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THE DEVELOPMENT OF TECHNICAL SKILLS IN LDC's

(Suggestions For An ISTC Program)

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SYNOPSIS

Introduction

This section attempts to establish the context for the rest of the paper by reviewing the functions of the ISTC as mandated by the International Development Assistance Act of 1979 and arguing that an essential part of the task of strengthening scientific and technologic capacities is the strengthening of the human and organizational capacities at the technician level.

Section One Program Planning and Assessment

This section suggests that the ISTC can have a major impact both on the choice of technologies and on the resolution of many training problems by systematically assessing manpower availability and utilisation options as early as possible in program planning, as locally as possible, at as low a level of aggregation as possible, and with as much iteration as possible between the policy options on the manpower supply side and the options on the demand or utilisation side. It suggests that much of the training problem is in fact a result of inappropriate choices of technology, underemployment or misemployment of existing skilled manpower, rigid employment and manpower utilisation policies, and inappropriate or inadequate incentives.

Section Two Quantitative Capacities to Train

This section suggests that, contrary to common assertions, in all but a few countries the current formal training capacities are meeting or exceeding the effective demand for skilled workers. Though the aggregate numbers being trained are adequate or near adequate, most countries: have serious gaps in their training capacities; have inadequate coordination and planning for existing capacities which creates much redundancy, underutilisation and inefficiency; and have inadequately developed the less formal training alternatives - extension and continuing education, in-service and on-the-job training, short-cycle and workshop courses - which are necessary to complement the formal training capacities and to make the

many small adjustments between the available manpower pool and the evolving needs of employers. The most effective roles for ISTC would be in helping countries to strengthen their planning and coordinating mechanisms for technical training and to create a more effective system out of their existing capacities. Other capacity problems which the ISTC might address include: the improvement of linkages between training institutions and employers; the policy issues of the appropriate stages for vocational specialisation; the causes and effects of the migration of skilled workers, including mobility within the country and mobility between developing countries; the special needs and limited options of the very small countries.

Section Three Technician-Level Manpower Utilization

This Section discusses some of the problems of coordinating the supply of skilled manpower with the employment and utilisation practices of industry. It suggests some industries in which the substitution of skilled labor for physical capital is possible, and argues that such policies of substitution require changes in training strategy and services. While they may ease the capital constraints on investment, they do not necessarily reduce the amount or complexity of training required. The Section also discusses some of the problems of allocating training places, including external training, and of coordinating training allocations with future demand. It recommends that the factors affecting occupational choice and career patterns should be priority issues for investigation by ISTC, since an essential assumption of efforts to redirect development must be that individuals can in fact be redirected and motivated to develop careers in priority sectors, locations and professional roles. It suggests that though there exists a substantial body of analytical and conceptual work on manpower utilisation, employment and training options for specific industries there is a need for one or more strong resource bases or clearinghouse functions which can collect and provide a point of reference for this work. Such a collection or point of reference would be a valuable resource for ISTC and the countries with which it will work and the ISTC is urged to explore means of support for one or more of the mechanisms currently being proposed by ASEE and other national bodies.

Section Four **Engineering Technology and Other Sub-Degree Training**

This Section discusses the growing interest in the U.S. and in many developing countries for more practically-oriented training for technicians and engineers and argues that the programs of engineering technology which are widely offered at the associate and the baccalaureate level in U.S. institutions provide a promising model for application in many developing country contexts. A major weakness at present limiting the opportunities for such institutions to cooperate with other countries is the absence of a representative organisation able to speak for the diverse technician training programs and institutions and represent their interests in international training and technical assistance. The large numbers and diversity of these programs which make them a major resource also make it difficult to mobilise and make effective use of their capabilities and experience. The ISTC is urged to explore means of creating or strengthening one or more organisational mechanisms for such institutions, possibly along lines of the proposal advanced by K. Nagaraja Rao and Lawrence Barrell through the International Division of ASEE. A number of specific suggestions are made for the kinds of technical assistance which would be useful to institutions in developing countries attempting to adopt such models, particularly on ways to structure training programs in close collaboration with industry and other employing clients. This section also discusses the need for improved organisation and planning for the placement of the increasingly large numbers of external trainees in technician programs in the U.S., such as the large programs from Nigeria, Venezuela, the Middle East and elsewhere financed as reimbursable technical assistance. The organisational effort needed to improve these training programs is parallel to the effort required to more effectively mobilise U.S. technician-training institutions for technical assistance and cooperation in developing countries, and the ISTC might usefully combine leadership on both sets of problems.

Section Five Industrial Extension

This Section suggests that one of the most direct ways to strengthen the technical capacities of countries is through information and advisory extension services for small industries. Extension systems are generally weak and underutilised in most developing countries, but they are particularly needed in support of small industries. Much of the needed skill acquisition requires very specific information and experience with specific technologies and working contexts, for which formal training can at best only be a preparation. The small industries sector is a critical part of the technology capacity of any country, both as an important part of the productive capacity and as the level at which much of the entry-level employment will occur -- thus the level at which much of the needed skill acquisition, working experience and application of formal training will be obtained. A particularly promising example of an industrial extension service is cited, TECHNONET ASIA, which works through 11 cooperating organisations in nine Asian countries, with support from IDRC in Canada. The ISTC is urged to seek opportunities to collaborate with this and other industrial extension efforts. The U.S. has much relevant experience with extension methodologies and the ISTC could play a very useful role in helping to facilitate the participation of U.S. industry, such as the machine tool industry, in helping to solve the problems of small industries with known technologies and their practical application.

Section Six Education and Training Aspects of Appropriate Technology

This Section recognizes that the strong worldwide interest in the development and application of more appropriate technologies and technology strategies will be a major influence on the programs with which ISTC will work. It suggests that too little attention has yet been given to the education, training, and manpower utilisation aspects of such technologies and suggests that the ISTC is in a unique position to give leadership on such aspects. It can help to clarify the skill requirements of such technologies, to improve understandings of how such technologies may be diffused and replicated, and to integrate these technologies and their design criteria and concepts into the curricula of mainstream technology training.

Section Seven Alternative Development Strategies

This Section suggests that technical training needs and policy options cannot be assessed independently of other social, economic and infrastructural policies. Alternative development strategies are stressing local values and a high degree of participation at the village level, self-reliance, employment as a primary objective, and direct responses to basic human needs. Such strategies, sometimes described as 'bottom-up' development, require different training emphases and modalities from those of the more conventional 'top-down' strategies. Among the differences which will affect ISTC programs are: integrated approaches which cut across sectoral lines, often requiring technicians trained in more than one discipline or technical area and able to work effectively as integrated teams with specialists in other technical fields; more direct participation by villagers and other primary clients in problem definition and program implementation, often requiring the technician to have additional functions as organiser, facilitator or animateur; increased use of paraprofessionals, often requiring the training of technicians with less formal education than conventionally required, and often requiring less formal training in local contexts; an increased reliance on local training resources, often requiring a degree of integration between the training programs and the development projects or production systems for which the technicians are being trained; and, an increased emphasis on the process of training, with the training programs expected to contribute to needs assessment, problem definition and technology adaptation as well as to transmit and develop specific skills. These are the kinds of training initiatives or strategies which are most difficult to assist through conventional technical assistance channels. They are, however, the kinds of initiatives for which collaboration in the form of exchange of ideas and experience and joint exploration of alternatives is most needed, and for which the ISTC could be useful in facilitating interchange. The ISTC can also contribute more directly by insuring that such alternative modalities are fully considered in the implementation planning for all projects or programs addressing basic needs.

Section Eight Technology and the Social Context

This Section argues that technologic capacity in its fullest sense includes the capacity of a society to make technologic choices and to cope with the results. It suggests that too little is known , and much of what is known in inadequately considered in current strategies for development and technologic change, about the processes by which people in specific societies and cultures use current technologies, perceive new technologic possibilities, adapt and change, learn and transmit technologic information and skills. Along with any efforts it undertakes to strengthen training capacities, to contribute to R&D on priority problems, and to transfer information and technologies, the ISTC is urged to support a variety of initiatives to improve understandings of these processes and their implications for the development of technologic capacities. Some of the areas suggested for inquiry are: the role of the group in the choice, use and legitimisation of technology; the treatment of technology, both traditional and modern, and of technologic change in formal school curricula; the role of arts and crafts, and crafts-based industries, in technology application and innovation; patterns of demand for schooling and training and the publicly and privately perceived benefits and incentives which influence such demand patterns; research on culture-specific cognitive, analytical and perceptual paradigms, risk-taking and risk-avoidance behaviors, and preferred patterns of organisation and participation.

In an important sense, the understanding of these processes and the development of technologic capacities appropriate to specific social contexts is both the starting point for ISTC planning and its most essential long-term goal. As E. F. Schumacher put it, " Know-how is no more a culture than a piano is music."

Section Nine Overview of an ISTC Program

In this final section, an overview is provided of the three levels on which the ISTC will be concerned with technical training (the strengthening of high-level scientific and technologic capacities, the application of these capacities, and the articulation of these capacities with the processes of technologic change in specific societies), some suggestions are made for internal staffing and program planning, and six specific initiatives are suggested for an initial program beginning in FY 1980.

Introduction

The purpose of the ISTC will be " to strengthen the capacity of the people of developing countries to solve their development problems through scientific and technological innovation, to foster research on problems of development, and to facilitate scientific and technologic cooperation with developing countries." (Section 21, International Development Assistance Act of 1979)

This paper is concerned with the issues and tasks on which the ISTC may base a program concerned with the training and utilisation of technician-level personnel. It will consider issues of planning and policy, the specification of skill needs for new technologies and investment priorities, external training issues, linkages between formal training institutions and the basic needs at the village level, and the need for greatly improved understanding of the processes by which people in specific cultures and development contexts acquire technical skills, make technologic choices and adapt to technologic change.

The ISTC will be authorised to encourage and support a variety of activities designed to strengthen the scientific and technologic capacities in developing countries, including the support of research on critical development problems, the exchange of scientists and other technical experts, advice and assistance to other agencies of the U.S. Government in their programs of scientific and technologic cooperation, measures to facilitate the participation of private U.S. institutions, businesses and individuals, and the dissemination of information, knowledge and technologies relevant to the needs of developing countries. Such direct efforts to transfer scientific and technologic knowledge, to strengthen local R&D capacities, and to cooperate in research and development on critical problems are much needed and desired by developing countries and seem likely to be the major part of ISTC's program efforts. However, the success of these efforts,

i.e. the effectiveness with which the scientific and technologic knowledge is applied to the solution of critical problems of development, will be determined as much by the human and organisational capacities in the respective countries to make use of the knowledge and skills which exist as it will be by the knowledge base on which such capacities rest.

The availability of specialised scientists and technologists, the adequacy of the supply of technicians at all levels, the effectiveness with which skills and capacities in the general society are identified and mobilised, and the degree to which all of these capacities are systematically interrelated and utilised are essential elements of a technologic capacity. Without the capacities to train the technicians, programs to utilise the technicians in appropriate ways and on preferred problems, and support mechanisms to help solve the working problems of technicians in these programs, the advanced scientific and technologic capacities cannot be brought to bear on most basic needs problems and are essentially impotent.

