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APPROPRIATE INDUSTRIAL TECHNOLOGY : AN INTEGRATED APPROACH*

by

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INTRODUCTION : A REVIEW OF CONCEPTS

It is now well over a decade since E.F. Schumacher first enunciated the concept of Intermediate Technology and five years have passed since his book "Small is Beautiful" took by storm the general reading public as well as those politicians and planners, economists and technologists whose concern is with the development of Third World resources. Since it was this phenomenon which has led to the Appropriate Technology movement, the International Forum on Appropriate Industrial Technology can be taken as an appropriate forum at which to review the developments which have taken place, to examine - to the extent that one can after such a short passage of time - the validity of the concept in its application, and to consider to what extent and in what direction further progress can be made in the future.

Were he alive today, Schumacher would be the first to affirm that his approach to development is not original. Starting from a basis of Christian ethics his philosophy draws heavily upon the teachings of Buddha and Gandi which he was able to study at first hand in the 1950s when he was UN Economic Adviser to the Government of Burma and subsequently adviser to the Indian Planning Commission.

Schumacher's personal and peculiar contribution to the economics of development has been to highlight the importance of technology in human development and to explain in terms which ordinary people can understand, the need to select technological processes which will enhance and not destroy the quality of life.

In Buddhism, Schumacher observed the function of work to be at least threefold: work should be so designed as to give a man a chance to use and develop his faculties; the organisation of work should encourage him to join with others, thereby overcoming his inherent selfishness and egocentricity, and work should aim to produce the goods and services needed for a becoming existence. From the Buddhist point of view, therefore, mechanisation and the organisation of work can follow one of two

paths - for good or for evil; the first, that enhances a man's skills and utilizes the products of his labour for his spiritual and physical wellbeing; the second, that reduces the need for human skills and makes man a slave to the systems he has created.

These basic concepts were supported and enlarged by Ghandian economic theories which state that:

- emphasis on increased productivity must be balanced by a proper attention to increased human wellbeing;
- man's needs are not unlimited; the satisfaction of some needs are more important than others; and society should concentrate on satisfying the needs of the majority rather than those of the few;
- there is a dignity in labour provided it is shared and used to further community interests and objectives;
- natural resources must not be used indiscriminately for short term gain; and renewable resources must, indeed, be renewed;
- economic development must be governed by ethical considerations whereby wealth is shared and the rich recognise their responsibility to and ultimate dependency upon their fellowmen;
- the individual is more important than the state or the corporation and, therefore, production systems should aim to enhance and not destroy the individual's way of life, providing him with work to satisfy his needs within his own environment.

Drawing upon these philosophies and his own experiences and observations of developing countries, Schumacher concluded that:

- Poverty is the over-riding problem and the source and centre of poverty lies primarily in the rural areas of poor countries;
- Conventional aid and development policies are ill-equipped to tackle the problem of poverty since they draw their experience from and have developed their expertise within an industrial, urban environment far removed from the rural/agrarian conditions prevailing in poor countries.
- In tackling the problems realistically the correct choice

of technology to be applied to local situations is critical - not only to increase productivity and wealth but, also, to increase general wellbeing and to preserve the quality of life and the environment;

- The most appropriate technologies in the prevailing circumstances of developing countries are more often likely to be a range of intermediate technologies which are more productive than the often highly labour-intensive but inefficient traditional technologies on the one hand but, on the other, are less costly, and more manageable than the large-scale, labour-saving and capital-intensive technologies of highly industrialised societies;
- To be fully effective, these technologies will respond to local needs and factor endowments. In general, they will be cheaper and smaller, giving a wider, more equitable distribution of capital investment; they will create employment, providing work opportunities in areas where people live; they will foster the use of local capital, skills and raw materials and reduce reliance on the importation of these factors; they will produce goods primarily for local consumption and use.

Although this philosophy was first enunciated by Schumacher in the early 1960's, and he sought to provide the means for its practical application in 1965 by the creation of the Intermediate Technology Development Group in London, it was not until the publication of "Small is Beautiful" in 1973, that it began to receive wide recognition and a large measure of acceptance by, first the public and later, by planners, economists and technologists. Indeed, until then, his views were received with amusement and even some hostility because they challenged the collective conventional wisdom of the developers and the aid givers. Only among those with long experience of working directly with poor people and of trying pragmatically to translate development plans into meaningful programmes which would bring lasting benefit to local communities did his views strike a responsive note.

Being himself a pragmatist as well as a philosopher, Schumacher recognised that in a world growing ever smaller, where industrial and, therefore, political and economic power is increasingly

concentrated, the process of industrialisation is essential but the path to industrialisation must take a new course in order to distribute its benefits to the poor as well as the rich, to close the "poverty gap" and to bring about more democratic conditions whereby the majority of people, as producers, have control over the factors of production and can participate realistically in the decisions as to how those factors are to be used for the general good.

A variant of the concept lies in the alternative technology movement brought about by the recent wave of conscientisation and protest at the bad effects of the existing industrial apparatus and its attendant miseries in the life-style of ordinary people. This social phenomenon, reinforced by movements in the United States and elsewhere which brought to public attention the absolute evils of modern warfare, the effects of pollution and the dangers of an indiscriminate use of non-renewable resources, has had the effect of stimulating the formation of large numbers of associations to promote the use of soft technologies which do not pollute, do not devour energy and raw materials and are compatible with less oppressive and more humanising forms of factory organisation. Among the extremists in this movement are those who believe that any form of industrialisation is, of itself, undesirable and who have chosen, therefore, alternative life-styles which seek to pursue "the good life", advocating the use of only the simplest tools and processes and eschewing any association with modern technology. Such views in no way represent the main thrust of the alternative technology movement in Europe and the United States which is concerned with a re-examination of industrial systems, the creation of small, more self-contained production units and the use of less violent and more energy-saving technologies.

