THE DEVELOPMENT OF THE FACULTY OF ENGINEERING, UNIVERSITY OF DAR ES SALAAM

By: W. Kreuser*

1. Students

The Faculty of Engineering, University of Dar es Salaam is now in the second year of its existence.

Although some of the buildings have not yet been completed, the Faculty has already moved into the new premises. The training workshops where all students spend nearly 50% of their time during the first year of the undergraduate course are in full swing since 1973, the first laboratories will be ready for operation early 1975.

The admission of students to the four years undergraduate course and the distribution to the departments are represented on the table below.

Department	1st Year	2nd Year
Civil Engineering		29
Mechanical Engineering	88**	20
Electrical Engineering		9
Total	88	58

**The first year is common for all departments.

In July 1975 the Faculty will admit 120 students the distribution of which to the departments after the first year will be: Civil Engineering 60, Mechanical Engineering 40, Electrical Engineering 20. Thus the Faculty will have reached its full admission capacity one year earlier than originally planned.

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2. Staffing

Apart from some vacancies in the Department of Electrical Engineering seriously impeding proper education, the general staffing situation is satisfactory.

Staff	Academic	Non-Academic	Total
Nationals	18	28	46
Expatriates	27	11	38
Total	45	39	84

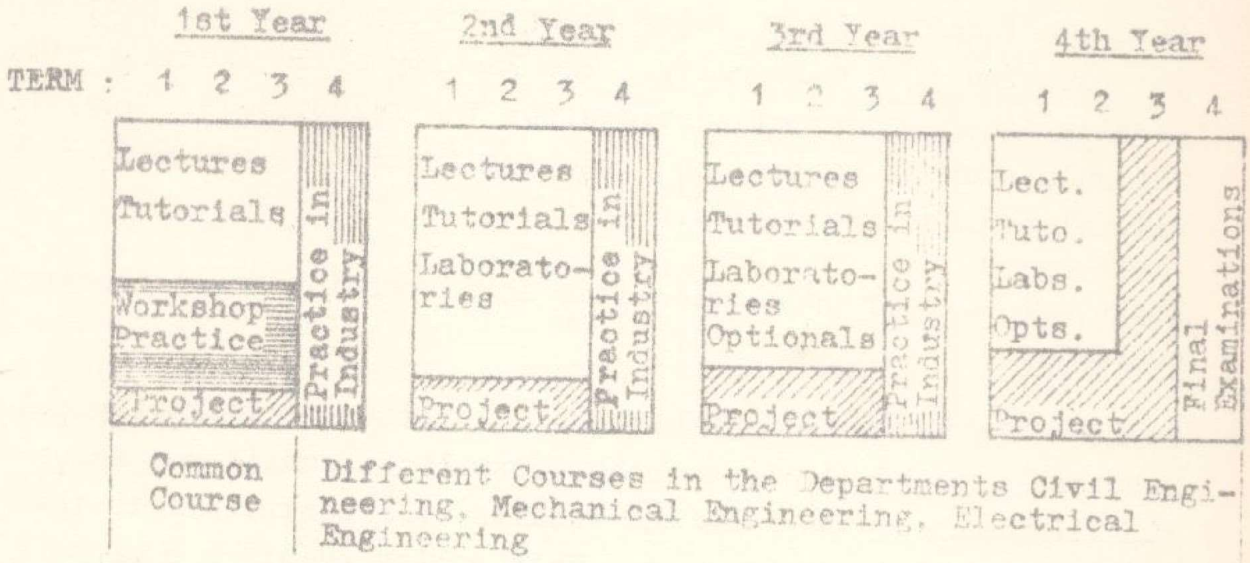
Compared with other engineering faculties in Africa the number of nationals on the academic level is encouraging although most of them are still on study leave for further training. When fully established, the student/staff ratio will be about 8:1.

3. Course Programme

The merger of theory and practice throughout the whole course is one of the main features of this Faculty. Workshop training of engineering students during the first year of undergraduate courses and the subsequent training periods in industry organized and supervised by the Faculty itself, have already proved that the practical approach is indispensable and must be a permanent component of engineering education.

Even in lectures and tutorials the choice of subjects to be taught and the methods of conveying knowledge to students must be governed by the aspect of applied engineering, for theory receives its practical value mainly by the possibilities of its application.

This principle of theory-practice materializes in the undergraduate course structure as follows:



Although curricula and syllabi* had to be changed several times within the last two years in order to adjust the programme to the needs of industry, everything is still open for further adjustments and supplements which might be necessary in the course of time because of new information and experience.

