the various characteristics of economic backwardness which are inter-related and complementary to each other. This is important because planning is always preceded by a dig into the developmental process and on the basis of the study of this process the conventional theories of development are replaced by modern theories of development.

The book is spread over seven parts and 18 chapters. Part I deals with the development process during the Plans and has not much to contribute to the earlier criticisms provided by most of the writers.

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Part II deals with one of the most important sectors of economy—Agriculture. It is true that agriculture provides a good indicator for judging the growth rate of an economy. But it is realised that in spite of the increase in per capita availability of food-grains, increased production, better use of fertilisers and pesticides, etc., have not contributed much towards so-called *Green Revolution*. There has been considerable increase in production of wheat or rice but the production of other food-grains has, by and large, increased marginally. More so, it has been shown that the Green Revolution has not spread over the whole country but has resulted in an intensive cultivation rather than extensive, and the concentrated areas are Punjab and Haryana. Besides this, according to Mahajan, "The fruits of Green Revolution are pocketed mainly by rich and prosperous farmers and the disparity between them and have-nots —particularly landless agricultural labourers - has increased." (Page 49). Thus, in order to come closer to the socialist reality, new strategies for agricultural growth have to be adopted.

As far as the policy goals and their fulfilments are concerned, the author has rightly pointed out the drawbacks of community development programmes, national extension services, role of gram sahayak, panchayati raj, etc. and feels that progress cannot be made in the agricultural sector unless stiff policy instruments and better control over the functioning of these programmes and services are adopted which would provide a sense of confidence and enthusiasm among marginal farmers and agricultural labourers.

Another important sector—Industry, has been segregated into small scale industries and medium and large scale industries and have been discussed at length in the light of the Industrial Policy. One might agree with the author that the size of the investment in this sector is not that important, whereas, the nature of investment plays a decisive role. In dealing with a crucial subject like Industrial Policy towards large-scale industries, the author's analysis suggests that the government is justified in extending the field of public enterprises for rapid industrialisation and exploiting those areas which do not attract private enterprise. In doing so, Mahajan has mixed up some of the fundamental issues relating to a balanced approach for development, but has failed to provide a serious discussion on Industrial Policy.

According to Mahajan, the organised consumer goods such as cotton

textiles, sugar etc. have reached a stage where further growth of demand for their products is bound to be slow. Hence, the government should devote more attention to capital industries and allow consumer industries to organise themselves as per the market situation. Firstly, the above two mentioned facts are not compatible, and secondly, the latter is not a worthy suggestion. This is because, as is known, the use of inappropriate technology and production of non-essential products can at times change the consumption pattern in an economy like ours. Moreover, one cannot pass a sweeping judgement that cotton textiles and sugar industries have to be ignored. The reviewer firmly believes that either the actual demand for these products have not been estimated, or the author has ignored the untapped domestic market. Instead of ignoring such vital consumer industries, the government, with some extra efforts, can revive them and regain the lost foreign market for cotton textiles and compete as equals in the world sugar market.

In a separate chapter on Public Sector Undertakings, though Mahajan strongly favours their growth, he has rightly pointed out their teething troubles, (which are well known). To carry the discussion a step further the reviewer feels that unless the public sector undertakings are given full autonomy, control over finance, and a fair chance to compete with private enterprises, they are bound to meet with failure, and the whole exercise of developing public enterprises would be futile.

Part V, deals with Trade. The ever-widening gap in balance of payments will continue as long as we do not make ourselves self-sufficient on the agricultural front. This is because the import of food-grains every year constitutes a major part of the total imports. The reviewer is of the view that (a) drastic control on food-grains imports, (b) reducing imports of luxury items. (c) improving exports of traditional goods such as Jute, Cotton textiles, Tobacco, Sugar, etc. would help in reducing the balance of payments gap.

Transport, a media for communication, forms an essential part of infrastructure (dealt with in part VI). A transport economist would be glad to see a section on inland waterways as a mode of transport. Though the author has given the horse power ratios of the various means of transport via land, railways and water as 1 : 10 : 70, it would have been better had he estimated their cost of carrying goods per-tonne-per kilometre. NCAER has conducted one such study, (the reviewer was

associated with the study) and has suggested that waterways is the cheapest mode of transport.

The seventies model, in the light of IV Plan and V Plan approach paper has been presented in the last part. All said and done, one feels that whatever were the problems in the beginning still remain and they vary only in magnitudes.