The growing acceptance of the intermediate technology concept as applied to developing countries and the alternative technology variant advocated by the many organisations in Western industrialised nations has brought about an overall re-examination of the social function of technology, leading to a realisation that its function is not merely to produce the "best" - meaning the most productive plant and processes - but, rather, the most appropriate technology, having regard to all the political, social

skill in large scale administration, management, buying, selling, and so on. When these conditions are not satisfied, so-called economies of scale become illusory. In any case, large scale tends to act as a principle of exclusion: only people who are already rich and powerful can embark on new productive enterprises. The small man is excluded and reduced to the position of a job seeker and when there are not enough jobs provided by the rich and powerful, he has no reasonable possibility of becoming productive. Smallness is, therefore, a pre-condition for rural development and it has increasing relevance to the economy, as a whole, of developing countries.

Much the same applies to simplicity and capital saving. It does not require great technological creativity to take a further step in the direction of complexity, capital intensity, and gigantism. The suggestion that the best of modern knowledge and intelligence should be engaged in the search for smallness, simplicity and capital-saving almost invariably meets the argument in the first instance that it cannot be done, or, if it were done, it would prove to be totally uneconomic. In this matter, prejudices and untested presuppositions are very deeply rooted. There is now accumulating evidence that it can be done, but it requires a more creative and original research and development effort than is normally forthcoming.

In putting forward arguments for the use of intermediate technologies, however, Schumacher recognised that its applicability is not, of course, universal; that those are products which are themselves the typical outcome of highly sophisticated modern industry and cannot be produced except by such an industry; and, further, that some of those products do have a place in underdeveloped economies, provided it is recognised that they are not normally an urgent need of the poor. If, however, people and planners are confined only to a knowledge of the well-known, conventional technologies which are the normal product of industrialised society, they have no options from which to choose what is most appropriate to their needs. An essential requirement for balanced development, therefore, is that planners and people should have access to a choice of technologies. It is for

and economic circumstances in a given situation. This new approach to technology has been adopted increasingly by international and bi-lateral aid agencies as well as by national governments. Appropriate technology has now become an accepted part of the language of development and, as is inevitable in such circumstances efforts are being made, knowingly or otherwise, to interpret its meaning in terms that are comprehensible to the users and in such ways that it can be assimilated by institutions without too much variation to their own established interests, concepts and methodologies.

Herein lies a danger that Appropriate Technology may come to mean all things to all men and different things to each. One may ask the question "What technology is appropriate?" and the response will reflect not only the needs of the situation in which it is to be applied but, also, the vested interests, attitudes and social circumstances of the person supplying the answer. The use of the expression Appropriate Technology, therefore, poses a question which Schumacher answers by suggesting that in the prevailing circumstances of developing countries the most appropriate technology is most often likely to be found among that range of intermediate technologies which are capital - and energy saving; small-scale and employment generating, capable of being decentralised so as to provide work where people live; which are relatively simple to produce, operate and maintain without placing undue reliance on outside capital and skills; and which utilise local resources, human and physical, primarily to produce the goods and benefits required by the producers.

These principles go against the conventional trend of technological and organisational development which is towards ever larger scale units. This is said to be justified by the economies of scale. Large scale production units, however, tend to create many sociological, ecological, and resource problems, the burden of which normally has to be carried by the community at large and does not enter into the unit's cost calculation. Even from a narrow economic point of view, large units are economical only when certain conditions are satisfied - high market density and/or highly efficient, reliable low cost transport system,

this reason that the examination of available choices in the field of industrial technology is seen as an important component of this Conference.

In insisting on technological choice, however, a clear distinction must be made between science on the one hand, and technology on the other: between scientific knowledge and its applications. The knowledge of scientific laws, of materials and of methods, is, in a sense, absolute; one could hardly talk of intermediate knowledge or intermediate science. But the application of the best knowledge can take many different forms and can lead to many different types of technology and modes of operation. It is here that the need for and the possibility of intelligent choice enters. Different economic and social conditions demand different applications. No one would deny that there are conditions in which the most sophisticated technology is the most appropriate and that there are other conditions in which an intermediate technology is the most appropriate. However, as long as an intermediate technology does not exist or is inaccessible because of a lack of knowledge and communication, the people in the latter condition have no useful choice. Either they do nothing at all or they do the wrong thing by trying to use an inappropriate technology; and then the result is negative.

The choice of technology must also concern itself with existing industrial development as well as with plans for the future. As already stated all development cannot be local and small-scale; certain industries must be, by their nature, large-scale and centralised. However, a critical examination of large and medium-scale industries - existing and proposed - can reveal:

- opportunities for the development of related small-scale service and processing industries in support of, or arising from developments in these sectors;
- opportunities for adapting existing technologies within these sectors so that they become more labour-intensive without significant loss in technical efficiency;
- as far as future plans are concerned, the scale of industrial development or the level of technology which would be most appropriate in the circumstances.

There are, therefore, significant linkages between large and

small industries and the adoption of capital-intensive technology in the large-scale sector of industry cannot be consistently justified by reference to economic efficiency. Analyses by the David Livingstone Institute of Overseas Development Studies at the University of Strathclyde, by the ILO and others provide strong support for the following conclusions:

- that the range of technological choice is large, and this remains true at least for some products even when the quality of the product is specified in a fairly rigorous fashion;
- that the least-cost technology is, on investigation, often nearer the labour-intensive end of the spectrum, if the technology is efficiently used;
- that in some industries, at least, substantial additional employment could be generated, even at high levels of output, with relatively little sacrifice of economic efficiency within the factory itself; and
- that, when transport and fuel costs are considered, small-scale projects, and the labour-intensive technologies normally associated with them, can become even more economically attractive relative to larger-scale operations.

Thus, the application of more appropriate criteria to decisions on technology to be adopted in the large-scale sector could:

- create more employment on an economically viable basis within that sector;
- reveal the economic attractiveness of smaller, dispersed projects in some industries hitherto developed on a large-scale; and
- by reducing the demands on limited investible funds by the large-scale sector, stimulate expansion, based on the funds so released, of employment and output in the small-scale sector.

Before examining some applications of these concepts it is perhaps necessary at this stage to summarise the foregoing and reach a common understanding of what is meant by Appropriate Industrial Technology.

The Appropriate Technology concept implies the use of technology which is adapted to given economic, social

and political circumstances; that these circumstances vary from continent to continent, nation to nation and, even, from one locality to another.