Each country requires a spectrum of technical manpower appropriate to its particular context and opportunities. The spectrum ranges from the practical to the theoretical and extends from skilled labor, craftsmen, industrial technician, engineering technician, engineering technologist, technical engineer, scientific engineer, engineering scientist, and scientist. Similar spectra are required for non-engineering personnel, e.g. in the medical professions, for administrators and managers, for educators and communicators, for service industries and primary producers. One of the most general problems facing many LDC's is that the spectrum is incomplete and skewed such that shortages of technical manpower exist along with surpluses and excellent scientific capacities or well-established craft traditions are underutilised.

Training capacities in most LDC's have expanded dramatically over the past two decades, in some cases in excess of the effective demand. However, there continue to be skill shortages in specialised areas and generally inadequate capacity to meet the demand for training from the numbers of adolescents entering the workforces. Existing training capacities tend to be poorly coordinated with employment, biased in content toward skills and technologies inconsistent with current development strategies, and structurally rigid in their ability to adapt to new skill priorities and

technology strategies. Existing programs mainly serve the needs of modern sector enterprises and centralized public services. Training, extension and support services for the traditional sector, for artisannal industries, for small-holder agriculture and for basic needs at the village level are inadequate, or non-existent.

The most common shortages are in the middle of the skills spectrum, i.e. the technicians, first-level administrators and support personnel, and the most common systemic problems are the relative weakness or absence of the institutions, organisations and programs which link the scientific and technologic resources with those who use and apply them. A major part of the task of strengthening the technologic capacity in the countries with which the ISTC will collaborate will be the strengthening of the local capacities to train, utilise and support the intermediate, technician-level, personnel.

Though the strengthening of such intermediate capacities will require local initiative, planning, investment and changes in incentives and employment policies, the ISTC can help to focus attention on such intermediate -level needs in its own assessments and planning. There is much valuable experience in the U.S. with technician training, with extension and information systems, and with the linkage of training institutions to industrial and public sector needs. Little of this experience has yet been effectively mobilised and made available to developing countries. There is also a set of newly important industries such as marine resources, new technologies such as solar technology, and new delivery systems for basic needs such as village-based public health systems, which are creating new technician needs for which little training capacity exists in developing countries and for which developed country experience is also weak and largely unassessed. One of the most productive areas for collaboration is the development of training models for such technicians.

In the U.S. one of the fastest growing forms of technical education is the two- and four-year engineering technology programs which stress the application of technology rather than the theoretical and scientific aspects of engineering, usually with a period of course-related work experience with industry. The development of engineering technology education in the U.S. responds to demands from employers for engineers and technicians with practical skills in specialised technical fields and coincides with a general dissatisfaction among developing country employers with the products of their engineering schools modelled on similar science-based engineering curricula. A number of suggestions for measures to help mobilise U.S. expertise and experience in the field of engineering technology education have been put forward in recent conferences, articles and editorials and further proposals are expected to be made in connection with the UNCSTED conference.

Section One Program Planning and Assessment

The problem areas of concern to ISTC are expected to include: increasing agricultural productivity and rural income; major health problems; population programs; information and communications; non-agricultural employment; environmental protection and natural resources management; energy planning and new energy supplies; nutritional improvement in poor families; plus other problem areas and sectoral focii which may be defined as the ISTC programs mature and evolve.

Each problem area or investment sector will have its own set of training needs and policy issues. These may differ in particulars from country-to-country, even within countries. However, there will be many of the same types of problems and the ISTC should adopt a systematic approach to planning, needs assessment and issue identification which it applies to each program, investment or new technology initiative it considers. In the long run, it may be that one of the major contributions of ISTC to technology policy may be through its development and application of systematic, or paradigmatic, analysis of skill needs, training and utilisation options.

The need is not so much for an elaborate assessment or modelling exercise. Rather, it is a need to make sure that before the ISTC gets fully behind a program a range of basic questions regarding the availability and probability of effective utilisation of skilled personnel, the appropriateness of incentive systems, the need for additional training, information or extension systems have been at least raised and options tested. Winston Gordon," On the Inevitability of Factor Substitution," Williams College Research Memorandum No. 46, April 1972, suggests an anlogy for technical choice between the situation where capital (intellectual commitment) is in the 'putty' stage and it is still possible to choose products to be produced and the 'clay' stage where the proposition is relatively firm and the main options are in adaptation, speed and 'capital-stretching' procedures. The recommendation is that ISTC begin its concern with technical training problems wherever possible while projects or investments are still in the 'putty' stage.

Among the elements of a systematic approach are:

- assessment of skill needs, based as much as possible on a functional analysis of job functions and utilisation practices at the level at which the skilled personnel will be employed -- i.e. at the level of production or delivery of services. Test whether local contextual factors, differences in scale or management practice, restructuring of the workplace would allow a different skill mix or utilisation policy. Many of the training problems can be eased or eliminated by better specification of what skills are actually needed, and by more flexibility in the use of available skilled workers.

- assessment of the indigenous supply of skilled manpower -- both current stock and likely availability from existing training programs. There is significant open unemployment and underemployment in most countries, and an inventorying exercise will often reveal overlooked local training capacity and/or personnel who could be utilised with some retraining or upgrading.

- assessment of who is being trained or employed. Distributional factors must be considered. Often the critical question is not whether skilled personnel are available, but whether they are available in the right places and with the right affiliations.

- analysis of incentive structures -- for initial recruitment and for retention in career patterns. How will the personnel be selected? Once trained, can they be retained at the levels and at the locations where they are most needed? Such questions are particularly critical for public sector services, and for programs directed at basic needs in the rural areas -- where incentives are often inadequate. Often the perceived shortages which are cited as arguments for increased training reflect inadequate or inappropriate incentives.

- testing of options to match supply of skills with expected demand: expansion and strengthening of existing training programs; use of in-service or on-the-job training; alternative incentive structures; changes in skill mix or utilisation; changes in scale, location or

control of production and service delivery; alternative choices of production or service delivery technology. In many cases what is required is not additional training or more highly skilled personnel, but information and assistance with specific technical problems encountered on-the-job.

The need is both for a systematic approach which considers all aspects of the manpower requirements, supply and utilisation problem and for an iterative approach which treats these aspects as synergetically and flexibly as possible, given whatever parameters exist in the local context. Much of the problem of matching training and the supply of skilled manpower with job requirements results from rigid employment and skill utilisation practices, inadequate consideration of skill substitutibility, the tendency to take the choice of technology as given by conventional practice in other contexts, inappropriate incentive structures, and other factors on the demand side.

Two of the most important weaknesses of current approaches to manpower planning (thus, to the assessment of technical training needs) are 1) the derivation of manpower requirements from investment decisions and choices of technology taken as given, with fixed coefficients for skilled manpower, and 2) the tendency to conduct the requirements assessment at such a high level of aggregation (national, regional, sectoral) that alternatives for training or skill utilisation at the level of the firm, project or local organisation cannot be considered directly. The ISTC can have an impact both on the design and choice of technology and on the problems of training and employment by conducting its planning as locally as possible, at as low a level of aggregation as possible, and with as much iteration as possible between the policy options on the manpower supply side and the options on the demand or utilisation side.

Though decisions for large investments or programs at the corporate or ministry level, the assessment of technology choices and manpower utilisation options must be based on the realities of the workplace and field situation. Most of the people with whom ISTC will collaborate -- in the planning and functional ministries, in the parastatals and private corporations, and in the research institutes and development centers, will be one or two steps removed from actual production and program implementation, as will be most ISTC specialists. Localised assessment will have to be a deliberate policy; it will not be sufficient simply to be more rigorous at high levels.

Some suggestions for ISTC planning and assessment:

- support analytical work on the manpower implications of specific technologies in advance of major investment or program decisions. Budgetary and planning deadlines tend to limit the consideration of alternatives, and major reconceptualisation after the initial parameters have been declared is usually difficult and often adversarial. This is a major problem for technical assistance contractors getting involved with assisted programs or projects. The program plans, recommended technologies and staffing patterns have been rather firmly set before the contractor is invited to propose a training strategy.
- stress studies which are as location and technology-specific as possible. Give priority to collaboration with groups working on a project basis and in clearly defined localities.
- concentrate on exploring options, clarifying implications rather than on developing 'correct' or optimum manpower utilisation models.
- bring project managers, first-level supervisors and community leaders into the planning and assessment exercises wherever possible -- or, better, initiate the exercise at the worksite and then seek the involvement of the higher-level decision makers.
- look for ways to use the assessment and planning exercises to support the development of networks of people interested in various aspects of the training and utilisation problem -- bridging between technologists, managers, and educator/trainers and involving people across sectoral lines, e.g. health, agriculture, small business, construction ...

The general point is that it is in the pre-investment assessment of manpower needs and technology options that ISTC can have a significant impact both on the choice and design of technologies and on the technical training problems. After such assessment has been done, it should be possible to assess what, if any, external resources including external training or technical assistance may be required, to assign training priorities for local institutions and programs, and to begin planning for implementation or investment.

It may be that the ISTC should not assume responsibility for program implementation or training beyond this point. The responsibility for the investment decisions and for implementation, including training, should remain with the respective ministries, private and parastatal corporations, and other entrepreneurs or organisations -- or assistance agencies where appropriate. In any case, the ISTC will not likely have the financial resources to make a significant contribution to implementation.

Section Two Quantitative Capacities to Train

In all but a few countries, current training capacity is meeting or exceeding the effective demand for skilled workers. This is contrary to common assertions regarding shortages, but is verified by the existence of marginal to severe unemployment and underemployment at all levels of training in most countries. At the same time there are shortages in most countries in specific skill categories and sectors. The most general problems are of coordinating the types of training with the effective demand, rather than problems of aggregate numbers being trained.

Two distinctions are critical to this discussion. First, we are concerned here with issues of the numbers, quality, and availability of skilled technical manpower, and with the required capacities to train such manpower. We are not directly concerned with the adequacy of general education systems and their capacity to provide educational opportunities to all the people who may desire, or for whom a given country would like to provide. Second, by effective demand we refer to the capacity to employ, as demonstrated by a willingness to do so when people with appropriate skills are available. The capacity to train technicians in sufficient numbers to meet, or nearly meet, the effective demand of the labor market is better than is often assumed for most countries, even though few if any countries are successfully meeting the social demand for education.

The fact that 'shortages' of skilled workers are commonly cited as a limiting factor on investment or project implementation does not necessarily mean that there is an effective demand for those workers. To be effective, there must also be identifiable positions with defined skill requirements, appropriate incentives (particularly , competitive salaries, benefits and status), and a reasonably serious attempt to locate and employ people appropriate for those positions. There may be a latent demand, or assessed need, where an observer or analyst or manager can say that there should be more employment of this or that type of skilled worker. However, until there is in fact a capacity to employ, such demand is ineffective. The distinction between assessed needs (latent demand) and effective demand is critical to the exercise of setting priorities for technical training. Where demand remains ineffective, no amount of technical training expansion or improvement is going to lead to increased employment and application of skills.