To adapt post-graduate education of Tanzanian staff to the needs of the country, the Faculty has established a research oriented post-graduate programme which is to be commenced in 1975 subject to the availability of supervisors and laboratory equipment. A course-oriented post-graduate programme will not be offered before 1977 when the first graduates are available.

In all post-graduate research the Faculty will stress the necessity to link research and education in general as much as possible.

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* For details on Curricula and Syllabi see Prospectus 1974/75, Faculty of Engineering, University of Dar es Salaam.

4. Strategy for Research and Consultancy

Although teaching is of major importance it is only a part of the function of a University. The Faculty of Engineering will provide other important services for the industrialization of Tanzania such as testing and research facilities and professional engineering advice.

There are already some guidelines in discussion for a research concept.

To meet the needs of Tanzania the priorities of technological research projects to be carried out will be considered under the viewpoint of how much the results will contribute to the socio-economical development. This policy requires a close co-operation between the Faculty and the government on one hand and industry on the other hand so as to identify appropriate research projects.

The identification and performance of research will be the major task of the departments.

As the "Office for Relations with Industry" continuously maintains the contact with Industry it will be a very helpful institution for the necessary linking of industrial production and university research. Hence ORI in co-operation with other institutions will assist the departments to identify research projects.

The specialization of science and engineering on certain fields and their departmental division of scientific activities, however, require interdisciplinary and inter-institutional co-operation for problem oriented research.

The membership of the Dean of the Faculty of Engineering to the "Industrial Research Committee", which is a sub-committee of the Tanzania National Scientific Research Council, is another means of establishing permanent contacts and obtaining information with regard to general research policy. This institution co-ordinates all research activities in Tanzania in order to avoid parallel research performed on the same problem by different research institutions.

All this shows that applied research on the field of technology is rather a complex matter covering numerous activities such as planning, construction and design, calculating, prototype manufacturing, testing which eventually leads to implementation in industry.

Research and consulting activities to be carried out by the Faculty are, however, limited by the technological know-how of the staff and the laboratory equipment at the Faculty's disposal. The increase of both qualified staff and research facilities in the laboratories is one of the prominent tasks the Faculty will have to attend to in the years to come.

The laboratories have already started to offer services on different fields such as material testing for building industry and metal working industry, soil testing and others. In addition there are first steps made with regard to consulting activities. The permanent involvement of the Faculty in activities related to the industrial sector will help to improve engineering education and to promote industrialization in Tanzania.

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TECHNOLOGY AS A GENERAL SUBJECT IN THE TANZANIAN EDUCATION SYSTEM

By: A Kanyilili*

1. Introduction

Technical education is organized and given in any country for either or both of the two objectives, namely:

a) As part of the general educations, like any of the other well-known subjects such as Mathematics, Geography, physics, etc. and

b) As a career or vacational geared programme to produce the required technical manpower at the three basic levels, viz:

Craftsman
Technician
Engineer.

There is no doubt in Tanzania today that we have accepted as a matter of policy the need to emphasize Technology in our education system. (See Nyerere: Education for Self-Reliance, March 1974; Tanu Directive on Small Scale Industries, March 1973 and Resolution 29 of the 16th Party Conference, October 1973).

In spite of all these pronouncements, however, it is very sad to note that there is a very strong doubt as to whether our education and manpower planners, and the policy makers themselves are fully aware of the complexities and organization required to run a viable, successful Technologically based Educational system in a country like Tanzania at its present stage of development.

2. Definition of Technology

Technology in this context will be defined as that subject which facilitates the imparting of knowledge, attitudes,

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skills and confidence connected with the designing, making, operating, maintaining and repairing of an article as well as its improvement, either in part or as a whole, based on enginnering principles. This technology is at four distinct but interrelated levels:

1) The General Elementary Level
2) The Craft Level
3) The Technician Level, and
4) The Engineer Level.

Objective (a) above is directed at the first level and objective (b) is directed at the second, third and fourth levels which are the career or Technical Manpower levels.

A viable successful Technologically oriented Education system cannot be set up without an understanding of the purpose, the relationship and the interdependence of all these four levels. Of course an understanding of the political-social-economic situation of the country is also necessary.