The expression Appropriate Technology can embrace all levels and types of technology depending upon circumstances - from the simplest to the most sophisticated and from the largest to the smallest.

However, in the circumstances of developing countries, with which this Conference is concerned, the most appropriate technologies will tend, in most cases, to fall within that intermediate range between the traditional technology of subsistence production on the one hand and, on the other, the conventional technologies of highly industrial societies.

Even in the case of large and medium-sized industries there are opportunities for introducing more appropriate technologies without significant loss in productivity.

The emphasis on Industrial Technology relates to the distinction between those technologies which are concerned with the production process - be it agriculture, manufacturing, mining or the like - and those which relate primarily to the provision of services. However, the distinction between the two is often more theoretical than practical since the provision of even basic services often involves some form of industrial process.

THE APPLICATION OF APPROPRIATE TECHNOLOGY : AN OVER-VIEW

It would be a mistake to judge the success and potential impact of the Appropriate Technology movement merely by the relatively modest achievements of the past decade during which the concept has become fashionable. The tendency to measure results achieved over short periods, usually governed quite arbitrarily by the requirements of project financing or the time limitations imposed by Development Plan periods is one reflection of the inappropriateness of most modern development programmes. Those with real experience

of working with people (and that, in essence, is what Appropriate Technology is about) know only too well that sound development is a gradual educative process and that dramatic results are often short-lived.

An assessment of recent results would also ignore the achievements of the process of rural industrialisation in Asia - and especially, in India and China - which owes nothing directly to the new Appropriate Technology movement, but which illustrates well the validity of the concepts when applied in favourable circumstances.

DEVELOPMENTS IN INDIA AND CHINA

Unlike many other regions of the world, both India and China had acquired a strong artisanal and rural manufacturing base in the 17th and 18th Centuries, which was submerged but not destroyed by the wholesale importation of foreign goods - the products of the Industrial Revolution - in the 19th Century and subsequently, the introduction of large-scale, capital intensive Western technology in the first half of the 20th Century. The effects on the thriving traditional rural economy of both foreign imports and urban industries were not lost on political leaders and others in those countries and indeed, they led Gandhi and others to develop the basic concepts from which the Intermediate and Appropriate Technology movements have sprung.

Consequently, in both these countries, political and social claims were accompanied by an aversion to the large urban industrial developments which came to be associated with elements foreign to national cultural aspirations. Thus the rehabilitation of rural industry became a part of the political objectives of those who opposed foreign domination, direct or indirect. It is paradoxical, however, that after political self-determination had been achieved, these countries, like most others which followed in the path of freedom from foreign domination, were caught up for a time in the drive towards progress along the path of modern urban industrial development. It was only when those developments did not achieve the desired results that new directions were given to industrial policies which placed greater emphasis on decentralised rural industries and the need to create large numbers of employment opportunities in the rural areas.

In China, the policy has been to limit the use of highly capital-intensive industries to specific sectors, such as the petro-chemical and steel industries, where the economic factors of scale and the technology employed have made small scale production impossible. Elsewhere, in the fields of textiles, agriculture and agro-industries, building and building materials, transportations and others, small production units are encouraged and flourish alongside large factories. In addition to filling the need for local employment, these enterprises have resulted in the reduction of marketing and transport costs, the elimination of imports in those sectors, the growth of capital accumulation locally and the decentralisation of managerial and technical skills. The process has also created an environment conducive to the emergence of indigenous research and development which has led to technical improvements to manufacturing processes peculiarly adapted to local circumstances (such as in the case of small-scale cement manufacture), as well as to a sound basis for local servicing, maintenance and repairs, and the provision of spare parts.

In India, the revival of the Appropriate Technology movement, which followed the failure of successive Five-Year Plans together with a realisation that large-scale industry and agricultural development alone would not, between them, solve the problems of mass under-employment and rural poverty, tends to obscure the very real achievements of a small number of local state and other organisations which had over the years striven to upgrade and enhance the productivity of rural industries. The efforts of the Planning, Research and Action Institute of the State of Uttar Pradesh, India, and others have resulted in very significant developments which include the manufacture of whiteware pottery as a village industry. Started in the mid 1930's this development had reached a stage by 1974, where there were some 250 small units employing about 25,000 people; this industry is now largely in the hands of village potters. Improvements to the technology of small-scale sugar production over the last fifteen years has resulted in about 10% of India's total production of crystalline sugar being manufactured in over 2,000 small, decentralised factories. Significant developments have also occurred in textiles manufacture, the local production of building materials, paper manufacture and in other industries.

DEVELOPMENTS IN OTHER COUNTRIES

Elsewhere in the World the application of appropriate technologies has been more modest and the examples less startling. Nevertheless, sufficient examples exist to give encouragement to the belief that - given time, a proper understanding of the implications of the process and the presence of a suitable politico-economic environment - the technologies now being developed and installed, often in pilot projects, will flourish, take root and spread. Examples already exist: soap and glue making and light engineering in Ghana; wood and metal working in Nigeria; the manufacture of bricks, tiles and other building components in the Sudan, Tanzania and elsewhere.

Unlike India, China and other countries in Asia and the Far East, many African and Latin American countries had not developed the strong artisanal and rural manufacturing base which had played such a significant part in Asian development. Thus, they lack in large measure a widespread acquaintance and familiarity with the technical and managerial skills which are such an important part of the industrial process. These skills take time to acquire; they result as much, if not more, from attitudes and exposure to teaching practice as they do from education and training. Even the skill of acquiring regular work habits is foreign to large numbers of rural subsistence producers. In those circumstances the provision of even the most appropriate technologies together with training in their use, is not enough - particularly in the case of manufacturing processes. They must be accompanied by the gradual acquisition of those industrial skills and practices which enable people not only to operate machines but to understand their purpose, function and potential as industrial tools.

Perhaps this is why in many countries the Appropriate Technology movement is achieving a greater impact in the non-manufacturing sectors; where local people see their needs primarily in the form of services: roads, transport, water supplies, education and health and, to a lesser extent, housing, fuel and lighting. Even essentials such as food and clothing are regarded as personal needs and often take second place. Anyone who has worked with subsistence agriculturalists will know how difficult it is for them to make the conceptual switch from "catch" crops to regular "cash" crops.