To conclude, the book is well written, of course, there are repetitions too. Had there not been any *In Brief* or *Summaries* after every section or chapter, the book would have been neat and compact in its presentation. One would submit, that Mahajan has taken pains to substantiate wherever required. An adequate bibliography and an index at the end makes it a complete book.

Modern Business–Its Organisation and Management

(Ninth Revised Edition)

Satya Saran Chatterjee

World Press Pvt. Ltd., Calcutta, 1975, pp. xv +635

Reviewed by K. S. Sastry*

The book under review is a classic by itself. Though the title is Modern Business, the material carried proves the other way. In the preface to the first edition, the author says, "There are several books. . . . , they do not satisfy the general reader because of their academic bias. . . . . This has encouraged me to write a standard book on Business." The author of this book is of the view that it is helpful for "Students of Business in Professional Studies." But one may aptly put this book as 'Guide' to the Intermediate students of Commerce,

Spreading over 37 chapters, and classified into ten parts, this book carries with it usual bibliography and an index. One should submit here

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that the bibliography is useful to "students of Business in Professional Studies."

Part I which deals with the introduction on 'Business' is not new and can be found in most other books. Besides this, second chapter "Significance of Organisation, Management and Control" is almost the same as described in the author's other book, 'An Introduction to Management – Its Principles and Techniques'.

In comparing management with that of human body, the author has failed to convey the meaning; for instance, "The entire body, while planning is the brain, organisation constitutes its nervous system, direction makes up its respiratory organs and control stands for human mind" (page 22), the reviewer fails to distinguish between 'brain' and 'human mind'. Perhaps, this comparison is unsuited in this context.

Part II consists of 3 chapters dealing with the elementaries of Business, viz., sole proprietorship, partnership and companies. Part III has been devoted to Company Laws. But instead of a chapter on Office Management, a chapter on Companies (dealt with in part II) would have been more appropriate in part III. Part IV has nothing to add new to the existing literature. It is heartening, that a note has been provided on 'The Concept of Productivity and the Productivity Movement in India' which is the need of the day. Unfortunately, the author has described what productivity is, but has failed to provide an approach to measure productivity.

Part VI which deals with Financial aspects like capital structure, financial market, special finance and development corporations, etc., the author has avoided delicate issues like 'depreciation'. Manufacturing Activities, which is dealt with in part VII, includes—'Plant Location, Layout and Building', 'Production Control and Methods Engineering' and 'Purchase and Store Keeping.' But one wonders whether Plant Location, Layout, etc., are manufacturing activities. A subject like Automation has not been mentioned even, which forms an important Integral part of 'Manufacturing Activities'.

Part VIII deals with 'Personnel Activities'. "At long last labour participation in management has been found to be a cure-all remedy for solving problems of industrial relations in India" (page 432). Unfortu-

nately, there is no evidence fresh or otherwise or a convincing logic to establish the validity of the statement.

The remaining two parts deal with 'Marketing Activities' and 'The Role of State in Business'. In the former, on an interesting topic like 'Advertising is Wasteful', the author has failed to provide a comprehensive discussion, whereas in the latter all the aspects mentioned in earlier chapters have been grouped together and dealt with under the heading 'The Role of State in Business'.

To conclude, though the author has taken pains to include as many topics as possible on the subject of Business, he has failed to provide concrete answers to the variety of problems already existing. The reviewer fails to evaluate the contribution made by this book to the body of literature available and feels that the author has fallen short of his target in producing a standard book which is not strictly academic bias. Obviously, this book can be considered as a handbook on 'Business'.

Short-Term Investment Fore-Casting

—An Exploratory Study

Samuel Paul & C. Rangarajan

(I.I.M. Ahmedabad)

Published by Macmillian Company (India), 1974, Pages 207, Price Rs. 50.00

Reviewed by N. Varadan*

The pivotal role of investment in the matrix of economic forecasting needs no emphasis. Forecasting usually is either for long-term or short-term. In most mature/advanced countries, not subject to much political pulls and pressures, long-term forecasting may be quite appropriate. But in a country like India, preparation of cash-flows more than a period of five years is quite jejune. The book under review is one such study, pertaining to a country like ours, where short-term forecasting alone becomes at once relevant and meaningful.