Since the early 1960's, the task of relating educational expansion to employment has been regarded as one of the most essential elements of economic and social development policy and planning. Shortages of skilled manpower were considered to be one of the main variables limiting economic growth and the efficient use of capital. Based on concepts of human resources as a form of capital, developed by T.W. Schultz and other economists, a number of attempts were made to quantify and forecast manpower requirements (particularly by industrial economists such as Harbison and Myers), to correlate requirements with modes of production (e.g.,Tinbergen), to develop planning models which integrated manpower forecasts with education plans (the most influential being the methodology used by OECD in the Mediterranean Project, see Forecasting Educational Needs for Economic and Social Development , Herbert S. Parnes, Paris 1962, and Economic Forecasting in Educational Planning, Paris 1967) and to base educational plans, particularly for higher education and specialised technical training, on such requirements models and forecasts (beginning with the Ashby Commission in Nigeria). Two general approaches emerged: the 'manpower requirements' models (Tinbergen, OECD) which attempt to forecast manpower needs by projecting the changes in industrial composition, using Leontief fixed coefficient assumptions regarding the structure of skills within industries, and; the 'rate of return' models (Schultz, G. Becker, G. Psacharopoulos) which attempt to determine the desirable rates for educational expansion by comparing the returns to various investments in education, using wages and income as the measure of benefit, with alternative investments.

Variants of both these approaches have been used in most countries during the 1960's and into the 1970's. , and most countries have based their educational expansion plans and investments on such forecasts. Virtually all of these forecasts identified substantial shortages, particularly in scientific and technical fields, at both the intermediate level and at higher levels of skill classification. Educational plans in turn were characterised by very high rates of projected expansion, much of which was in fact achieved. The increases in educational capacity thus tended to coincide with the increased quantities of skilled manpower that had been projected as desirable. More recently,

analysts have concluded that most of the manpower forecasting approaches have very serious methodological and practical shortcomings -- particularly weakness in data, differences in time perspective between the period of requirements forecast and time frame in which educational responses occur, the unreliable assumption of fixed prices and wages, and the lack of a rigid correspondence between production level, occupational structure and educational structure -- and that despite the seeming correspondence between the projections of manpower requirements and the high rates of educational expansion over the past two decades there is very little evidence that these earlier forecasts have accurately explained, or even significantly influenced, the patterns and the rates of educational expansion. Michel Debeauvais, currently Director of the International Institute for Educational Planning, was one of the first to make the general criticism,

> " The independence of the two areas of educational and employment planning may be attributed to the fact that both series of efforts could not be coordinated in time, as it was usually impossible to wait for the results of employment forecasts (only determined after economic aims were) to begin making enrolment forecasts. But doubtless the most important factor is the difficulty that the countries had in influencing the development of educational systems. Social pressure was chiefly exerted for the extension and prolongation of general education, and graduates have continued to manage mainly in the service sectors (particularly the public services), whereas the forecasts for manpower needs gave priority to the training of qualified industrial and agricultural workers. It is primarily in the field of out-of-school industrial training that programmes (whether planned or not) have been successfully implemented in a considerable number of countries. But the most important training complex, the educational system, has developed <u>almost independently</u> of the 'needs of the economy', as estimated by planners"
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> <u>Education and Employment</u>, Series B, No. 22, International Commission on the Development of Education, UNESCO, 1971.

Debeauvais and most economists now agree that there are highly important interrelations between educational systems and economic systems, but that they are much more complex than previously assumed. Further, the fundamental problem facing planners is no longer the problems of shortages of skilled workers and inadequate educational expansion as perceived during the 1960's, but the growing surpluses of graduates of secondary and higher education and the shortages of employment opportunities.

Edgar O. Edwards and Michael P. Todaro were among the first to challenge the assumption that so long as the demand for educational places exceeds the supply,

expansion is socially and economically justified. In their paper " Educational Demand and Supply in the Context of Growing Unemployment in the Less Developed Nations " (subsequently published as"Education and Employment in Developing Countries", Education and Development Reconsidered, F. Champion Ward, ed., Praeger, 1974) they argue that since the economic signals (particularly wages and the costs of education)are artificially determined, there is an excessive demand for education at the same time as there are lagging job opportunities.

> "... employment opportunities in the modern sector are artificially restricted largely because 1) factor prices are distorted, capital being underpriced and labor being overpriced, favoring labor-saving methods of production, 2) technologies are often borrowed from advanced countries where labor is a relatively scarce resource, 3) job specifications require excessive education, partly in emulation of advanced-country standards and partly because the educational system is itself overproducing, and 4) excessive resources are devoted to education, diverting them from more productive and more labor-absorbing investment opportunities elsewhere in the economy.
>
> " On the other hand, the demand for additional education is inflated because 1) the income differential between modern- and traditional-sector employment is artificially high even when modified by the existing probability of employment, 2) perceived employment probabilities may be exaggerated because of the visible success of predecessors in the system and the temporary surfeit of employment opportunities as expatriates are replaced following independence, 3) employers give preference to the better educated even though additional education adds only marginally to productivity, and 4) the portion of the cost of education that is borne privately is usually nominal. Moreover, the demand for education may be even greater at higher levels because of the artificial stimulus created by government financial policies (in many cases made possible by the assistance of donor agencies), which reduce the proportion of total costs borne by the individual as he moves up the educational ladder. In addition to stimulating excess demand for higher education, these policies also raise serious questions of equity since they often lead to a situation in which the higher education of the rich is being subsidized out of public revenues extracted from the poor through regressive tax systems. These several factors suggest that privately perceived benefits may exceed the private costs of education even though the net social benefits are very low or even negative, and this divergence may be greater at higher than at lower educational levels." (Edwards and Todaro, op cit, pp 4,5)

There is now a substantial literature, most of it from the past decade, documentir these problems of economic incentives and price signals, and confirming that the major problem at present and for the next decade is the problem of unemployment and underemployment. Despite this, shortages of skilled manpower

continue to be identified and cited in support of further rapid expansion of training capacity. There is no question that 'bottleneck' skill shortages do exist in specific skill areas, sectors and industries, and that all countries must continue to expand their education and training capacities and to coordinate these capacities with the manpower requirements of their economies and public services. However, the ISTC should be cautious in accepting any generalised suggestions of widespread shortages of skilled manpower and major quantitative deficiencies in training capacity. Before considering measures to increase training capacities, ISTC planners should consider whether factors such as the following have exaggerated the perception of shortages:

- mechanistic use of fixed coefficients for skilled manpower which underestimate the amount of skill substitution possible in given production systems.
- inadequate incentives and unattractive conditions of employment which make it difficult to attract and retain the workers who are available.
- overestimation of formal credentials and certification needed for specific levels of employment, or specific jobs.
- manpower projections based on overly optimistic expansion and growth plans
- 'requirements' approaches which treat manpower supply as the dependent variable and choice of production technology or investment sector as independent variables.
- excessive aggregation of manpower estimates in rigid categories, which often masks the success of individual firms and employers, while showing shortages at the sectoral level and in 'desired' categories
- the basic fact-of-life that few public sector managers in any country ever admit to being adequately staffed.
- the related fact-of-life that it is easier to build new training capacities than it is to reform existing programs and effect necessary changes in employment practices and incentives.

Expansion of training capacity is occuring in most countries, often very rapidly. ISTC cannot do very much to assist this expansion, which is limited mainly by financial resources and the numbers of technical instructors available locally. The most helpful role for ISTC would be in assisting countries to develop training systems out of their present capacities, which tend to have serious gaps, imbalances and redundancies. Countries need the full spectrum of technologic skills, from scientists with theoretical knowledge to craftsmen with very practical skills. The problem is partly that countries may have the wrong distribution of skills along the spectrum (the distribution should differ for each country, economy and development context) and partly that they have complete gaps in the spectrum.

Inadequate training capacity and/or skill shortages are most apparent in:

- public sector services, more than private industry
- maintenance and operating crafts, more than production technicians
- administrative and managerial skills of all kinds
- production skills in new or expanding sectors
- specialised middle-level technical skills requiring periods of practical experience
- control technologies, e.g. instrumentation, computers
- sub-disciplines of engineering, e.g. agricultural engineering

Technical skills such as these cannot easily be developed in formal technical training institutions without very close coordination and cooperation with industry and other production sectors. Much of the skill that needs to be developed requires experience with specific pieces of technology, production systems and working problems in the field. A basic problem in most countries is that training responsibilities are fragmented among several functional ministries, major corporations and parastatals, and there is generally inadequate coordination either among the training institutions and programs or between the training programs and the employing industries or services. As is discussed in the following two Sections, the U.S. has some substantial relevant experience with the linkage of training institutions to employment. At the State level, there are relevant models and experience in planning and coordinating technical training facilities and programs. The ISTC could help to facilitate the exchange of experience with these models and coordination mechanisms with planners

and administrators in other countries. A substantial amount of work on linkages between training institutions and industrial R&D has been done by the OECD, both individual country studies and comparative studies. The ILO and the Commonwealth Secretariate provide technical assistance to countries trying to establish national planning and coordinating mechanisms for technical training. The ISTC should be familiar with these efforts.

Other efforts which the ISTC might support :

- efforts to improve the linkages between the training institutions and the employers of their trainees. This is needed to:
  - improve the relevance of training
  - improve the link between training and ongoing R&D
  - establish a better correlation between supply and demand
  - improve incentives to hire
  - provide a linkage to outreach services and extension
  - involve the employers as a resource for training
  - reduce training redundancies and concentrate critical mass

  Concentrate any ISTC technical assistance, planning or advisory efforts on those training programs linked directly to employing industries and public services. Many countries have industrial training funds financed by employer contributions -- the SENA apprenticeship training system in Colombia and the SENAI program in Brazil being good examples. There are also polytechnics keyed to specific industries, industrial proprietary schools - e.g. Ford Vocational-Technical High School in Argentina, major corporations such as ARAMCO or their parastatal counterparts such as SONELEC and SONATRACH in Algeria which essentially run their own education and training systems, major public services such as the railways and ministries of works which often have major internal training programs. Many other examples can be found.

  One of the most direct ways for ISTC to influence linkages will be a general concern in each of the programs or projects with which it works,

to insure that linkages are established with specific training institutions and programs, whether or not the new initiative itself has a major training component. This is similar to the approach being taken by the World Bank, which is now reemphasising project-related training.

Work on these linkage problems should be a high priority for ISTC It need not be expensive, but it is a key organisational problem. The inadequacy of these linkages is one of the sharpest contrasts between the training systems in most LDC's and the training systems in the more developed industrial countries. It is an area where the U.S. has many lessons and models to offer.

- At what stage should training become vocationally specialised? There has been a continuing debate since the early 1960's (based partly on the work of Philip Foster in Ghana, Archibald Callaway in Nigeria, V.L. Griffiths in Kenya and others) over the question of whether early vocationalising of primary and secondary schooling makes any difference in terms of eventual career choice, or readiness for specialised training at higher levels. The ISTC can expect a variety of invitations to work on vocationalising of formal schooling at the primary and secondary level. The evidence is quite mixed and inconclusive. Generally, it suggests that vocationalised curricula has some utility when the education at that level is terminal for most of the students, and when it leads fairly directly to employment; that for students proceeding to higher levels of education the early vocational exposure is relatively meaningless and possibly disfunctional; and that the most important 'vocational' preparation skills may be basic literacy, numeracy and behavioral influences of the schooling environment. In any case, the ISTC should review the research and case evidence on such questions before it considers any program initiatives in vocationalised formal education.