This is one of the reasons leading to the adoption by the ILO of its "Basic Needs" strategy, and it may indicate where programmes of appropriate individual technology in those countries should start, at least insofar as these programmes relate to what this paper suggests is the over-riding problem of rural poverty. Even the basic, essential services require and depend upon an element of industrial production: the provision of tools, equipment and domestic utensils; methods of transport and transport services; pumps and piping for lifting and conducting water; bricks, tiles, cementitious materials and the like for housing and construction; the manufacture of furniture and equipment for schools, and clinics including educational materials, paper and the compounding of drugs.

APPROPRIATE INDUSTRIAL TECHNOLOGY : SOME POLICY CONSIDERATIONS

Whilst it is true to say that the broad concepts outlined in the first part of this paper are becoming widely accepted by planners, both in the aid-giving and aid-receiving countries, relatively little thought has been given to how they can be practically and systematically applied to industrial development within the framework of national development plans. To the extent that they have been adopted as government policy, examples exist of policy directives emphasising the need to introduce "intermediate" or "appropriate" technology programmes with little evidence that such policies have been systematically and consistently planned, applied and supported; and this, in spite of the increasing attention which has been given in recent years to the need for macro-economic policies which are consonant with and support appropriate technology programmes.

As against this, there are numerous examples of the successful development of a wide range of local initiatives embodying the principles outlined above - successful, only to the extent that they continue to operate locally but without having had any significant "spread" effect and without contributing significantly to the total development effort within the country or within the industry concerned. These local initiatives are, for the most part, a reflection of the adaptive skills of local people and their response to technologies which enable them to enter the market economy; too seldom are they the direct result of a conscious effort or an articulated policy on the part of governments.

One reason for this has already been referred to in passing; it is that although the terminology of Appropriate Technology is now widely accepted, to the extent that it has become part of the international language of development, its implications are often not understood or misinterpreted. Many planners consider the matter only in terms of products and industrial processes without giving thought to the socio-economic circumstances surrounding their application, or to the supporting measures required to ensure their success.

Given that in developing countries the appropriate technology will most often tend towards small-scale capital saving products and processes, it is often the case that the odds are against the use of such technologies, for one reason or another: the vested interests of large manufacturers, the persuasiveness of the international purveyors of conventional technologies, the risks involved in introducing new technologies, and the ease with which large, capital-intensive schemes attract international finance. If, therefore, national policies advocate the use of appropriate technologies, generally or in specific industrial sectors, then national steps must be taken to ensure a systematic and planned approach to the implementation of those policies.

The Need for Comprehensive National Technology Policies

The above calls for comprehensive technology policies corresponding to the overall socio-economic development strategy of the countries concerned which will guide decision-makers in their choice of technology, help to formulate supportive legal and financial programs and make provision for the proper allocation of resources for training, research, development and eventual application.

Several developing countries already have some form of science and technology policy, together with related research institutions. The emphasis on science and research, however, generally overshadows the relevance of technology. The emphasis on scientific researches focuses on the technical and "hardware" aspects of technology and pays little, if any, attention to the social and commercial aspects of implementation. They are seldom

directly related to corresponding national socio-economic policies and programs and do not address themselves to the fiscal and other measures which are necessary before identified technologies can be translated into commercially viable production processes. Too often they disregard the fact that, although critical, technology is in the end merely a tool to be used in the industrial process.

Where national plans recognise the need for a balanced industrial mix which will provide for the fostering of small as well as large industries in order to create local employment opportunities, save on imports (of goods and capital) and add value to the exploitation of local resources, Technology Policies should ensure at the national planning level the implementation of the following procedures:

- Establish the basis for industrial development to conform with national political, social and economic objectives. This will identify and distinguish between those industries to be developed centrally, on a large scale and those which are to be developed as small local enterprises.
- Establish central planning control procedures to give effect to the above and to ensure that the needs of the small industry sectors are adequately recognised and its products protected from foreign or large industry competition (through taxation, import licensing, etc.)
- In the case of large and medium scale industries, establish procedures to examine the feasibility of introducing simpler, more labour-intensive production processes.
- Examine the extent to which small service and processing industries can be generated in support of developments in large and medium-scale operations.
- Make an equitable allocation of capital resources (finance and manpower) and share of capital investment (goods and services) between industrial sectors and between large, medium and small-scale needs.

- Review the provision of manpower training and extension services to ensure that they adequately reflect the needs of the different sectors - particularly in regard to small industry.

- Provide for and co-ordinate R & D facilities and institutions which are required to adapt or design; introduce and promote appropriate technologies.

- Establish procedures for introducing technology development programs to test and evaluate the effectiveness of new technologies through pilot projects.

- Establish appropriate facilities to encourage successful projects and to promote them beyond the pilot project stage (credit, raw materials supplies, government bulk purchasing schemes, etc.).

There is nothing very original in these proposals and, indeed, most governments take somewhat haphazard steps towards implementing some or all of them. What is lacking is a purposeful and systematic approach which examines the problem of applying technology across the spectrum of national development policy and takes steps to ensure that the appropriate measures are formulated, understood and applied in order to achieve an integrated approach to industrial development.

One problem, frequently observed, is the lack of real communication between policy makers, the planners and the implementers. Thus, for example, it is not unusual for politicians to be unaware of, or to misunderstand, the need for protection and promotion legislation in order to implement a policy of industrial decentralisation; or for departmental heads, when implementing mechanisation programs to be aware that these may run contrary to policy directives, the effects of which have not been clearly analysed or enunciated. There are a number of known examples of separate ministries following different and conflicting policies in the process of implementation - the introduction, say, of a capital-intensive, turnkey project for shoe manufacturing by a Ministry of Industry which competes with efforts by the Ministry of Rural Development to foster the local manufacture of shoes by village cobblers.