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Bearing in mind, presentation of a unified model for investment forecasting bristles with practical difficulties, the strategy of presentation has been attempted in the following manner :

Chapter 1—deals with the existing literature on the subject ;

Chapter 2—highlights the problems of forecasting plant and equipment expenditures in India;

Chapter 3—focuses attention on the forecasting of construction expenditures;

Chapter 4—spotlights the capital consents and investment in corporate sector;

Chapter 5—analyzes the sources of funds and investment in corporate sector;

Chapter 6—discusses forecasting corporate investment with the data of term-lending institutions;

Chapter 7—projects the predictive performance of Government budgets;

A case-study (pertaining to Gujarat State Electricity Board) is also presented at the end.

Investment forecasting refers to the forecasting of gross fixed investment in the economy. Net changes in inventories have been excluded from the study. Gross fixed investment means Plant and Equipment and Construction. Again, construction can be divided into residential and non-residential. The study is limited to the organized sector of industry in the economy. Investment has been treated as an autonomous component.

Any attempt at the estimation of functional relationships for forecasting fixed investment in India, will have to be brusquely brushed aside due to the fact that the play of market forces, the data limitations and the nature of the independent variables not being of a lagged type delimit the scope of study.

The divergence between *ex ante* and *ex post* investment, with investment intention being kept in the silhouette, has been neatly tackled by the authors.

The unique contribution of the authors which runs demiurge throughout the book is the analysis of the Lag Structure. Orders refer to the firm commitments made by the investors. Orders are a useful predictor only if there is a systematic time-lag between the placing of orders and the occurrence of investment. But lags vary due to ever so many reasons. A detailed study has been made in the book with reference to different types of industries. A conceptual framework is sought to be provided by the authors with the help of the statistical techniques like regression co-efficients and testing of hypothesis. More detailed workings could have been given so as to make it understandable to the layman.

The authors have overemphasised the impact of backlog of orders. Different writers treat this differently. A more sophisticated approach may be to treat the backlog of orders as fresh orders for each year ! The authors themselves are very sceptical about the influence of 'Backlog'. Unless a systematic time-series analysis is done, as authors themselves opine, (which is shared by the reviewer also) no tangible outcome can emanate out of this research.

Turning to construction expenditure forecasting, a detailed discussion is given on the employment of behavioural models, the nexus between the permits and completion of contracts and other critical variables. Quantification of these influences and prediction of construction trends with the aid of econometric models give room for freshness of approach.

Authors answer the pertinent question raised by some, about the usefulness of forecasting construction with the aid of permit data If the mix of buildings does not change substantially over time, permit and completion data may reflect the movements in construction activity reasonably well. Once a series on construction expenditure becomes available, the ability of the permit series to forecast construction expenditures may be tested. It must be remembered that there is no particular lag structure as the most appropriate in a given situation between permits and completions. Despite data limitations, the authors

have been able to give cogent evidence of the influence of lagged permits on completions. Financial and organizational factors may not be that much important in explaining the variability in lag structures.

In the chapter on 'Capital Consents and Investment', an attempt has been made to forge a link between capital consents and capital raised. Capital raised in a year was regressed on capital consents of the same and the previous years. The best lag structure was obtained when capital raised in a year was related to capital consents of the same year and the previous year. The impact of the injection of additional variables has also been tested.

In the context of Sources of Funds and Investment in Corporate Sector (dealt with in next Chapter) the link between capital formation and the anticipatory data relating to external finance has been traced. The linear regression of capital formation on capital consents *plus* loans sanctioned of the previous period gives the co-efficient of determination. It was found that the fit of the equation does not improve with the addition of capital consents and loans sanctioned, with a lag. (The term 'Regression' is a misnomer in this context. 'The Line of Best Fit' serves the purpose).

In the chapter on 'Forecasting Corporate Invesment', the authors bewail that though the project proposals are screened by the term lending institutions at the time of granting of loans, no adequate *post mortem* examination is done. The total value of project may have to be revised or proper phasing of capital expenditures is necessitated. This has been the practical experience of the writer, too. It is heartening to note that recently research studies have been started by some financial institutions on the aspect of cost over-run in project implementation. The authors may, perhaps, well elaborate upon this in their next edition.

The price of the book alone is rather prohibitive and beyond the reach of the middle class intellectual elite.

The authors deserve high praise for ushering in new ideas and provoking creative thought—an additional milestone to the existing body of knowledge—'Fresh woods and pastures new'.