- Another set of issues for ISTC study may be the effects of the migration of skilled workers - both internal and external migration - on the allocation of training or schooling capacities in the exporting country

and in the receiving country. Manpower planning models are increasingly taking such flows into account. A good recent example is the integrated computer based manpower forecasting model prepared by the World Bank for application in the Middle East, where such migration is a major part of the manpower supply. However, there has been little study of the effects of such flows on training capacities. It is clear that in some countries training capacities have been allowed to lag due to demand being filled by external workers - e.g. training in construction trades, retail business training in East Africa, or commercial fishing in West Africa. It is also clear that in some countries training capacities have been allowed to grow substantially in excess of local demand - e.g. medical personnel in the Phillipines and Egypt. Much has been written on the subject of 'brain drain' to developed countries and its effects on high-level manpower and institutional capacities in LDC's. There is a parallel problem of 'skills drain' between LDC's which may be more serious but is less well understood.

- Another capacity problem which the ISTC might address is the special needs and limited policy options of the very small countries. Somewhat irrespective of the financial resources and general level of education of countries, the small size of some countries makes it difficult for them to establish the diversity of institutions and specialised training programs they require. The questions of what balance to strike between general academic and specialised schooling, the utility of multifunction universities and polytechnics, the need for regional and external training, planning and coordinating models ... all have a different character in the smaller countries. The ISTC may want to give seperate attention to countries such as the Caribbean nations, Costa Rica, Sierra Leone and Liberia (joined in the Mano River Union), Fiji (U/So. Pacific) and other small countries. One option would be to help these countries share experience on these issues and options. One of the few attempts to address such problems was by the Institute of Commonwealth Studies, in a series of workshops 1962-64. See Problems of Smaller Territories, Burton Benedict, ed., Athlone Press, 1967.

Section Three TECHNICIAN LEVEL MANPOWER UTILISATION

The main concern of the ISTC is to effect improvements in the choice and application of technology. Such decisions are best made at the level of the firm or project. Research, policy analysis and planning intended to influence such decisions must be disaggregated, if not conducted, at this level. In those sectors or industries with relatively homogenous production or service delivery technology, analysis and planning may be usefully conducted at the level of industry or program.

The ISTC is not advised to stress macro, ie. national, manpower planning in its program. These tasks are reasonably well addressed by countries in the course of their national economic and educational planning, and other assistance agencies -- USAID, IBRD/IDA, UNDP, ILO -- are available to provide technical assistance where it continues to be needed.

The ministries and development institutes responsible for national manpower planning are however among the local organisations with which the ISTC will want to collaborate . It will be important for ISTC planners working on sectoral or industry problems to be familiar with the data bases and planning models used at the national level, and their limitations. Improved analysis at lower levels may be expected to contribute, over time, to improved national manpower planning which is less linear than conventional 'requirements' models, more sensitive to changes in incentives than conventional 'rate-of-return' models, and which gives more weight to substitutibility of labor and the possibility of alternative production or service technologies. For a partial model of an approach which attempts to take account of a rapidly changing demand for skilled personnel, see the " Market Adjustment Model" prepared for Venezuela by the Center for Policy Alternatives at MIT.

It was suggested earlier in this paper that the ISTC stress needs assessment as early as possible in project or program planning, i.e. when decisions on choice of technology or factor proportions are still in the 'putty' stage. There is relatively little that can be done to change factor proportions (thus, manpower requirements and the demand for training) in already established industries. However, there is scope for alternative training strategies, particularly increased use of in-plant and in-service training, and for revised assessments of minimum skill and credential requirements based on functional analyses of specific jobs.

Whether labor can be substituted for capital in a particular manufacturing process depends substantially on the product. " In continuous process industries (chemicals, pharmaceuticals, metal refining, oil refining) and in the production of many consumers' goods and intermediate goods on an assembly line the scope for such substitution is quite limited, except in certain ancillary operations, particularly materials handling and packaging. The main type of activity in which gain (measured in terms of social costs) may be achieved by the substitution of labour for capital are in road-building, irrigation, housing and construction generally, and in the production of woven fabrics, clothing, woodworking, leather, some foodstuffs (including foodstuffs for local consumption in local areas), bricks, tiles, and some of the simpler metal products." from The Multinational Corporations in Africa, UNECA, Rex Collings, London, 1973, p.13.

It is this second category of manufacturing which offers a substantial amount of substitutibility which is not usually allowed for in the more mechanistic 'requirements' approaches to manpower planning and which offers substantial scope for alternative education and training approaches, including on-the-job, in-service and in-plant training. These are also the industries which are most in need of technical information and advisory services. In setting priorities for its industrial extension activities, TECHNONET ASIA (see section on industrial extension this paper) has agreed upon a list of industries in order of their degree of need for technical information: (IDR/Focus, 1977/4, p.9)

1. metals
2. food processing
3. wood-based industries
4. plastics
5. packaging
6. electrical appliances and products
7. agricultural waste utilization
8. ceramics
9. rubber products
10. footwear
11. leather
12. construction/building materials

There is a need for improved estimation of skilled and semi-skilled manpower requirements in the labor-intensive industries, such as the above. Skill requirements outside the formal employment system of the public sector and large corporations are typically underestimated and undercounted. If ISTC is to give emphasis to smaller-scale production for local markets and to

more labor-intensive delivery systems for social services and development infrastructure, one of the more direct ways it can assist is by improving these estimates and encouraging consideration of alternative staffing patterns. The ISTC should review the industry studies of UNIDO, the work on transfer of technology of the OECD Development Centre, and the employment policy research of the ILO World Employment Programme. See also the ILO country studies for Kenya, Sri Lanka and Colombia. In the U.S., one of the best resources is the small industries program of the Engineering Experiment Station, Georgia Institute of Technology.

One of the most frequently mentioned manpower problems for small industries is management, particularly 1st-level supervisors, and administrative skills including accounting, purchasing and materials handling. It is not clear just how the ISTC might address this problem, but it should at least be sensitive to this constraint in its assessment and planning activities.

Major shifts away from capital-intensive strategies to more labor-intensive production and development strategies may produce at least short term redundancies in highly specialised manpower. These redundancies, or the fear that they will arise, are one of the sources of resistance to major shifts of strategy. Examples may be found in engineering, medicine, specialised production technicians, high-level management. Part of the problem is that a shift of investment strategy can be effected more rapidly than can a shift in the training priorities of established institutions , or a shift in the economic and status incentive structures for specialised manpower. How much of the problem of 'brain drain' or 'reverse technology transfer' represents redundant high-level manpower, and to what extent will labor-intensification increase the redundancy? Alternatively, to what extent are capital-intensive technologies favored as a way of soaking up the surpluses of engineers and other high-level manpower? The ISTC should be sensitive to such questions in its strategic planning. Again, one of the ways in which ISTC can contribute is by consistently raising the manpower requirements issues in all of its assessments of alternative technology or development strategy. Manpower planning must be closely coordinated with projected development strategy, must be projected rather than just linearly extrapolated from current plans and requirements, and must be projected over a long enough period (at least 5 years) to give the training systems time to adjust.

The assessment of skilled and semi-skilled manpower requirements is particularly needed for the alternative or "appropriate" technologies currently being emphasized. To date, most of the discussion of appropriate technologies has been concerned with the appropriateness of the technologies themselves and the products produced in terms of social need, factor endowment, local market conditions and other local environmental parameters. Part of the concern has also been with technologies and products appropriate to low-income, marginally skilled and underemployed populations. The skilled manpower requirements of these technologies have hardly been assessed, and an unfortunate impression has been created that these more appropriate technologies are technologically "softer" and less demanding of specialised scientific and technologic manpower. In fact, the opposite may be true, at least in the design stages of development. Some of the most experienced technologists, e.g. M. K. Garg in India, argue that the technical skills required are both more specialised and more complex, though perhaps fewer in number. The main point is that too little is known about the skill requirements either in the design stages or in large scale application. Some of the appropriate technologies may be both labor-intensive and skill-intensive. All technology and production systems require some number of highly-skilled workers -- ranging from economists and managers/administrators to engineers to millwrights and tool-and-die makers to architects and surveyors and draftsmen to basic scientists and researchers. The skill mixes, priorities and even forms of employment for these specialists may be quite different from more conventional, capital-intensive systems, but if the alternatives are not to be obstructed or made less efficient by critical skill bottlenecks it will be necessary to make more detailed estimates than presently exist and to project them as part of the overall manpower planning and education planning efforts. Until this is done, major shifts of training priority are going to be difficult to achieve. Technical educators and trainers need guidance on the numbers and skill priorities and they need to be convinced that an orientation toward more "appropriate" training is not a turning away from excellence and professional specialisation.

In addition to the need to improve numerical estimates and projections, there is a need to improve the allocation and coordination mechanisms. Some suggestions are made in the following section. Two areas affecting planning are the

coordination of external technician training and the factors which influence occupational choice and career mobility within countries.

Most countries have some reasonably effective mechanism for allocating scholarships and fellowships for external degree and graduate training. There are few good examples of effective mechanisms for sub-degree technician training. Though most countries have preferred to train most technicians locally, external technician training is now growing, particularly for specialised skills. Much the same reasons as make internal coordination difficult, i.e. the division of responsibility for technician training among several functional ministries and major private or parastatal corporations, makes the coordination of external training difficult. It may be that the most effective coordination is to be found in the countries with a high degree of public participation in industry and in those countries able to finance most external training as official scholarships -- e.g. Saudi Arabia, Venezuela, Algeria. In other countries, e.g. Nigeria, the allocation mechanisms have broken down under the weight of numbers and due to the lack of an adequate mechanism in the U.S. for coordinating placement. The Commonwealth countries have some models worth studying, particularly the Colombo plan scholarships which are generally well coordinated with manpower needs without being tied to specific projects, as is most U.S. bilateral assistance for U.S. training and as is most multilaterally financed external training.

The utility of the allocation model developed by CPA (MIT) for Venezuela is that, based on a detailed supply and demand study with a range of mid-term projections, a methodology is applied to establish 'relative demand' among the needed specialties, with the priorities among specialties reflecting common needs across sectors rather than the needs of specific industries or programs within sectors. Available scholarships are then allocated according to 'relative demand' with three modes: open scholarships available for study in any area the applicant may choose; closed scholarships available only for the study of specific specialties; sectoral, or semi-open, scholarships for study in broadly defined priority areas.

Possibly the weakest link in all efforts to coordinate manpower supply with demand is the inadequate understanding of the factors which influence occupational choice and career mobility -- i.e. what happens to trainees after training.

Lateral, vertical and occupational shifts after completion of training tend to negate efforts to plan manpower supply. Internal migration and out-migration (brain drain to advanced countries and skill drain to labor-short countries) tend to strip systems of critical manpower. Few institutions conduct systematic tracer studies of their graduates and most discussion of career patterns and job satisfactior after graduation is anecdotal and unreliable. Support for such studies would be helpful.