A prerequisite to the creation of a comprehensive Technology Policy and plans for its implementation is that decision makers should have access to information on available alternative technologies and the extent to which these might be transferred to local institutions. Without this expert information, investment decisions have to be taken with insufficient knowledge of the options - and with the inevitable result that, in spite of policy guidelines, well known conventional technologies will almost certainly be chosen. Steps need to be taken, therefore, to ensure that a capability exists to collect and analyse information on alternative technologies and to make the results known to the appropriate planning authorities and departmental heads.

These deficiencies - the lack of systems whereby the appropriate technologies are identified and steps taken to ensure that they are consistently applied so as to reflect national objectives - call for the introduction, within the national planning authority, of a capability to examine the technology components of national and departmental plans, to have access to information on the range of available industrial processes, to be able to choose the appropriate technologies and, thereafter, to ensure that these technologies are promoted and used. Because the application of Appropriate Technology implies the mobilisation of people, its successful implementation will depend, also, upon the creation of educational and other social programmes designed to help people recognise opportunities for industrial development and to provide them with the skills and incentives to take advantage of them.

The Role of Academic, Scientific and Research Institutions

Passing reference has already been made to the need for developing countries to direct the resources of their academic, scientific and research institutions towards more appropriate research related to local needs. It is a sad fact that institutions of higher education and research are, too often, concerned to establish their status within the international academic community, with the result that they build up educational systems and commit limited resources to projects which reflect the kind of long-term research being undertaken in similar institutions in the highly industrialised nations, but which have little relevance to the

immediacy of local needs. One result of this is to establish an academic elite, whose members are capable of dealing with complex high-technology problems but who have lost contact and sympathy with the real needs of the majority of people in their own countries.

It is not suggested that the development of more appropriate technologies requires persons of lower academic qualifications; to produce simple solutions to complex problems often needs the application of the highest skills and resources. It is the recognition of true priorities which needs to be developed and an attitude to problem-solving which must undergo change if the resources of universities, colleges of technology and research institutions are to be properly mobilised and used for the national good. In their favour, it should be stated that industry and governments in developing countries seldom identify these institutions as a resource potential and fail to draw them in to programmes for technological research, development and application.

Happily the situation is changing and there is increasing evidence that academic and research institutions are beginning to direct their attention and activities towards the needs of industry and the solving of local problems.

A good example of what can be achieved is illustrated by the Technology Consultancy Centre at the University of Science and Technology, Kumasi, Ghana, which provides a link between the technical and scientific expertise of the University and government agencies, local entrepreneurs and craftsmen. With a staff of fourteen, the TCC draws on the expertise of about thirty senior university staff; and its work falls roughly into three categories:

- Technical and Commercial Advice to Business and Government: this has included advice on the manufacture of gunpowder, rubber mouldings, wood and coconut charcoal, leather goods, envelopes, sugar, blackboard chalk, kaolin, shoes, tonic drinks, jams and preserves, glues, lost wax brass casting, bead making, oil palm cultivation, and weaving. It has also undertaken the chemical analysis of soap, glue, bleach, alcohol, latex fluid, cassava starch, soapstone and caustic soda.

- Development and Testing of New Products: a pedal driven rice thresher, baby incubator, traffic lights, pyrolitic convertor to produce fuel oil and combustible gas, as

well as charcoal (this in collaboration with the Georgia Institute of Technology); bullock carts, irrigation pumps, ploughs and cultivators, wood fired (and electric) soap and caustic soda plants, dryers for cassava, pepper and spent brewers' grain.

- Production Units Attached to the TCC: a Unit making steel bolts employing 15 trainees which produced 30,000 bolts for local sale in 1975-6; construction of soap and caustic soda plants; the manufacture of rice threshers, bullock carts, gate hinges, replacement plough shares, saw benches, water tanks, hoes, charcoal stoves; a weaving unit employing 7 weavers; animal feed from dried brewers' grain using screw press and solar drying producing 2 tons per week; and a soap pilot plant which produced 109,000 bars in 1975-76.

In the next five years, the TCC plans to turn its attention increasingly to the rural areas, setting up two regional workshops for demonstration of new products and training of local craftsmen as well as providing extension services to local entrepreneurs. Young graduates are being trained as project managers to act as links between the University and individual craftsmen and businessmen who have sought advice.

Appropriate Technology Institutions in Developing Countries

A feature of recent developments has been the formation of a number of Appropriate Technology institutions or centres in developing countries in Asia, Africa and Latin America as well as the Pacific which, to a greater or lesser extent, carry out work similar to the TCC in Ghana. It is sufficient here to mention the oldest as an example: the Appropriate Technology Development Association, Lucknow, India, covers a wide range of technologies, some highly sophisticated. A summary of activities in which the Association has been or is involved is given below:

- Scaling down of Large Scale Technology
  - (i) cement making
  - (ii) paper making
  - (iii) cotton spinning

(iv) jute spinning and weaving
(v) wool spinning
(vi) chemical fertiliser manufacture
(vii) improving the efficiency of mini sugar technology by:
- manufacture of liquid sugar from molasses
- plate evaporation
- screw press for higher extraction

- Scaling-up of Village Technologies
(i) hand loom weaving
(ii) blacksmithing
(iii) carpentry
(iv) extraction of vegetable oil
(v) village pottery, both red clay and white ware
(vi) village tanning and shoe making
(vii) rice milling

- Home Living and Community Technologies
(i) village power pool
(ii) village sewer disposal system and environmental sanitation
(iii) village transport
(iv) bio-gas
(v) solar cookers
(vi) animal husbandry
(vii) social forestry and forest based industries

Regional Institutions of Appropriate Technology

Recent trends in the development of Appropriate Technology institutions have tended to favour the establishment of Regional Institutions. While this tendency serves to satisfy the urge of planners which compels them to seek to rationalise their plans, there is no evidence to suggest that Regional Institutions of Appropriate Technology will serve any really useful purpose. Indeed, there is every reason to suppose, on the evidence of similar regional organisations, that they will have little effect upon the programmes of national governments or the lives of ordinary people. The whole concept of Appropriate Technology, with its emphasis on the use of local resources by local people to serve local needs, goes contrary to the tendency towards regionalisation.