3. Confusion in the Present Structure of Technical Education

If one studies cirtically The Engineers Registration Act (1968), The Education Act (1970), The National Vocational Training Act (1974), The National Examination Council Act (1973) and the Act which established SIDO (Small Industries Development Organization) in 1973 coupled with the job descriptions of various officials in different Ministries of the Civil Service and the parastatals together with the Annual Manpower Reports to the President, one cannot help but come up with a very confused picture of Technical Education set-up in this country. It is clear that many organizations and officials are duplicating their efforts without a clear central directive as to what each is supposed to do. Worse still, these officials more often than not carry out their duties uncoordinated or in competition to each or some of each other.

The same unsatisfactory picture emerges when one observes the current pronouncements and activities on the Diversification of secondary schools, the TAPA (Tanganyika Parents Association), Technical Schools, SIDO Training Centres, National Vocational

Training Program, Tanu Youth League Technical Schools, Voluntary Urgency Vocational Training Centres and the two-year Post Primary Schools (four are to be started in each of the eighty-five districts).

4. Need for authoritative coordinated efforts

Clearly such a situation calls for clear and coordinated efforts at all levels of our society, otherwise we may fail not because of lack of the will and enthusiasm to promote Technology, but rather, inspite of it. Some of the people and organizations, if not all, are jumping on the popular bandwagon without a clear objective of what is to be achieved and the method to be employed in achieving it.

If these very commendable efforts are to bring the desired fruits of moving Tanzania away from the present position of Technology dependency (hence permanent economic dependency) to full political and economic independence, we MUST understand the two objectives of Technical Education and the four levels of Technology. So far our efforts are directed at producing the technical manpower at the craftsman, technician and engineer level.

This is good. BUT, and this is the main purpose of this paper, we cannot produce the required manpower simply by dealing with the second objective of technical education without at the same time dealing with the first, that is of introducing Technology as a general component of our education. Every boy or girl who goes to school must learn at least Elementary Technology as one of the subjects, and every effort must be made to teach Technology in the non-formal way. The Radio, the Newspaper, the Factory and all the other media of Adult Education must be mobilised to teach this important subject.

5. Objectives and Problems

Space does not allow me to go into detail on the objectives, problems, and solutions in introducing Technology as a general component of education, and of promoting it to each of the three career oriented levels.

Let me briefly mention some objectives of teaching this subject.

Technology is an important preparation for life in the modern technological age. We are all surrounded by gadgets and tools which have become necessities rather than luxuries. Think of the family who could not hear our President's speech of the food situation in the country simply because the batteries of the radio were reversed, or of the outcry in the last budget session of our National Assembly when Ndugu Elinewinga was put to task on TANESCO failures. Twenty years from now electrification and water projects will be widespread throughout the country. Will that time find us capable of living safely and economically with electricity and water taps, pumps, etc., or shall we have to call special "fundis" even for the simplest technical jobs? And who knows, by that time we may well be required to interpret technical drawing and instructions correctly before we can do most of our things such as " ,rowing" our foods in our kitchen, using the correct fuel for our car when other fuels will have been developed, washing our clothes, etc. etc.

Most of our buildings, furniture, home appliances, driving instructions, motor cars, type-writers, etc. etc. do require at least some elementary technical knowhow to be able to use them properly. With the advent of more development these requirements will increase. Yet we are prepared to spend years in school, sometimes sixteen to eighteen years, without learning that subject (technology) which finds immediate and continuous application in our everyday life.

Technology helps to create the right attitude and assists the appreciation of the value and problems of organizing a viable successful structure for the advancement of industry. Of course there will be specialised teachers and students of technology, but without the rest of us having an idea of technology we shall not be able to assist these specialised personnel to advance themselves. Good music is played by musicians but it cannot be appreciated by the uninitiated listeners. Footballers play better football and advance themselves if the spectators know at least the elementary rules of the game, such as how the goals are scored, when the ball is out of play, what is a foul, a corner kick, a penalty etc. Without such an appreviative public the game would not have advanced at all. Similarly, without an understanding public, technology will continue to be given low priority in practice, although it will be highly regarded in TANU conferences and elswhere.

It took twelve years before the Faculty of Engineering was established in our University and TANU has never really come up with a thorough going policy paper on technology, despite last year's guidelines on small scale industries which resulted in the establishment of SIDO. But can SIDO in its present structure and strength be able to really coordinate and promote heavy industries based on steel and machine tools, or will this country continue to pride itself only on Makonde Carvings, handcraft work, etc. These are works of art. They are not the basis for industrial revolution.