Clearly, income incentives and status considerations are primary factors and need to be better understood and addressed in planning and policy. Other areas for inquiry include the occupational modelling which occurs within the training program, the accuracy of trainee perceptions of future employment opportunities, the influence of peers and family on career choice, the influence of training availability on career choice (raising questions of selection criteria and entry qualifications), rigidities within the training institutions preventing lateral transfer (raising questions of the appropriate level for specialisation) and the effects of professional isolation, frustration and stagnation on retention rates in specialised fields (raising questions of the need for in-service training, professional support services, job mobility and the appropriate relationship of skilled technicians to ongoing R&D and policy bodies). <u>These factors affecting occupational choice and career patterns should be priority issues for investigation by ISTC since an essential assumption of efforts to redirect development must be that individuals can in fact be redirected and motivated to develop careers in priority sectors, locations and professional roles.</u>

A great deal of the analytical and conceptual work on manpower utilisation and employment in specific industries has already been done, or is ongoing, by international organisations (particularly UNIDO, ILO World Employment Programme, OECD Development Centre, IBRD) by research and development centers (e.g. IDS/Sussex, IDRC, ODC, Brace) by institutions in developing countries (e.g. IDS/Nairobi, PAID, CLADEA, TECHNONET ASIA) by U.S. universities and research institutes (e.g. MIT Center for Policy Alternatives, Georgia Institute of Technology, Yale Economic Growth Center, Washington University, Stanford, and several dozen others) by industrial and trade associations, by labor centers (e.g. African-American Labor Center) and by domestic-oriented U.S. agencies (e.g. DOL, Commerce, USDA, DOE). Most of this work is readily accessible, much of it published, and a first step for ISTC would be to collect these materials and establish a documentary resource base for ISTC planning and program assessment.

NOTE: As of this writing, I do not know of any U.S. organisation or center which provides a resource base or clearinghouse function for materials on manpower utilisation, employment and training options for a wide range of industries and services -- though there are a number of partial resource centers at universities and professional associations focused on specific sectors or regions. There is also a National Center for Vocational Education, based at Ohio State University, which provides a clearinghouse function for USOE. IFTC may want to consider support for such a clearinghouse concerned with international needs. One proposal has already been made to ASEE and others by N.K. Rao and Lawrence Barrell for a clearinghouse on engineering and industrial technology education and training -- discussed further in the section on technology training in the U.S.* Other suggestions are noted in The Role of U.S. Universities in Science and Technology for Development: Mechanisms and Policy Options, Robert Morgan et al, Washington Univ., Sept. 1978

See first chapter on limitations in the data base, pp. 303-305 on resource base development, p.332 on professional society linkages, 478-480 on NAS/NAE/NRC activities, including BOSTID)

* See "A Proposal to Reform U.S. Efforts in Engineering & Engineering Technology For Development," ASEE Meetings, Tampa, January 1979.

Section Four ENGINEERING TECHNOLOGY AND OTHER SUB-DEGREE TRAINING

There have been several recent recommendations for a shift of attention from the development of baccalaureate and graduate-level training capacities to the development of associate degree training programs. This is particularly recommended in engineering fields, where degree and post-degree training is now reasonably well developed in most countries (though not all) and the most serious shortages of manpower and of training capacity are at the skilled technician level. There appear to be five main reasons for this shift:

- the imbalance in the supply of skilled manpower , with increasingly adequate flows of engineers and shortages of skilled technicians - the shortages of technicians often limiting the employment of the engineers
- the emphasis on practical problem-solving and more direct application of technical training, implying a shift from the science-based engineering programs to programs of engineering technology.
- the growth of engineering technology programs in the U.S. and other developed countries which has only recently (over the last two decades) created a substantial external training capacity at this level and a body of expertise at this level relevant to technical assistance efforts in developing countries. Engineering technology now has a degree of professional acceptance and credibility, the lack of which previously limited its acceptability as an appropriate professional training model in developing countries.
- the increasing concern with the direct transfer of known technologies and processes. In addition to the concern for strengthening indigenous R&D capacities, there is a concern for keeping current with and maintaining access to the rapidly changing technologies in specialised fields.
- the cost-effectiveness of sub-degree technology training. For much the same reasons that have led to the growth of associate-degree programs in the U.S. , shorter-cycle higher education of all kinds is being viewed as the main means by which the high capital costs and long lag times of engineering training can be reduced.

There are really two sets of recommendations. One is to give more emphasis to the training of engineering technologists, shifting somewhat from the almost exclusive emphasis at present on training the scientist-engineer. Note: the recommendation is for a shift of emphasis to include more engineering technology, not for an abandonment of science-based engineering as part of the development of indigenous R&D capacities. The appropriate balance to be struck has to be worked out country-by-country. The second recommendation is for more emphasis on sub-degree, short-cycle training of technologists and specialised technicians.

In the U.S. there is a very large number of training institutions, varying greatly in size, strength, duration of training and area of specialisation. Until recently, little of this capacity has been utilised either for the training of foreign students in the U.S. or as a resource base to be drawn upon for work in other countries. With the exception of a few relatively large and long-established institutions such as the William Hood Dunwoody Institute in Minneapolis, which has been involved internationally since the 1950's, few of these institutions have been directly involved in assistance programs. Recently, there has been growing involvement, mainly under contract to private corporations and parastatals. There are also some recent programs, e.g. the Nigerian-financed placement of some 2,000 technicians in U.S. institutions through the Office of Reimbursable Technical Assistance, which are leading to a major increase in the number of foreign trainees placed in these U.S. institutions.

K. Nagaraja Rao and Lawrence Barrell, in an editorial in Science, Sept. 1978, suggest that there are some 700 U.S. institutions engaged in technician training programs relevant to international needs. There are 89 2-year technical colleges accredited by the Engineers' Council for Professional Development, offering associate degrees in engineering technology and industrial technology. Also accredited are another 30 colleges offering both associate and bachelor's degrees and 35 colleges offering only a bachelor of science in technology. There are also very large numbers of community and junior colleges, about 400 technical institutes accredited by the National Association of Trade and Technical Schools (NATTS -- mainly proprietary trade schools offering certificate-level training of 18 months or less), and numerous secondary-level poly technics and trade schools as part of the public education systems. The very large numbers and diversity of these institutions is part of the problem limiting

their effective use for international training. One of the most direct ways by whi ISTC could help would be by assisting, through their representative bodies and accrediting associations, the inventorying of the capacities and specialised programs which currently exist.

There is a major absence of a representative organisation or clearinghouse at the national level able to speak for the diverse technician training programs and institutions and represent their interests in international training. A preliminary proposal has been advanced by Rao and Barrell for consideration by the International Division of the American Society for Engineering Education. Barrell has also been invited (by IIE and AAAS) to participate in the NGO UNCSTED meetings and to present additional proposals on the kinds of mechanisms needed to more effectively mobilise and coordinate programs of cooperation with U.S. technical training institutions.

It is not clear at this point what form such an organisation or clearinghouse should take, what relative emphasis should be placed on clearinghouse functions vs. representation vs. operational responsibility for support services to U.S. institutions, nor what the most politic linkages would be with existing agencies, organisations and regional groups. There may be a need for more than one mechanism or service. However, there is substantial consensus that a major organisational effort is needed before these institutions can be more fully involved or drawn upon for international activities and it is recommended that ISTC explore this need with ASEE and with other professional and technical societies and accrediting agencies -- such as ACE, AACJC, NATTS -- and with the industries and countries which are looking to tap these resources. Another organisation working with industrial training problems is the American Society for Training and Development (ASTD) in Madison, Wisconsin.

The kinds of cooperative educational services which U.S. technical institutions could provide to similar institutions in developing countries are summarised in the Discussion Paper of the invitational workshop on "Meeting the Training Needs of Developing Countries in the Management of Technology" held at the Rochester Institute of Technology, March 8-10,1979, which included a number of key industrial executives as well as experienced technical educators.

(Excerpt from RIT Invitational Workshop Discussion Paper)

The delivery of training ought properly to be done by developing country institutions themselves. U.S. support could provide consultative and cooperative educational services to those institutions in the following areas:

- research and development of generalized innovative training programs that would address the country's development needs and goals.

- institutional structures which could facilitate the ability to seek out and accept non-formal program assignments from industry and government.

- processes for building working relationships with prospective client organizations, to identify and analyze training needs relevant to the organization's structure and objectives.

- curriculum and training materials development

- identification of useful alternative delivery systems for training programs, e.g., radio/television/newspaper courses, on-the-job courses, special location and time of courses, etc.

- development of training faculty for non-formal courses; especially, the identification of experts within local or expatriate firms who, with administrative guidance and curriculum specification from the training institution, could greatly increase the institution's training delivery capability.

- methods for attracting and motivating students, with particular attention to local conditions and customs, and with special regard to the varied backgrounds and learning needs of young adult and adult students.

- systems for evaluating training programs, as to both the delivery of the program, and the effectiveness of the program in meeting the industry or government objectives for which it was designed.

- on-going self analysis of the efficiency and usefulness of the various training delivery systems.

The RIT workshop also made the following observation, which suggests one of the ways in which the ISTC could collaborate:

> "While in most cases educational institutions develop their new programs or services in conjuntion with sympathetic individuals from industry, the risks associated with the effort are usually borne by the institutions. There are both financial risks to the institution and career risks for the educators involved, and the problems connected with curriculum development, program delivery, and especially student motivation, of course fall on the institution.
>
> The educational institution therefore finds itself in an unaccustomed marketing role - in which it is marketing both a service (to its students) and a product (to industry) at the same time. And the success of the endeavor depends to a great extent on how well the institution does its marketing. Perhaps the most useful kind of initiative the U.S. could undertake to further training objectives in developing countries would be to support efforts at helping educational institutions in developing countries adopt and carry out successful marketing strategies."

Some additional initiatives which ISTC might consider:

- the current mechanisms for the placement of foreign students into technician-level training programs in the U.S. are quite unsatisfactory, particularly for the large-scale placements such as are being implemented for the Nigerian technician program. This program has placed some 2,000 technician trainees with only minimal screening of candidates, little selectivity of training institutions, haphazard placement with little coordination of specialised placements, and inadequate orientation and follow-up support for either the trainees or the institutions. It is urgent that these mechanisms for placement and program coordination be thoroughly reviewed and more adequate guidelines and mechanisms be established before further large-scale placement is officially encouraged.

- Most of the technician-training institutions are relatively small and, except for the few which are part of larger universities, do not have strong social science, language or area studies programs. Advisory and counseling services for foreign students at these institutions are weak or nonexistent. Further, since many of them are proprietary or are funded mainly by states and communities, there is little budgetary subsidy for the guidance and counseling of foreign students, or for the mundane

but essential work of administering visas and tuition remittances for foreign students. There is a need both to insure that there is financial provision for such guidance and supervision, particularly for the officially sponsored students, and for some means of providing technical assistance to the U.S. institutions who are unfamiliar with the special needs and problems of foreign students. Many of the smaller institutions are finding these services difficult to provide and unless some means is found to ease the financial and administrative burden at least some of the institutions are going to be reluctant to accept further foreign students. The ISTC might explore this problem with institutions such as IIE and AAI , and organisations such as NAFSA , SIETAR and others who have previously been involved with providing such counselling and orientation for university placements. A partial model for assisting technical institutions with their organisational problems may be the National Institute for Staff and Organisational Development, recently formed at U/Texas, Austin, with support from Kellogg Foundation to provide technical assistance to 53 colleges.