ILO Conventions and India

Dr. N. Vaidyanathan,

Minerva Associates, Calcutta; 1975; Rs.36.00

Reviewed by R. V. Mathai*

After Dr. P.P. Pillai's book, 'India and the International Labour Organisation', which appeared in 1931, Vaidyanathan is the first Indian scholar to attempt a comprehensive treatise on ILO and India. During the last few decades, and, particularly, since the Declaration of Philadelphia (1944), the aims and purposes of the International Labour Organisation have undergone radical change. The size and composition of the organisation have also changed in appreciable measure. In the area of its main task of standard setting in regard to labour matters the ILO has, in the context of revolutionary industrial technologies, adopted more than a hundred each of new Conventions and Recommendations, about a four-fold increase. More significant than numerical increase has been their dimensional change. There have, no doubt, been several piecemeal efforts through official reports and articles in labour journals, highlighting some of the special aspects of this change; but a comprehensive, critical appraisal has been long overdue. Dr. Vaidyanathan deserves credit for ably filling this void.

The key-note of Vaidyanathan's doctoral thesis is a critical examination of the Conventions regarding Social Security, Man-power Planning and Employment and Human Rights in relation to their impact on and interaction in India. He deplores the unrealistic manner in which most of the Conventions are framed, paying scant regard to multifarious problems and numerous difficulties which a large majority of the States comprised in its membership, especially those on the theshold of or in the process of development, are likely to face in attempting to implement them. It would appear that the ILO is concerned, almost to the point of an obsession, with the exactitude and textual perfection of the instruments than the accession of the large majority of the members to these instruments. The author's careful analysis of the difficulties and problems encountered in India in ratifying many of the Conventions should be of interest and concern to those dealing with

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these matters not only in this country but also in several other developing countries where the problems are more or less similar. A pointer for more purposeful action for governments of developing countries is shown; but more important, guidelines are indicated for the ILO itself to mould the instruments in a manner more realistic and down to earth.

The Indian procedure for examination, ratification and review of Conventions has been elaborated. The ILO structure, objectives and functions, its operative fields and procedures have been described in the introductory chapter. The extensive documentation and cross referencing testifies to Vaidyanathan's pains-taking thoroughness. Ex-president Shri V.V. Giri's Foreword adds lustre to this publication. Accession of the book is sure to enrich libraries of teaching and research institutions and of workers' and employers' organisations.

Development of Marginal Farmers and Agricultural Labourers

S. M. Pandey

Shri Ram Centre for Industrial Relations and Human Resources, New Delhi, 1972.

Reveiwed by R. K. Sharma*

During the Fourth Five-Year Plan a provision of Rs. 150 crores was made for initiating two special programmes for enabling the rural poor "to participate in the process of development and share its benefits". One of these programmes (viz., Marginal Farmers and Agricultural Labourers Development Agency or MFAL) was initiated in 41 districts for the development of the most vulnerable sections of the rural society, namely the farmers owning less than one hectare of land and the landless agricultural labourers. A lot of official data are available to show the progress of this programme in terms of expenditure, coverage of farmers and the amount of credit distributed etc. These data, however, do not throw light on some of the important aspects of the programme. For instance, has the MFAL Programme served

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the purpose for which it was started ? How far the benefits of MFAL have gone to the really vulnerable sections of the rural poor ? And what has been its impact on the levels of incomes and employment of the marginal farmers and labourers ? S. M. Pandey's study is a commendable attempt to answer such important questions with specific reference to the MFAL programme in Mathura District of Uttar Pradesh.

The study is based on a sample survey of 338 households in two selected blocks of Mathura district where MFAL was initiated during January 1971. In this study the author has analysed in detail the impact of MFAL on income, employment, occupational structure, expenditure pattern and debt position of the selected marginal farmers. In addition, he has made a critical evaluation of the working of the MFAL agency. In the end he has given some valuable suggestions to improve the working of MFAL.

A significant finding of this study is that the agricultural labourers have been virtually bypassed. According to the study only five labour households against a target of one thousand could get loans for the purchase of milch cattle. This has been largely due to the unwillingness of both the Commercial Banks and the Cooperatives to give loans to the landless labourers because they are unable to furnish the required security. The benefit derived by the landless labourers have been limited to some additional employment created by programmes of rural works. The neglect of landless laboures by MFAL is, however, of no surprise to the author. "That the landless agricultural labourers were unlikely to be immediate and substantial beneficiaries of the MFAL assistance was clearly indicated in several official documents". But one can ask as to why they were included in MFAL ?