There is, of course, a need to avoid unnecessary duplication in the adaptation and development of technology; there are, also, instances where local resources and facilities are insufficient or inadequate to cope with special demands. In the case of the former, unnecessary duplication can be avoided by strengthening systems of communication and information between national bodies. In the latter case existing research institutions are home or abroad can usually respond to requests for help on a project specific basis. Indeed, great advantage can be derived by national Appropriate Technology organisations working in close association with specialist institutions in the industrialised nations. The latter usually have a long association with research into development problems; they also have access to the latest developments in fields of high technology and are well placed to identify the extent to which these developments can be modified and adapted to local needs.

THE ROLE OF BI-LATERAL AND INTERNATIONAL AID AGENCIES IN FOSTERING THE USE OF APPROPRIATE INDUSTRIAL TECHNOLOGIES

Just as the development and use of appropriate technologies requires a conscious effort on the part of national governments so, also, it needs the participation and support of bi-lateral and international agencies and through them, the intelligent participation of the international business community. Most, if not all, international organisations have committed themselves in one form or another, both to the concept and to programmes of appropriate technology and many governments have taken positive steps to give greater emphasis to the use of appropriate technologies in their oversees aid programmes.

International organisations, however, face some inherent difficulties when seeking to execute coherent appropriate technology programmes. Most of these difficulties are related to the size of the organisations concerned and their method of operation. By their nature they find it administratively easier and, indeed, more cost efficient to cope with smaller numbers of large projects than with larger numbers of small ones.

This is particularly so in the case of international banking institutions where responsibility for finance and control can be exercised more easily if that responsibility is centralised. Thus, whatever may be the declared intentions of such organisations and,

even, the wishes of those who administer them, the unavoidable effect is often to favour large, capital-intensive and centralised enterprises rather than to take the commercial risk and administrative inconvenience of supporting a number of smaller but possibly more appropriate models. In essence, development banks are, like any other banking institutions, concerned with returns on investment; their ability to support large numbers of as yet untried small schemes with venture capital is very limited. It is, therefore, to their credit that not only the World Bank but some of its regional associates, notably the Asian Development Bank, are positively seeking ways and means of assisting in the establishment of smaller and more appropriate industrial developments.

Another function of size is the fact that personnel - other than some of those physically located in the field - have great difficulty in coming to grips with the realities of actual situations. They can seldom afford the time required fully to understand the operation of local systems and markets, or to acquaint themselves with alternative technologies, and so there is a tendency to apply previous knowledge, experience and criteria to new situations. Since many are by training, experience and inclination more familiar with conventional industrial processes they bring their experiences of those processes to bear upon local situations without giving proper consideration to the alternatives. Personnel with an intimate working experience of alternative, small scale technologies and their application in real-life situations are hard to find; they are seldom found among the ranks of conventional aid agencies.

Finally, confusion is caused by, and conflicting advice often emerges from, international organisations because of an apparent overlapping of interests, functions and spheres of operation. This is particularly so in the case of industrial development where, although UNIDO might be expected to provide the focus, other agencies can, with good cause, lay claim to an interest in one or other aspect of the industrial development process and, for very natural but unwarranted reasons of self-interest, all agencies seek to clothe it with their own perception of the problem and its solution. Hence the need, referred to earlier in this paper, to have a clear and commonly accepted understanding of the meaning and implications of Appropriate Industrial Technology and - to the extent it is possible - a clearer demarcation of responsibilities.

What has been said of international aid agencies applies equally, of course, to bi-lateral agencies, with the added disadvantage that their perception of needs and priorities is coloured by national as well as institutional interests which, although legitimate from the point of view of donors, may not correspond with the interests, priorities and motivation of the recipient countries.

In these circumstances, there is an argument for international and bi-lateral aid agencies to make greater use of local and non-necessarily governmental intermediaries, not only to funnel finances but, also, to undertake research, development and installation of appropriate industrial technologies, so that more flexible and locally comprehensible programmes of development might emerge. Significant steps are already being undertaken along these lines by UNIDO and other international agencies and, among others, by the American, British and Dutch governments who have introduced procedures for financing non-government organisations, both in their home countries and abroad, who are concerned with the development of appropriate technologies. The British Government's initiative in this field is specifically directed towards industrial development.

In considering their role in the development of Appropriate Industrial Technology, international and bi-lateral aid agencies should draw upon the experience of recent years, which indicates that a global strategy might concentrate upon the following features:

Creating a Favourable Politico-Economic Environment for Appropriate Technologies

The continued development of a more favourable environment for the introduction of appropriate technologies may require a conscious effort to change existing attitudes in the face of a commercial, institutional and research climate in developed and developing countries which often favours sophisticated capital-intensive processes. The role of an aid donor in bringing about this change is likely to be limited but important. Donors can help to introduce the concept to those involved in research in developing countries, to senior and middle-level management in government departments, to entrepreneurs and manufacturers and to those involved in formal education, particularly university students,

who will be the decision-makers of the future. Support to research institutions undertaking appropriate technology, training schemes for government employees and improved information services are all ways of achieving this.

Providing Adequate Information on Appropriate Industrial Technologies

Information about conventional, capital intensive processes developed in industrial countries is usually easily available as part of the sales package made up by manufacturers. For smaller manufacturing processes, and particularly those which have been developed outside the industrial countries, it is harder to obtain information. Often the manufacturers have developed such processes for locally identified market needs and see little reason to advertise them beyond the known catchment area.

The need for information about appropriate industrial technologies, both generally through publications, technical specifications, industrial profiles and the like and, also, specifically, in response to technical enquiries is well recognised by public, international and bi-lateral agencies, and by many private Appropriate Technology agencies, all of whom seek to provide specialised services of one form or another in this field.

Much attention has been given in recent years to the assumed need to create an international data bank of appropriate technologies, but practical steps to this end have not proceeded very far. Whilst the systematic communication of information is highly desirable, it may be that the advocates of centralisation of technology information should pause to consider the value of the steps they advocate. To pursue such a course is to misunderstand the nature of the need. Appropriate Technology is not immutable and what is appropriate today will be inappropriate tomorrow. Yet all experience indicates that, in the case of information as in many other matters, centralised mechanically controlled systems are not discerning and once recorded, such information tends to become established as the best available irrespective of subsequent developments.