- There have been a number of suggestions of the need to develop in the U.S. training programs more appropriate for the needs of foreign trainees. More such suggestions can be expected in the UNCSTED recommendations. This does not appear realistic, given the fact that most of these associate degree programs are primarily state and community funded, and have no difficulty filling their programs with U.S. students. It is also argued that the more technical the program the more universal it is and any attempt to bias it toward the needs of particular countries would have the effect of giving a partial exposure to the technology. Further, there is clear evidence that the developing countries sending trainees to the U.S. are giving preference to well-established programs. In part, it is a reluctance to pay the extra costs of developing a specially tailored program and in part it is a judgment that the litmus test of a quality program is that it is fully accepted as appropriate for U.S. trainees.

The implications are two: First, if courses more appropriate for developing countries are to be developed, they will more likely be an expansion or broadening of current programs (adding new technology and perspectives

for all students) rather than a bias or selectivity within an existing curriculum; and second, that if U.S. institutions wish to develop programs more appropriate to international needs, intending to attract additional foreign students, they must find ways to begin the development well in advance of any specific opportunity to collaborate with or train students from other countries.

- There appear to be emerging several new sub-degree or first degree technical professions for which few training models yet exist. Some of the more developed are the paramedical professions, the agricultural technologist, and the engineering technologist. Others still at earlier stages of maturation are the industrial extension worker (see Section Five), the veterinary technician, the village linguist (see PLFM case in Section Seven). An interesting example of a new program in the U.S. of direct relevance to LDC's is the associate degree program in fisheries technology at the University of Rhode Island. As the ISTD works on alternative development strategies and new problem-area emphases, it should be alert for these new categories of technicians and be prepared to explore their training implications. The design of such new programs are particularly good opportunities for collaboration between U.S. and LDC professional groups and institutions.

- There is considerable scope for the transfer of curriculum and training materials at the lower levels of technical training. This is being done increasingly by the private sector, with semi-programmed packages being marketed or provided as part of the emplacement of equipment or manufacturing capacity -- e.g. agricultural equipment, electronics and computers, machine tools, processing equipment, petroleum operations. Most of the training being provided in this manner is directly related to investments of U.S. firms, e.g. electronics training by GTE Sylvania in Algeria. It is in the interest of the firm to make training available.

- There is much other technology which is fully in the public domain and raises few questions of proprietary knowledge or job export, but which is not transferred effectively at present. A few PVO's, notably ORT (Organisation for Rehabilitation through Training) and OIC (Opportunities

Industrialisation Center) are engaged in such transfer, but there is surprisingly little involvement of U.S. institutions, except through their training of foreign technicians in the U.S.. Direct technical assistance with program or institution development efforts is exceptionally expensive for most basic technologies. However, in basic technologies such as the metal trades, surveying, food processing, small motor and pump maintenance, etc., there may be overlooked opportunities to involve technical training specialists at U.S. institutions and U.S. industry in the development of training modules and materials and in collaborative working relationships with counterparts in developing countries. Most industries would be quite willing to cooperate. The missing ingredient appears to be mainly the lack of an organised way of channeling the technical materials and manuals that are readily available and of bringing localised needs to the attention of industrial specialists who could help. See the discussion in Section Five of the TECHNONET ASIA mechanism as an example of the kind of local network with which U.S. training specialists might collaborate.

Section Five Industrial Extension

One of the most frequently mentioned needs is for the development of extension information and advisory services for small industries. In addition to being generally undercapitalised and relatively small, these industries tend to be managed by individuals who have neither the time and resources nor the contacts to make effective use of the information, advisory services and R&D facilitiies available to larger and more established industries.

However, it is now widely acknowledged that the strengthening of the small industries is one of the priority tasks of development. This is the level at which most new employment must be generated; it is the level at which most local innovation will occur; it is the level at which most goods for local consumption are produced; it is the level at which much of the value added processing may be accomplished, providing needed stimulus to primary production; and, it is the 'weak link' in the transition from the low levels of technologic capacity which currently exist in many countries to the more advanced capacities which countries are seeking. This is also the level at which, in the absence of improved technology and the skills to apply it, most of the labor-exploitive practices which so concern U.S. labor occur.

There is abundant historical evidence, as well as contemporary research, demonstrating that the development and spread of technical skills in society begins with the small-scale industries and artisanal production. Despite this, development in most countries continues to be biased toward large scale industrialisation; technical training continues to be based mainly on formal schooling; R&D capacities and information services continue to be concerned mainly with the needs of the large industries, particularly those which are export-competitive. The critique here is not so much of the long-term bias toward larger scale and higher technology forms of industry, as it is of the tendency to by-pass the intermediate stages of small-scale industry and entrepreneurship.

Though most efforts remain relatively small and under supported, most countries give at least some attention to the small industry sector, and the growing interest in appropriate technology is drawing further attention to this level. Extension and advisory services for small industries have not been a major

part of U.S. international assistance programs. One example was in Nigeria in the 1960's, where Ford Foundation and USAID supported 3 Vocational Improvement Centers (VIC's) and 2 Industrial Development Centers (IDC's) both directed at small industries and entrepreneurs. There are a number of small projects managed by PVO's such as CARE or the Overseas Education Fund of the League of Women Voters. However, it cannot be said that these add up to a significant program effort and further assistance in this area should be encouraged by ISTC. One factor which may draw more attention and investment to small enterprises is the realisation that a high percentage of these enterprises are managed by or are responding directly to the economic needs of women -- retail trade and transport, food processing, weaving and other crafts-based industries, small construction, as examples -- and as development programs take the needs of women more seriously the creation of economically viable local production units and entry-level employment becomes a high priority. One group which would be a particularly good source of advice to ISTC on such needs is the International Women's Tribune (IWT) in New York. There are also several good Technology and Development programs at U.S. universities (e.g the East-West Center) and the small industries program of the Georgia Institute of Technology Engineering Experiment Station, supported as a resource center by USAID.

There is a substantial body of literature discussing the problems of small-scale industry, artisannal production, and appropriate technology applications. Among the more useful references discussing the practical problems faced by such industries are the following:

Appropriate Technology Problems and Promises, Nicolas Jequier, ed., Development Centre of the Organisation For Economic Co-operation and Development, Paris 1976.

Choice and Adaptation of Technology in Developing Countries, OECD, Paris, 1974.

Employment, Growth and Basic Needs: A One-World Problem, ILO, 1977.

Technology and Employment In Industry, A.S. Bhalla, ed., ILO, Geneva, 1975.

Transfer of Technology For Small Industries, OECD, Paris, 1974.

Three of the general problems faced by the small-industries (and by the appropriate technology) organisations are: how to design extension and information services which link their R&D and resource center capabilities to the diverse needs of large numbers of clients - particularly when the clients are often unable to identify and articulate their own needs; how to maintain access to technologic information and expertise - particularly when the information needed is highly situation-specific and difficult to anticipate; and, how to link their activities to those of other organisations in the country or region having similar problems and experience - ie. how to reduce the isolation of these small organisations and facilitate the lateral transfer of working experience.

The most impressive example of a comprehensive effort to strengthen advisory capacities within countries, to develop professional expertise on the delivery of extension and information services to small industries, and to develop a network of organisations and practitioners within a region is the TECHNONET effort in Asia. Begun in 1972 with major assistance from IDRC in Canada, TECHNONET ASIA is a cooperative grouping of 11 participating organisations in nine Asian countries, which aims at improving the quality and efficiency of production in those countries' small and medium scale industrial enterprises. Particular emphasis is given to the application of knowledge concerning known (my emphasis) processes, methods, techniques, equipment, modifications and approaches to existing operations, effected by the transfer of technical information and provision of industrial extension services. TECHNONET operates out of IDRC's Asia Regional Office in Singapore. Participating Organisations:

Bangladesh	- Bangladesh Small & Cottage Industries Corporation (BSCIC)
Hong Kong	- The Hong Kong Productivity Centre (HKPC)
Indonesia	- Departemen Perindustrian (DP)
Korea	- Korea Scientific and Technological Information Center (KORSTIC
Malaysia	- Standards and Industrial Research Institute of Malaysia (SIRIM
	- Majlies Amanah Ra'ayat (MARA)
Phillipines	- U/Phillipines Institute for Small-Scale Industries (UP ISSI)
	- Economic Development Foundation (EDF)

Singapore - Singapore Institute of Standards and Industrial Research (SISIR)

Sri Lanka - Industrial Development Board (IDB)

Thailand - Department of Industrial Promotion, Min. of Industry (DIP)

John Woolston (Director, IDRC Information Sciences Division and one of the chief proponents of TECHNONET ASIA) stated its goals as follows: (Newsletter 9/76)

> "A great number of international agencies are wrestling with the problem of how most effectively to respond to (resolutions to facilitate the transfer of technology). Proposals are floated for technology data banks, new systems for the international referral of technological enquiries, reforms to the international patent system and, inevitably, new institutes where well-endowed researchers can develop theories about how it all can be made to happen. Yet, while no one denies that the industrialized countries and the international agencies could be more effective in stimulating the diffusion of technology, at the same time there is a growing realization that the greater part of man's technological know-how is already freely available - and that the biggest problem is that the developing countries are ill-equipped to find it, evaluate it and apply it.
>
> TECHNONET was devised, back in 1972, to help strengthen the capabilities of South East Asian countries at the industrial grass-roots. Many indigenous industries lack even one person on staff with technical training. For such an industry, a visiting engineer or technologist (one from the same culture, and with an open mind and the motivation to help) can make a truly significant impact - and, on many occasions, the only technology needed is that which the technologist already has in his own head. ... We have something to prove - that by effectively deploying a proportion of its own technological manpower for advisory work, a developing country can be, technologically, much more self-reliant than has hitherto been imagined. We are on the way to proving this."

Though resources may not permit the kind of direct support provided by IDRC (about $1 million per year for 7 years), the ISTC should look carefully at the experience of TECHNONET and look for ways to support such activities in other regions. The UN system is encouraging mechanisms for 'Trans-National Cooperation' (NC) and it seems likely that similar networking efforts will

be attempted in regions such as West Africa, the Caribbean, Central America, the Andean countries, the Middle East.

The following aspects of TECHNONET seem particularly interesting:

- the methodology for the Industrial Extension Training Courses (INDEXTRAC's) Formal training courses of approximately two months, with emphasis on diagnostic process, organisational dynamics and information systems as well as technical and managerial skill development. It would be useful to know more about how these courses are organised and run, the methodology used, and what factors contribute to successful training.
- the apparent success of TECHNONET in establishing industrial extension as a legitimate profession - in part through the development of professional organisations of asian industrial extension officers on a country basis.
- the workshops and training materials being developed for the development of entrepreneurs, which includes motivational training and awareness workshops -- a subject on which there is an increasing amount of research in the U.S., some of it beginning to be applied in development projects.
- the experience of TECHNONET with information systems and with the training of information system personnel. In particular, it would be useful to assess the utility of US attempts to transfer known technology through information systems such as the National Technical Information Service (NTIS) of the Department of Commerce, PVO networks such as VITA, commercial services such as INTERTEC (Control Data) or ORBIT III (System Development Corporation) or DIALOG (Lockheed). Many other services exist for specialised fields and industries. Though the ISTC may address some of these possibilities under the rubric of a program concern with information systems and technologies, it may also want to address them from the point of view of technology education. How do people learn about information sources? How do people receive information? Do small entrepreneurs define their information needs and seek information in different ways from larger organisations? What mix of media, face-to-face extension contact, and formal training is most efficacious? How should information specialists be trained?