As regards the marginal farmers the study shows a brighter picture. The various schemes under MFAL have helped the beneficiary marginal farmers to increase their employment and incomes, though not according to their expectations. In particular, the scheme for the purchase of milch cattle has been quite successful. By and large, the benefits of MFAL have gone to the genuine marginal farmers, even though the farmers belonging to upper castes have gained more than those belonging to lower castes. According to the author, this is due to the fact that "in the existing rural setting advantages of development schemes are likely to accrue more to people belonging to higher caste

groups".

The study reveals many disquieting aspects of the working of the Agency. For instance, nearly one-third of the selected non-beneficiary farmers were not even aware of the existence of MFAL. Besides, a larger number of the beneficiaries found the officials to be non-cooperative or indifferent. This is partly due to the prevailing attitudes and partly to the fact that the MFAL Agency has to depend upon the existing agencies for the execution of its scheme. The officials of these agencies find the work of MFAL an extra burden on them and, therefore, their involvement in the programme is marginal.

In order to solve this problem, the study has suggested the strengthening of the staff of the MFAL Agency and provision of some financial incentives to staff of other departments involved in MFAL activities. But more important factor is a change in the attitudes of the officials who continue to give preferential treatment to larger farmers. It was also observed that the Land Development Bank grant loans for minor irrigation only to those applicants who buy engines from specific dealers who, as alleged by farmers, sell sub-standard machines and also charge higher prices for accessories etc. Therefore, the study emphasises that "if the government is really interested in improving the conditions of marginal farmers and agricultural labourers then the attitude and loaning practices of cooperative societies and banks should be changed."

Industrial Cooperatives in India

S. C. Mehta

Atma Ram and Sons, Delhi, 1975, pp. XVI+323, Price Rs. 40.00

Reviewed by V.S. Mahajan *

While the Government of India has been very keen since 1951 to develop small industries for solving the twin problems of the country (a) mounting

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unemployment and (b) scarcity of financial resources, it is found that the steps taken to foster the growth of these industries on healthy lines have been inadequate. It is well known that small industries cannot be economically viable unless their size of manufacturing and operation is extended. Such extension of size would help these industries to reap economies of scale and thereby enable them to lower down their cost of manufacturing as well as help small industries on healthy lines. And here the formation of industrial cooperatives would provide an ideal solution to the economic viability of small industries. Through these cooperatives small industries would be enabled to have access to modern facilities particularly latest techniques of production, management and marketing which are enjoyed in abundance by large industries. Thus cooperativization would provide all those technical and financial benefits enjoyed by large industries and at the same time enable small units to retain their independent character.

Dr. S. C. Mehta is to be complemented for writing a book on "Industrial Cooperatives in India" a subject which has not attracted much attention. One would however hesitate to agree with the very first sentence on the blurb : "The present work is the first analytical exposition of the operation of industrial cooperatives in india " One gets lost when one looks into the table of contents. The book, which is divided into 21 chapters, does not follow a logical pattern. While chapter 2 is devoted to Cooperation and Industrial Cooperatives", the Role of Small Industries vis-a-vis Large Industries is taken up in chapter 4 and in between, Chapter 3 is devoted to "Industrial Cooperatives in Foreign Countries. Here the author could not have done justice to 13 foreign countries in about 10 pages. The treatment is pedestrian and does not follow any logical sequence. It would have been better if he had concentrated on two or three foreign countries, especially those whose experience could have been beneficial to India.) Chapters 6, 7 and 8 are devoted to "Profile of Industrial Cooperatives in India". Here the performance of All India Handloom Board, Khadi Commission and Village Industrial Societies (including Handicraft Societies and the Board, Coir Societies and the Board, Secriculture and Central Silk Board has mainly been dealt with. The author has again failed to make an in-depth study of these bodies. Chapter 9 is devoted to "Industrial Cooperatives in Various States". As usual, the author gives bare outline of industrial cooperatives in States. Here he should have either extended the treatment of industrial cooperatives in States to more than one chapter, or if he wanted to concentrate

on one chapter alone then he should have selected one or two important States.