What is needed is knowledge of knowledge - knowledge of who is doing what, and where and in what circumstances so that the latest information can be drawn together from time to time and for specific purposes - either for periodic publication or in response to specific enquiries. Those who strive to provide information services, there-

fore, should seek to strengthen communications between the resource centres - of research and development, professional institututions and the like - manufacturers and industrialists already producing or partaking of appropriate technologies and prospective new clients of those technologies.

Finally, the need for information relates not only to the availability of appropriate plant and processes but, also, to the new markets in which they may have relevance. Here again, while much market research has been undertaken in developing countries into the need for conventional processes in conventional, urban and central situations, little work has been done to discover the needs, purchasing power and constraints relating to the much larger and ultimately more significant rural sector. Difficulties of transport, communication with potential clients, deliveries, servicing, maintenance and spare parts - have all tended to deter investigation of those markets; by and large, only sociologists have paid attention to those aspects and their views, unfortunately, are too often considered not to be relevant to matters of commerce and industry. A new expertise needs to be developed then in the field of rural and informal market research and this is an area to which international agencies might pay more attention.

Research and Development of Appropriate Industrial Technologies

Action-oriented research and the development of appropriate technological models in response to developing country needs and situations provides a fruitful field for assistance, co-operation and collaboration both between industrial and non-industrial nations and between developing countries themselves, where work done in developing technologies for local use in one country may be transferred to another in similar circumstances more appropriately than the transfer of technology from highly industrial to non-industrial conditions. Identification of the need for R & D generally arises from two sources: the first, in response to enquiries which reveal that although the hardware exists and the applied technology is well known, it requires practical adaptation to suit local circumstances; the second, where a product or process is not commercially available in a form in which it can be used, with or without adaptation.

Modifications required to existing plant and processes are often minor in character - e.g. the introduction of a more appropriate part - usually requiring a minimum investment of funds and expertise but a comparatively large investment in time and follow-up. Little research is required and firms making the product are often willing to assist with or advise on the modification at little or no cost. However, it is more difficult, time-consuming and expensive for firms in developed countries to make the overseas linkage and to evaluate the results. There is a need to forge more direct contact with the field situation and in some cases, for linkages with overseas institutions capable of effecting the modification and evaluating the results in the field situation.

Innovation usually requires a greater investment of capital, skills and time. Whilst the need for new technology may be perceived by the innovators, a demand for it will not have been created - simply because it does not yet exist. In these instances, there is little point in carrying out market research until the technology has been developed and tested; yet the absence of firm evidence of demand can lead to a rejection by aid agencies of proposals for development. R & D of new systems inevitably carries greater risk than adaptation of existing systems, but this should not constitute a deterrent to original work.

Experience is that there is no lack of goodwill and capability in universities, research institutes and industry which can be mobilised to undertake R & D projects on an "as required" basis, instead of governments and aid agencies employing central staff on a permanent basis for the purpose. What is needed, however, is a flexible and effective linkage between identified needs and these resources, together with some capital for R & D. However, the carrying out of a successful project - from identification of need through to final production - is a complex exercise involving close contact with the researchers and clients in all its interim stages. In such an exercise it is not sufficient merely to link needs with resources and provide the necessary finance; constant monitoring is required which is best done by operational units established or identified for the purpose.

Development work carried out within the countries of need has significant advantages. The main advantage is that there can be more direct contact with the client resulting in a clearer awareness of local needs and circumstances. Local raw materials, the parts supply situation, the market demand, the conditions under which the equipment will be used, etc., can be more easily understood. Further, instead of R & D being initiated mainly in response to enquiries a more positive approach can be taken by local researchers towards the identification and satisfaction of local technology needs, as has been evidenced by the work of the TCC Kumasi and the ATDA, India, to whom reference has already been made.

As against this, the constraints to successful R & D in many developing countries are numerous:

i. there is a shortage of academic and research institutions. Where they exist, their staff are too often engaged on research which has little relevance to the immediate technology needs of the majority;

ii. similarly, local industrial concerns have limited R & D facilities and capabilities;

iii. government and aid funds for R & D are limited and mostly restricted to use on the more conventional type of research projects. Where funds for more action-oriented research are available they are often applied only to larger industry problems;

iv. overseas universities, research institutes and industry, although closer to the need, have little information on developments in the use of appropriate technologies elsewhere and, therefore, they are not conditioned to look for alternative solutions.

Nevertheless, in furtherance of the concept of developing local self-reliance, there is a need to encourage and facilitate local institutions to undertake R & D for local purposes. They require financial assistance and, perhaps, more important, exposure to the opportunities available to them to undertake work directly related to the solution of local problems and needs.

Translating the Results of R & D into Production Processes

This represents one of the greatest bottlenecks to the effective

implementation of appropriate industrial technologies. The reasons are numerous and varied; they are concerned as much with the need to create the correct socio-political environment within which the concepts of and criteria for appropriate technologies can be implemented, as with the proper injection of capital and technical resources.

An important part of the Appropriate Technology concept is that the manufacture and servicing of plant and equipment should be fostered locally and, only when it is clear that this course is not viable, should consideration be given to manufacturing in developed countries for export to developing countries. Nevertheless, such manufacturing for export does have an important part to play in many instances. Somewhat different constraints apply, and different action is needed to overcome the problems relating to the manufacture of products and processes developed for local manufacture or for export to developing countries.

The major constraints to inducing firms in developed countries to manufacture small-scale plant and equipment for export are especially severe for the smaller, but potentially more flexible firms; in general, they appear to be:

i. Technological - a lack of knowledge of the type and size of technology required.

ii. Marketing - a lack of knowledge about the size and distribution of markets; how to exploit them and when to approach; how to handle diverse foreign currency and trading situations; the difficulties of servicing and the need for an overseas sales force.

iii. Finance - unusual capital strains engendered by the risks of tooling-up for and dealing with new and rapidly changing markets; low returns for individual firms dealing with small scattered markets, with high administrative and service costs; cash flow pressures during initial market development and from extended lines of communication, e.g. delays incurred in obtaining foreign exchange clearance.