The ISTC might best collaborate with such organisations providing industrial extension for small industries by working to facilitate their access to known technology through U.S. firms, individual technologists and technical institutes. An organisation similar to VITA (or an expansion of VITA) may be appropriate. An important consideration for ISTC planning is that many, if not most, of the technical problems and information needs of small industries are highly situation-specific and require direct contact with experienced technicians and industrialists. These industries require experience and "trouble-shooting" skill more than textbook knowledge, and information and manuals. More than an information system is needed. The support must be responsive to specific needs and provided mainly through person-to-person contact. There is reason to think that many U.S. industries, such as the machine-tool industry, would be willing to participate in a support program for small industries, if an entity such as ISTC could create the necessary linkages and coordinating organisations.

Section Six EDUCATION AND TRAINING ASPECTS OF APPROPRIATE TECHNOLOGY

There is a rapidly growing literature on appropriate technology. New organisations, programs and publications are appearing almost daily. The literature, organisations and programs are too numerous to summarise here, but it is assumed the reader is familiar with the general field and major arguments. Virtually every country with which the ISTC may work, every international organisation or assistance agency with which it may collaborate, and every U.S. university and organisation with which it will interract will have some degree of interest in the field of appropriate technology, if not an active program.

One of the most striking things about most of the programs and writing is that very little attention has been given to the education and training aspects. There appear to be 4 main explanations for this:

- there is an assumption by some that the needs are quite apparent, and strongly felt by potential users. Technologists have failed to respond to the needs. If the needs are correctly identified and new technologies or products are provided, they will be readily assimilated.

- prominent among the design criteria are that the technology be simple, easily maintained, labor intensive and understandable/controllable/producible by people with minimal formal training. Thus, an'appropriate' technology which requires extensive training to produce or maintain is inappropriate by definition.

- most of the innovation and development of appropriate technologies to-date has been undertaken by individuals and small groups. They have not yet reached the stage where they find it necessary to expand beyond their core group -- or they are growing by accretion, recruiting innovative peers who have gained their skills and perspective through a variety of existing means. Few have reached the stage of trying to replicate themselves and train a second generation. A major exception is India, where appropriate technology goes back at least to Gandhian policies and where there has been at least three decades of attempts to include appropriate technology in the formal schooling and training systems.

- Most of the emphasis to date has been on the identification and development of technologies. It is only recently that this set of technologies and development efforts has begun to be sufficiently large and comprehensive that it has begun to be taken seriously as a legitimate professional area by technical educators.

In any case, there is little doubt that the field of appropriate technology is going to pervade the ISTC program, and the country programs with which it will work. The ISTC is in a unique position to give leadership on the educational and training aspects. It is recommended that this be given a prominent place in ISTC planning.

Elements of an ISTC program on education and training aspects of appropriate technology:

- each new technology and production system raises a set of skill issues. Most AT examples are relatively small-scale, localised efforts, or are still in the prototype stage, and relatively little is known about their skill implications. (see discussion under technician-level manpower planning)

- most diffusion theory has been concerned with the spread of information and innovation in modern sectors and through educated, literate people. The diffusion process for information in the traditional and subsistence sectors is not well understood and most information services are not well designed for the poor farmer, the artisan, or the illiterate. The ISTC can help to bring improved understandings to bear on new approaches to rural extension, training and information systems.

- as appropriate technology becomes more accepted as part of mainstream development strategies, there is a need to incorporate its concepts and design criteria in mainstream technology training. There are many questions of content and emphasis, including the question of whether it should be core content or an elective area for specialisation. Several universities in the U.S., Northern Europe and Canada, and in a few of the larger LDC's are working on the development of such curricula. Little is being done in sub-degree training institutions or in the primary and secondary schools. Most groups are working relatively independently and with little support. The ISTC might contribute initially by helping to form a working group of post-secondary educators interested in these curriculum issues.

Section Seven ALTERNATIVE DEVELOPMENT STRATEGIES

The ISTC program efforts will be closely linked to the efforts in most developing countries and regions to design and implement development strategies appropriate for specific contexts. Recent writings on alternative development strategies stress three themes: meeting basic human needs, fostering self-reliance, and building on local values. There is much semantic, conceptual and political debate as to precisely what alternative development means and requires in each context. Some agencies, e.g. ILO World Employment Programme, stress the growth and spread of employment as the primary objective. Others, e.g. the World Bank, stress the growth and spread of income. Still others, e.g. FAO and WHO, emphasize direct responses to basic needs. UNDP, USAID and others attempt to straddle these strategies with integrated development approaches combined with direct responses to basic needs. Recently, there has developed a strong interest in 'intermediate', 'appropriate', 'alternative' technologies.

Two cautions for ISTC:

- First, the ISTC should expect a tension between its concern for bringing scientific and technologic excellence to bear on basic needs and problems and the increasingly common contention that such alternative strategies are less demanding of rigorous scientific and technologic application. This contention, or its implication, is both scientifically naive and corrosive of the political and professional acceptability of work on such alternative technology strategies. The ISTC can have a major impact on such development work by bringing the basic needs problems into the mainstream of R&D work by established scientists and technologists and by stressing training approaches at all levels (from university to community) which are scientifically and technologically rigorous while also being more appropriately designed and linked to the users or consumers of new technologies and technically skilled manpower. Norman Dahl, writing in the Final Report of the IIT/ Kanpur project (one of the largest attempts of the 1960's to transfer the best of U.S. engineering capacity) suggests that in the strictest sense there is no distinction between technology in the sense of knowhow or process and technology in the sense of

scientific understanding.

> "I don't underestimate the difficulties of getting 'engaged'. Good problems are hard to find, as any researcher knows. However, they're not going to be found unless they're looked for, ... And to repeat a refrain, the faculty should search for problems which need to be solved and not only for those that they think they can solve. ... I would emphasize that important problems come in many guises, some of them pretty mundane, and there is nothing demeaning in applying rigorous scientific thinking to any problem; the demeaning factor enters only when the rigor leaves."

- The <u>second</u> caution is that the ISTC will contribute most appropriately and efficaciously to alternative development strategies by working as collaboratively as possible with local scientists and technologists and with an explicit concern for the design requirements of specific contexts. Though much of the science and technology with which the ISTC will work, or will assist in mobilising and transferring, will have a degree of universality, the ISTC's influence on the choice and application of technologies will be accomplished mainly through its collaboration with local planning and training efforts. Denis Goulet, in <u>Looking at Guinea-Bissau: A New Nation's Development Strategy</u> (ODC occasional paper No. 9, March, 1978) suggests that Guinea-Bissau illustrates the tension in the current international emphasis on alternative development strategies.

> "Paradoxically, the lesson of greatest importance is that the best model of development is the one that any society forges for itself on the anvil of its own specific conditions. Lip service and ritualistic homage are, it is true, paid to this truth by most planners and politicians. In practice, however, they continue to act as if someone else's development recipes might best apply to their conditions. Guinea's chosen path eloquently testifies to the possibility that a small and poor nation, while keeping itself open to currents of thought and experimentation outside its boundaries, can avoid falling into a sterile imitative stance, a doctrinaire rigidity in application, or an exaggerated relativity in the face of multiple options which would lead to paralysis. Development planning, precisely because it is an art and not a science, must be responsive to local conditions, concrete

constraints and the specifics of available creative potential."

'Integrated Development' approaches are increasingly common, particularly for the development of rural areas. In the better examples a very comprehensive approach is taken, attempting to integrate agriculture, health, infrastructure, water, nutrition, credit, administrative systems and other services. Ideally, the technical staff for these programs would be trained or experienced in more than one of these areas, or would in other ways (e.g. in-service staff development) be helped to integrate the skills and perspectives of other technical areas into their work. In practice, this is rarely done and most staff are trained conventionally for work in only one of these areas.

Systems are usually integrated horizontally, involving a mix of sectoral programs and services, but are not integrated vertically. Heirarchical structures remain, information and extension is unidirectional from the center or 'top' of the system, communities are treated as clients or targets, with little direct participation in the assessment of their own needs, planning and implementation.

There is considerable recent work, predominantly in the field of public health, on village-based development planning which stresses the direct involvement of villagers in planning and needs assessment and the training and employment of village-based technicians as the primary agents of service delivery. A useful compendium of this work has been edited by Doris Storms, Design and Management of Auxiliary Based Health Programs: Lessons from Developing Countries, APHA, 1978 (draft). Other relevant work is being conducted on participatory research and planning at the International Center for Adult Education, Toronto. The ISTC should review this work and its implications for training of technicians at the village level.

A second general problem affecting training for integrated development is the difficulty of linking the training institutions into an integrated system. Though there is often a degree of coordination and integration at the university level (often the development program is linked to the university) there is little coordination and integration at the technician level. The main reason for this is that technician training is commonly divided between several functional

Ministries and programs. This creates problems of coordination, hinders the integration of technical content between training programs and not infrequently leads to elements of existing training capacity being overlooked by planners and program managers. The ISTC could contribute by reviewing the experience of existing integrated development programs, helping to develop policy guidelines for the integration of training programs and (wherever the ISTC has an opportunity to collaborate in the planning or implementation of integrated projects) working to insure that all available training options are systematically considered and utilised, with as much integration and cooperation as possible.

Alternative development strategies are by their nature new approaches in at least some respects. On the other hand, one of the prerequisites for relevant, applied training is an extant system reasonably similar to the one in which the trainees will be employed.

Tha conventional approach tends to be to use carefully selected, highly-trained specialists in an experimental or pilot application, proceeding at later stages to extend the capability through counterpart training and the development of training programs for skill replication. This is very expensive, usually depending to some extent on expatriate specialists or indigenous specialists who may be equally expensive and even more difficult to spare from other duties, and the lag time from experimentation to large-scale application is often too long.

More recently, again notably in the public health field - with other examples in agriculture and rural development -- there have been attempts to concentrate as a first priority on the identification and training of village-based technicians and entrepreneurs, leaving the resultant program, service or production to be decided and shaped to a considerable extent by these individuals. The role of the larger sector programs and administrative infrastructure then becomes more one of supporting, facilitating and providing technical inputs rather than leading. These approaches are sometimes called "botton-up" development strategies in distinction from the more conventional "top-down" strategies. They have their roots partly in the community development and 'animateur' strategies of the 1950's and 1960's,

but with the addition of the emphasis on local self-reliance, decentralised planning and non-formal skills training which have emerged in the 1970's.

Examples of such bottom-up development efforts can be found in many countries. Among the better known examples are the Harambee movement in Kenya, the village self-reliance efforts in Tanzania, and the communal development efforts in China. Some of the most relevant experience may be in the newly independent countries such as Portuguese Africa, where such bottom-up strategies were a necessity during the years of liberation struggle. Rather little of this experience has been assessed for application elsewhere. The Inter-American Foundation has supported a number of efforts in Central and Latin America, see their publication They Know How. Much of the non-formal skills training experience has been collected in published case studies, see for example the publications of International Council for Educational Development (ICED) and the Non-Formal Education Information Center at Michigan State University.