6. Underutilization of Local Productive Resources

Again consider the number of misplaced, underutilized and idle craftsmen, technicians and engineers in this country. Consider the abolishment of the former Moshi and Ifunda Trade Schools; consider the shortage of basic hand tools in our technical training institutions; consider the importation of foreign goods and manpower for purposes which can satisfactorily be met in this country, for example the designing and building of school workshops, simple pumps, simple laboratory and workshop equipments etc. Consider all these and many other cases, and the conclusion must be that our policy makers and planners only pay a lip service to technology.

Without introducing Technology as a general subject in all our schools this apathy, these mistakes will continue to be made. The fact is that scientists and technologists (of all shapes and sizes) require wholehearted support and motivation from all corners before they, in their turn, can use their knowledge and gifts to lift this country from her present position of weakness and economic dependency to one of strength, confidence and full independence based on self-reliance in both agriculture and industry.

The necessary support and motivation cannot be forthcoming without changing the pattern through changing our attitude by introducing technology as a compulsory subject in our schools and colleges. Then our politicians, directors and managers will at least be initiated in technology, if not technologists per se, able to appreciate the value and problems of technology and willing to apply the necessary solution not out of pressures but because of understanding.

7. Foundation for Subsequent Training

A general Technology in schools is a necessary foundation for any subsequent training in technical education. The first year of the four year engineering course is necessary only because the entrants to the course do not have this foundation from schools. Again some of the students may well have entered the faculty out of curiosity or misguided notions, but they have no aptitude for an engineering career. It is important to sort out the gifted from the misguided and determine, at least attempt to determine, students inclinations before they enter a specialised training.

Technology does promote the sense of imagination and improve childrens interest in creativity. Thus it is the basis for do-it-yourself hobbies and activities, such as painting the walls of ones house, modifying our kitches, greasing our cars, or indeed, even improving our technology in evening classes.

Modern teaching demands that lessons be illustrated by aids as much as possible. Technology is therefore necessary for the better preparation of teachers.

8. Reducing Maintenance Costs

It must also be pointed out that technology in schools and colleges is very necessary if we are to reduce maintenance costs of these institutions. In one year alone (1970/71) the Ministry of National Education spent over 3½ million shillings on the upkeep of schools and colleges by Comworks and 1.8 million on the maintenance of plant and vehicles assigned to these institutions. In 1973 the Dar es Salaam Technical College was spending 9,000/- every month for hiring Co-Cab buses because the College's own bus and truck were very often in Comworks workshops. The buses were required to transport students from their hostel in Keko National Housing Estate (at 8,000/- a month).

This hiring continues to this day because due to bureaucratic red tapes at high government levels the college somehow has to wait for the World Bank and the Netherland Government to build sleeping places (and workshop area), a job well within the technical capacity of the college itself.

What is lacking is the necessary backing and understanding at the high levels of the government, the required administration and organization and somebody with authority to cut these red tapes which is the cause of many of our failures today especially in the technical fields. We have the manpower and other resources to reduce maintenance and other costs but the necessary organization is lacking.

9. Conclusion

Many other reasons could be given as to why it is important to introduce and develop technology now at all levels and all forms of education and training (formal as well as non-formal), not least the first most important level of general elementary technology. Failure to deal with this level now will result into frustrating our otherwise well intentioned efforts to produce the required specialised careers in the three other levels of craftsman, technician and engineer. Let us hope that Tanzanians will pull themselves together and rise to the occasion. They will mount their energy and other resources to the establishment, promotion and maintaining of a viable successful structure for this task, based not on political emotions but on realistic understanding of what is required.

BIBLIOGRAPHY

1. African Regional Plan for the Application of Science and Technology to Development. Working paper presented to the Conference of Ministers of African Member States Responsible for the Application of Science and Technology.
United Nations Publications, Dakar, January 1974.

2. Summary conclusions of the IDS/Day Hammarskjold Seminar on "Education and Training Alternatives in Education in African Countries" Institute of Development Studies, University of Dar es Salaam, May 1974.

3. J.K. Nyerere: "Education for Self-Reliance"
Ministry of Information and Tourism, 1967.

4. A. Kanyilili: "Introducing Technology into General Education in Tanzania" in Studies in Curriculum Development No. 4
Institute of Education, University of Dar es Salaam, 1973.

5. J.F. Rweyemamu: "Underdevelopment and Industrialization in Tanzania" Oxford University Press, 1973.

6. I.L.O. Report on Employment, Incomes and Equality in Kenya, 1972.

7. Idrian N. Resnick: "Revolution by Education. Longmans 1968.

8. John S. McNown: "Technical Education in Africa"
E.A. Publishing House, 1970.

9. UNESCO Report on the Conference on Elementary Technology as a component of General Education in Africa, Nairobi, 1971.