Any combination of the above represents higher than ordinary risks and frequently inhibits manufacturers from committing resources, personnel or capital to the manufacture of small-scale equipment

needed by LDC's.

Consideration of the constraints reveals various means by which firms may be encouraged to manufacture small scale plant and equipment for the Third World. These include:

i. Technical information - the need to make firms more aware of the level and types of technology needed in developing countries, e.g. by newsletters, seminars, etc.

ii. Marketing information and sales services - the provision of services which would provide surveys, arrange contacts, provide for demonstration installations, etc.

iii. Financial assistance - the provision of capital finance to enable firms to tool-up for new production and to bridge delays between start-up and take-off. Also, assistance in establishing demonstration plant and pilot projects.

The problems of generating a local, small-scale manufacturing capability in developing countries are, in essence, similar to those described above; in the developing country context even "small-scale" may represent larger changes relative to current operations and the size of the economy than in an industrial context. Additionally:

i. knowledge about alternative technologies may be even more limited; access to that knowledge is difficult, and local capabilities for developing technologies may be unknown or undeveloped;

ii. market forces often direct resources (e.g. raw materials, machine components and personnel) towards more conventional uses, thereby pre-empting many of these resources or failing to develop others needed by small manufacturers; and

iii. financial resources which are typically scarce have also been directed towards conventional capital intensive developments so that not only does the small-scale manufacturer face investment choices which for him are disproportionately larger than for his industrial country counterpart, but, also, venture capital is harder to find and import regulations, marketing programmes, etc., are skewed against his interests and needs.

In these circumstances, there would seem to be a need for a greater emphasis on identifying local small-scale industry opportunities, providing easier access to technical information, financing R & D and pilot projects (including training), and providing on-going advice and evaluation through technical assistance programmes. Funds are needed, also, to support production during the relatively longer start-up and take-off periods in developing countries.

CONCLUSION

This paper has sought to describe the conceptual origins of Appropriate Technology, some of the main developments which have taken place both in developing countries and by aid agencies; it suggests, also, some policy issues which need to be examined and some areas in which practical assistance might be given by aid agencies. In the final event, however, the successful adoption by developing countries of Appropriate Technology in industry will depend upon their own understanding of what is involved as well as upon their will to do so. In this context, aid agencies can help and enable the process; they cannot bring it about.

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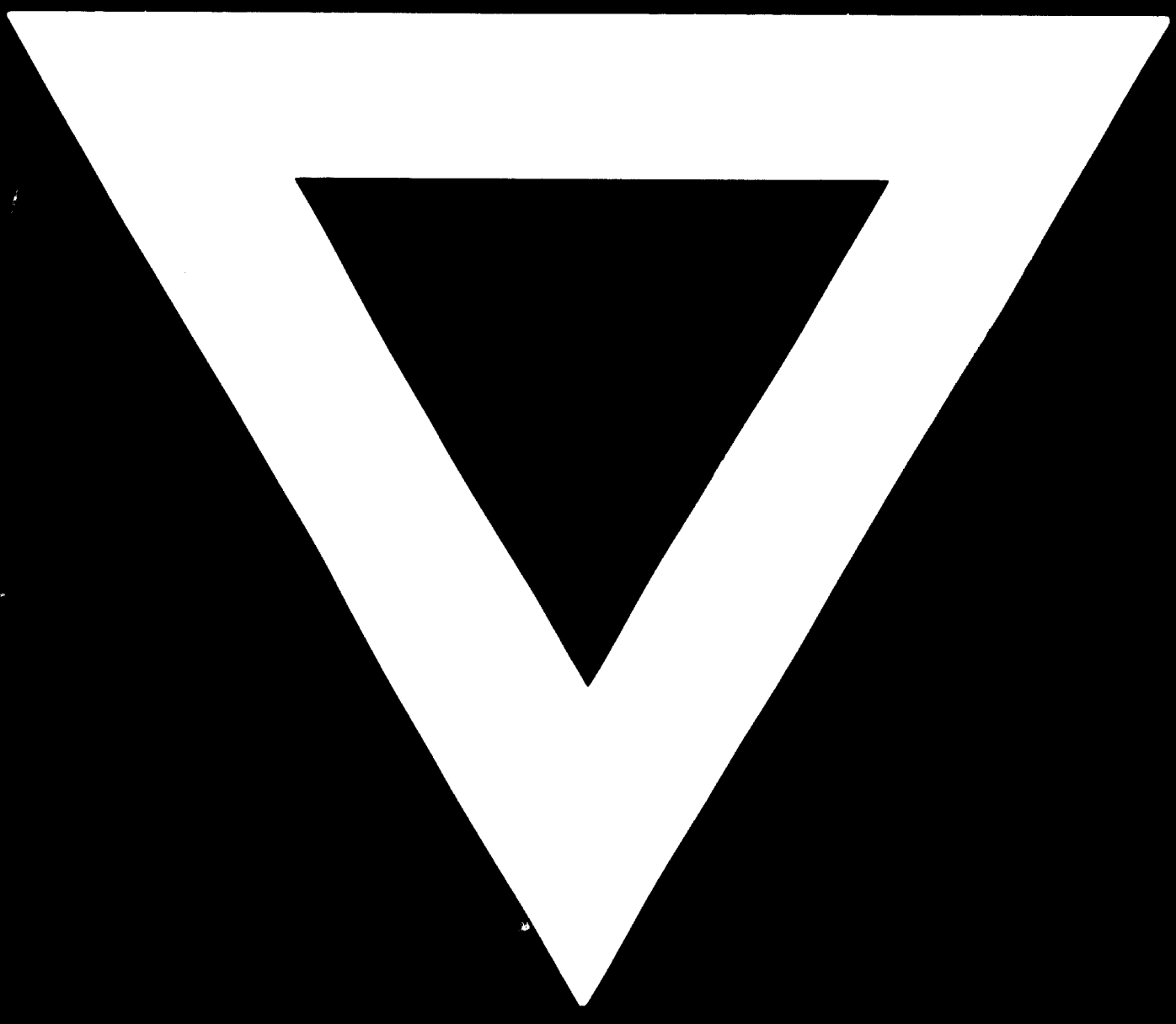

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