"Operation of Industrial Cooperatives" is spread over six chapters (Chapters 10-12, 14-16). Chapter 10 deals with membership, capital structure etc. of industrial cooperatives, and chapter 11 is concerned with their administration. Chapter 12 deals with the procurement of raw materials. Chapter 14, 15 and 16 deal respectively with marketing; analysis of expenses; and accounting (like costing, budgeting, auditing etc.). These are the core chapters of the book and are comparatively well written and analytically sound. The author has gone deep into the various aspects of the operation of industrial cooperatives.

"Financing of Industrial Cooperatives" is dealt in Chapter 18. Looking at the performance of Cooperative banks, one feels doubtful whether the establishment of industrial cooperative banks, as suggested by the author, would serve useful purpose in helping industrial cooperatives. One feels that it is not the lack of finance which handicaps the growth of industrial co-operatives, rather it is the absence of scientific management and control in industrial cooperatives which is to be blamed for their poor performance. So, unless both management and control are toned up, finance would not be of much help in the growth of industrial cooperatives. "Cooperative Education and Training" find its place in Chapter 19. In Chapter 21 the author deals with "Some Case-Studies of Industrial Cooperatives".

The book thus covers practically all aspects of industrial cooperatives in India, though the reviewer feels that the author would have done better had he concentrated on crucial aspects of industrial co-operatives and analysed these in detail. He would do well to rearrange the entire material when the next edition of the book is published. On the whole, the book is extremely informative and should be read with interest by all those interested in the working of industrial cooperatives in India. It is a useful addition to the growing literature on Cooperatives in India.

[illegible] cost control is to ensure that actual costs correspond to planned costs. Failure to meet that aim results in the failure of the company to meet its required profit margin. The structure of the Handbook is designed to ensure that managers understand what cost control techniques are available to them and how they can be utilized within each department. Part one explains the nature of costs and the principles of

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New Books : Annotated List*

cost control, while, Part two provides a variety of approaches and techniques of major importance in the management of costs. Part three demonstrates how to apply these methods to the office administration, personnel, R & D, manufacturing, purchasing, marketing and distribution functions. A glossary of terms and definitions completes this comprehensive and readable Handbook.

Financial Management of Production

Lock, Dennis

Essex, Gower Press, 1975, 253pp, £ 6.25

The key phrase in every manager's vocabulary today is 'Financial Management'. In production, perhaps more than any other functional area, the application of sound financial principles and techniques can be the corner-stone of a company's survival. Chapters on Financial Management of Production reflect this perspective, and focus attention on four major areas directly relevant to the production function :

(i) Elements of accounting ; (ii) Planning for production ; (iii) Cost techniques in production; and (iv) Controlling factory costs.

The chapters present, in a detailed and practical form, financial techniques such as budgetary control, cost estimating, value analysis and cost accounting. It examines specific production topics as well, for example, inventory costs, project appraisal and maintenance costs.

Information Systems for Modern Management

Murdick, Robert G & Ross, Joel E

New Jersey, Prentice-Hall, 1975, 671pp, $ 14.50

This edition gives description of methods and practices which form the basis of the present day computer-based information systems. This helps a manager, as well to plan pragmatically in co-ordination with the computer specialist. It also enlists the radical changes management theory and practice have undergone in the past two decades, particularly, in the seventies.

Manufacturing Organization and Management

Amrine, Harold, T. and others

New Jersey, Prentice Hall, 1975, 588pp, $ 15

Beginning with a discussion of the significance of productivity in manufacturing, this book traces the background of management, explores organization and planning, and then moves into manufacturing systems design—plant location and layout, manufacturing processes, methods engineering and work measurement. The section on manufacturing control deals with areas such as inventory, production, quality, maintenance and costs. A section on manufacturing relationships discusses the human and financial elements. Management requirements and appraisal of results are covered in the final section. The presentation of information on such a specialised subject is in non-technical terms and provides a complete view for persons not familiar with management of manufacturing.

Poverty and Income Distribution in India

Srinivasan, T. N. & Bardhan P. K.

Calcutta, K. P. Bagchi & Co., 1975, 551pp, Rs. 100.00

Brings together some articles on methodological issues arising from planning for removal of poverty, the patterns and trends in income distribution in India, and on evaluation of policies that have been pursued with reduction of inequality as an objective. While this volume is by no means a comprehensive study on the problems of poverty and income distribution in India, it is perhaps fair to say that it brings together most of the quantitative information on, as well as policy aspects of, income distribution in India during the two and a half decades of planning since independence.