10. The Diversification of Secondary Education in Tanzania: Directorate of Planning, Ministry of National Education, Dar es Salaam 1973 and 1974.

11. A. Kanyilili: "The New Curriculum for Technical Schools" to be published in Studies in Curriculum Development
Institute of Education, University of Dar es Salaam.

12. Annual Manpower Reports to the President.
Ministry of Economic Affairs and Development Planning 1970, 1971, 1972.

DISSEMINATION OF APPROPRIATE TECHNOLOGIES

By: Harold Dickinson *

1. The Problem

The large international aid and development organisations endeavour to use the economic solutions of rich countries to resolve the problems of poor countries. This situation has led to the establishment of complex and capital intensive industries which have little impact on the needs of the poor and almost none on the needs of the poorest peasants who remain outside the monetary system.

The poor peasants remain in an economic sector based on traditional modes of production. Agrarian reform has produced widespread social and political change but has had relatively little impact on the production techniques of the bulk of the rural poor. It is possible that acceptable new technologies are to be found in other regions or other countries but the peasant sector of an economy does not have access to sufficient capital or credit to obtain imported technology.

2. Technology Levels

In the practical evaluation of technologies it is convenient to consider production processes at three different levels:

Cottage Industries - where there is little differentiation of labour. All members of the family, or extended family, play some part in the production process using traditional skills that have been little influenced by modern technology. To extend the range of products it is necessary to seek new cheap and simple processes, to improve access to markets and to offer the possibility of exchange of local products for industrial products. To improve cottage industries the

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capital available is likely to be small and any acceptable technology must be almost costless.

Small Industries - where the proprietor is both an enterpreneur and an artisan who works alongside his workers. Such industries may use simple, often old or antiquated, machines and require several different manual skills. The differentiation of labour, however, will not be great. The problems of such production units are relatively complex and it is unlikely that the proprietor has any conception of the relationships between the various factors of production. Industries of this kind have great difficulty in finding external capital, as the risk is great, and possible innovations must be cheap enough to be financed from the proprietor's savings.

Modern Industries - where specialised machines are used with a demand for highly skilled and responsible workers. The plant is likely to represent a considerable capital investment and to obtain a return on capital competent managers are required.

All three levels of manufacture require specialised forms of education or practical instruction. For cottage industries the instruction process is dependent on association and assimilation. For small industries there is an informal education process including elements of assimilation and apprenticeship. For modern industries there is need for a range of formal instruction and apprenticeship for the various activities and skills.

In all kinds of production situations it is necessary to find a technology that can meet production requirements whilst making fullest use of immediately available resources - raw materials, credit, capital, labour, transport, markets - and which is acceptable, or adaptable, to the society that wishes to make use of it. Such a technology is called an 'Appropriate Technology' and it must be both technically and socially appropriate.

3. Characteristics of Appropriate Technologies

- with particular reference to the rural sector.

It is possible to describe a large number of features that may help to identify an 'appropriate technology'. In any practical situation it is possible to envisage a range of alternative technologies that could meet the immediate, and near future, production needs but final selection would have to take into account a complex set of economic, social and technical relationships. With particular reference to the rural economy it is necessary that an 'appropriate technology' should:

3.1 meet the technical needs of the production situation by:

3.1.1 using local materials and power resources.

3.1.2 minimising the content of imported materials.

3.1.3 ensuring that the product will be produced in adequate quantity and acceptable quality for existing or potential markets.

3.1.4 ensuring that the product can be conveyed to market by available transportation without deterioration and in sufficient quantity and with adequate regularity to encourage demand.

3.2 meet the social requirements of the production situation by:

3.2.1 using existing or easily transferable skills and avoiding complicated, time-consuming and costly retraining.

3.2.2 offering continuing, or expanding, job prospects.

3.2.3 minimising social or cultural disruption by increasing production and productivity by successive small increments rather than by larger single steps - individual income steps in excess of, say 10% are likely to be socially disruptive.

3.3 meet the economic requirements of the production situation by:

3.3.1 minimising the capital demand from local or national resources.

3.3.2 minimising foreign exchange requirements.

3.3.3 ensuring that capital is used in a way that is compatible with local, regional and national economic plans.

3.3.4 ensuring that the main economic benefit returns to the producers and is not captured by a new class of middle-men.

3.3.5 obtaining greater integration of producers into the monetary system - in many peasant societies money is only used for beer and funerals.

4. <u>The Source of Appropriate Technologies</u>

There are several possible lines of investigation that may be followed in order to find an 'appropriate technology'.

The first is to modify existing practices, at the technical or economic level, so that production may be increased or diversified without large demands being made on resources or on the structure of local society. Innovations at this level may involve minor design modifications of traditional tools or machines, the introduction of new materials or the modification of a traditional use pattern for existing materials, or increased monetary circulation by improving the access to markets. The stimulation of demand for new products from the town may well be the most important factor in stimulating production for marketable surpluses rather than for a static local demand. This is the more usual way in which economic and consequential social change, occurs at village level but by its dependence on a number of barely understood factors the process tends to be haphazard and difficult to integrate with wider economic aims.

The second is to revive and introduce an older well-tried technology from an earlier stage of development of a different economy. This approach is particularly attractive in that the earlier experience with the technology may be expected to lead to success more readily than with an untried innovation. There is, however, a difficulty that may be insuperable: whilst the technology may have been effective in the past it is unlikely that any record exists of the way in which it was economically and socially integrated into the society that made use of it.

The third is to invent a new technology, or change the scale of a modern technology, to meet the needs of a particular situation. This is the slowest way to produce innovations. It is also costly and demands a range of skills experience and knowledge that are unlikely to be found in a poor country.

For all these approaches design requirements have to be conditioned to a situation where capital is scarce and unskilled labour plentiful in contrast to the situation in wealthy countries where technological design is conditioned by relatively dear labour and a plentiful supply of cheap capital or credit.

Every society in the world has developed a wide range of technologies on which it depends for survival. These technologies have changed with time to meet changing needs and until relatively recent times all changes have been slow. With the rise of modern industry and the growth of scientific understanding technological innovation has become almost exclusively confined to a few countries. Over 95% of scientific and technical research and development is carried out in the wealthier countries and almost all applied research is directed to the problems of the wealthy. What little research is done in the poorer countries is carried out by nationals or expatriates trained in, and accepting the values of, the wealthier countries of the world.

5. Dissemination of Technologies

We have seen that to further economic and social development it is necessary to provide new ideas and new impetus based on an understanding of the economic, social and technical requirements of a particular situation. Thus there is a need for organisations to offer consultancy services to all levels of manufacturing industry, from the peasant producer to the state corporation, in the same way that agricultural extension services are provided by many colleges, universities and governments. (We see the start of such an organisation in Kumasi in the Technology Consultancy Centre of the University of Science and Technology).

The problems of such a service are greater than can be borne by a single institution no matter how well endowed and it is essential that supporting organisation be set up to develop new technologies, to exchange process and device information, to carry out research on technical and social adaptation of new techniques and, above all, to produce a corps of professional workers in what is essentially a new field of service based on the formerly separate approaches of economics, sociology and technology.

There are two immediate problems of orientation that will have to be changed if appropriate technologies are to be developed and introduced at a reasonable rate. Firstly the wealthier countries must, as part of their aid programmes, channel first-class scientists, technologists and sociologists into research and development work that seeks to solve the problems of the poor in the context of the conditions in which the poor live. Secondly, the professionals of the poor countries must be persuaded to seek education and experience as a means of bettering the lot of their fellow nationals and not as a means of abondoning their national problems and joining, superficially at least, the wealthier world. In this the institutions of the wealthier countries can play a part by taking the problems of the poor as being as important, and in their own way, as complex as the problems of the rich.

If these steps can be achieved there is the prospects of an increasing deployment of the worlds resources to back up national or local consultancy or advisory services that are the key to the transfer of technologies to the point of need and application.

6. Conclusion

The central problem of finding 'appropriate technologies' for the development of poor countries lies in giving the poor access to scientific and technical knowledge in a form that both reflects their needs and is assimilable by them. No one doubts that the laws of science are universal but access to the benefits of science depends on the quantity, quality and cultural orientation of the available scientists and technologists. Until responsible scientists and technologists with adequate funds are available to enable poor countries to obtain freedom of technical choice there is little likelihood of the mass of the world's population escaping from poverty. Should suitable technologies become available the choice to use them or not will still depend on the wisdom of political leaders - new technologies can only offer new opportunities they cannot guarantee results.

The main problem of the world is poverty. The only way to escape is to make the fullest intelligent use of all available economic resources. 'Appropriate Technologies' are now seen to be a very important factor in development and they may well be the only factor that is not too costly to use.

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