Additional studies would be useful to review the organisational dynamics of these development efforts at the level of the village or community. How are truly representative community leaders best identified; how can communities best participate in defining their own needs and training their own technicians and development workers; how can these efforts be linked to other sectoral programs and training institutions without pre-empting their local leadership?

One example of a project which seems to have successfully addressed these problems is the Projecto Linguistico Francisco Marroquin (PLFM) in Guatemala. This project, which began on a volunteer basis in 1970, assessed its primary objective as being the training of villagers in basic field linguistics. It was argued that only by creating the capacity for villages to work and articulate their needs in their own language could such villages begin to evolve a development strategy fully appropriate for their own needs. Since virtually all development activities in the Mayan highlands were planned and carried out in Spanish, reflecting the dominance of the Ladino social structure, Mayan leadership and initiative was effectively bypassed. Even those efforts legitimately attempting to improve services or development in the highland villages were handicapped by the lack of local organisations.

The key to local organisation and mobilisation was language. The PLFM concentrated on working with village leaders to select and train field linguists who would work in their own languages and who would thus create at least the capability for villages to organise and to assess their needs within their own linguistic, cultural and cognitive paradigms. How, or even whether, the villages subsequently used this capability was not directly the concern of the project. The project has been successful in training more than 100 villagers having only a few years of primary education to be highly qualified field linguists. These villager linguists are now an important part of the local capacity for self-directed development. A history and analysis of the PLFM is in preparation, with support from Ford Foundation.

Dr. Joe Wray, Harvard School of Public Health, discusses the need for systematic attention both at the top and at the bottom of any health care system ("Maternal and Child Health," WHO December, 1975, mimeo).

> "... it is generally acknowledged that much of the effort which has been expended at the 'top' has no effect at the grass roots level, there is now a great deal of interest in 'building from the bottom'. ... it seems clear that efforts are necessary both at the top and the bottom, and that concentration on either alone, however effective the efforts may be, is unlikely to succeed. ... the 'best available team' must include personnel from both the 'top' and the 'bottom' -- but their joint efforts in developing the 'model' must be concentrated at the 'bottom'."

This point seems relevant for ISTC, which should have a concern for skill development and utilisation at the 'bottom' as the correlary of its concern with high-level skill development and utilisation.

A related point is also made in the article by Joe Wray.

> "... far and away the greatest need is for the demonstration of a system, however deficient in some respects, that is capable of providing the necessary <u>coverage -- a system that reaches out into the community and provides access to all those who are supposed to be served</u>. However skeletal at first, such a system can be strengthened once it is in place; however small a portion of the 'MCH package' that is provided initially, this can be increased as resources permit -- <u>but only if the system -- the basic infrastructure -- is there</u>." (emphasis his)

This point also has relevance for ISTC. The starting point for almost any effort to improve local technical capacities -- whether by training programs, extension or information diffusion projects, or by the direct dissemination of materials and equipment -- should be the identification of or creation of some kind of system or matrix into which the new effort can be linked. "Appropriate" development and technologies may require appropriate linkages to existing systems in the society. The manner in which these systems are chosen or created may determine what come to be considered "appropriate."

Section Eight TECHNOLOGY AND THE SOCIAL CONTEXT

Most of this paper has been concerned with the need for technically trained manpower and the ways by which the ISTC can help to bring technical skills more effectively to bear on priority problems of society. There is also a need to consider the social context itself and the ways in which people in specific contexts learn about and adapt to new technologies. Technologic capacity in its fullest sense includes the capacity of the society to make technologic choices and to cope with the results. As E.F. Schumacher observed, "know-how is no more a culture than a piano is music."

Since at least the second industrial revolution, the acquisition and application of technology has been considered to be one of the major determinants of social progress and economic growth. Only relatively recently has the proposition been taken seriously that social factors may determine the nature and direction of technologic change.

All societies have and use technologies, perceive new technologic possibilities, adapt and change, learn and transmit technologic information and skills. However, these processes are not well understood for specific societies and cultures. There are few good examples of research in this area. One recent example is by Andreas Fuglesang, who describes the learning and innovation processes among traditional tool makers in Papua-New Guinea. See Doing Things...Together, Dag Hammerskjold Foundation, 1978. One of the implications of his observations is that experimentation and innovation behavior is present in all cultures. In labelling societies traditional, with the implication of stagnant or unchanging, we may only be observing that our innovations haven't yet been made. Perhaps the most important observation by Fuglesang is that societies make decisions, receive information, change or resist change, as a group rather than as individuals. Both in attempting to assess the possibilities for change and in attempting to train or 'transfer' skills needed for technical change, it is necessary to concentrate on the dynamics, behavior and felt needs of the group as well as those of individuals within the group. One of the major limitations of all institutional training models is their emphasis on learning by individuals.

There have been several major controversies over how culture and cognition are related and whether there is any basis in reality for the assumptions that differences in scientific or technologic development processes are related to differences in thought processes, language, cultural or physical environment and context. The literature is very complex and will not be summarized here. A good overview of these debates as well as the results of their own research is provided in, The Cultural Context of Learning and Thinking, an Exploration in Experimental Anthropology, Michael Cole, John Gay, Joseph Glick, Donald Sharp and associates, Basic Books, New York, 1971.

Their research began with an inquiry into the difficulties of Kpelle children in Liberia with western-style mathematics. This research, which was subsequently extended to include language, concluded that the differences in learning between Kpelle children and children in the U.S. had little if anything to do with differences in cognitive ability, but had very much to do with the kinds of knowledge which are valuable in specific cultures and contexts. Their investigation concentrated on three major classes of learning phenomena: The role of classification in memory and learning, the process by which attributes are combined to form concepts, and the way in which various problems are solved. Their emphasis on culture-specific skills and learning processes has direct relevance for ISTC, and is the emphasis recommended here for ISTC research efforts intended to improve understandings of the processes of scientific and technologic learning and change.

> "These observations fit quite well with what our common sense and many anthropologists have suggested. People will be good at doing the things that are important to them and that they have occasion to do often. The generalization implicit in this theory of cognition is that primitive cultures tend to make different sorts of intellectual demands than technologically advanced cultures. ... This notion of culture-specific skills can be contrasted with what might be termed an ability theory, which is especially prevalent among psychologists. The general thrust of the ability theory is that for a variety of reasons different groups or individuals develop "better," "more," or "more powerful" generalized intellectual abilities than others. ... It is important to recognize these two orientations at the outset because they distinctly

> color the nature of research on culture and cognition. One important assumption of the aptitude approach is that a given task (whether it be a question on an IQ test or a Piagetian problem) evokes the same kind of behavior regardless of who performs the task. The logic of the task itself and the cognitive processes it taps are comparable, even though content may be subject to cultural variation. Clearly, if the same task evokes widely different behaviors in subjects from different cultural backgrounds, the aptitude approach is going to lead us astray. If we think we are assessing the amount of aptitude X when in fact a subject is engaged in behavior Y, our conclusions are likely to mean little.
>
> "We believe, on the other hand, that one cannot assume that psychological tasks, be they derived from theories of cognitive development or the structure of intelligence, evoke the same kinds of behaviors in subjects from different cultures. When we present a task to a subject and he appears to respond randomly or stupidly, the first question we must ask is 'what is the subject doing?' Behavior is never random, although it may seem random to an observer with a particular orientation. Only after it is determined that subjects from two groups are engaged in the same activity (applying the same processes), can one ask questions about their relative abilities."

Technology is often defined as applied science, and there is a rather explicit assumption that the growth of scientific capacities and of scientific ways of thinking is a precondition of technologic change, development and the solution of most problems of society. Michael Moravsik, in "Science and the Developing Countries," a contribution to the U.S. country paper for UNCSTED, suggests three ways by which science has an influence on human world views.

> "The first example is the impact of science on epistemology, that is, on the theory of knowledge. In non-Western societies, knowledge is often regarded as a closed entity, which is already available in its entirety, either from a book or an old man, or from a magician. In contrast, the scientific outlook represents knowledge as an open field in which appropriately formulated questions, combined with skillful and thoughtful efforts, can constantly generate entirely new knowledge ... Without the belief that we ourselves can generate new knowledge through experimentation and search, innovations in a developmental sense could hardly come about.

> "As a second illustration .. the idea of change. Traditional views of the world often hold that our surroundings are, on the whole, the same all the time, apart from possible fluctuations, and that the state of the world, as well as human history, really need not be described in time but only in space. Science, on the other hand, emphasizes time as an essential parameter in the description of any phenomena, and human history is also viewed as a phenomenon that is a strong function of time. Again the contrast is evident: if change is not an important element in the world view, what we call conservatism is a natural part of people's attitudes, and also absent is the urgency that characterises human activity in Western communities.
>
> "Finally ... according to the scientific view, man is capable of gaining increasingly deeper understanding of nature and correspondingly acquire a growing control over his fate. Again in contrast, in many traditional world views, man is a helpless pawn in the hands of supernatural or probabilistic forces which determine his fate and against which he has little recourse. The implications for the development process are obvious."

It is a mistake to make too sharp a dichotomy between "Western" and "Non-Western" or science-based and non-science based cultures. Fatalism, determinism, feelings that we already know more than we know how to handle and that 'things are in the saddle' are present in all cultures and societies, including the U.S.. However, there seems a general validity and universality to Moravsik's contention that these are among the inertial factors that must be overcome if science is to become part of any cultural and social context and be used constructively for technologic change and improvement within the context.

In addition to the obvious recommendation for the strengthening of indigenous science and technology at all levels, including a prominent role for science in the formal school curriculum, there may be other ways by which education can help to overcome this inertia.

First, it may be that one of the essential cultural or social preconditions for fostering further scientific success and discovery <u>is</u> success, at something. It may matter less what the scientific accomplishment, dis-

covery or innovation is, or how it came about, than the fact that it occurred. There are successes and accomplishments in every society, even the 'traditional' and part of the educational task for stimulating more scientific and technologic accomplishment may be the task of giving greater visibility and credibility to the successes and discoveries which have occurred in that society and context. Ideally, stress would be given to accomplishments by people of that society. However, we can also reflect on the U.S. scientific culture in which generations of school children have been raised with a history of scientific accomplishment and invention, with their imaginations and ambitions unhindered by the fact that so many of the most remarkable scientists and inventors were foreign born.

Second, a similar point may be made with regard to change. No society is static, however slow the pace of change may be, or seem to be to an adolescent with little experience or information beyond the village in which (s)he and most of their ancestors were born. Education for change may have to be about change. There are few good examples of curricula which do this well or systematically. Even most of the attempts to develop new, locally relevant, curricula in LDC's have generally concentrated on the static elements -- the flora and fauna, the geography, the important people, events and institutions, etc.. However, an awareness that change has occurred, that change is continuing, that further change should be expected, and that the changes can be managed with confidence by the people themselves may be an essential objective for the preparation of people who will be expected to participate in and contribute to further technologic and social change.

Third, we may simply be strategically wrong in equating technologic improvement with social change. Recent events in Iran and elsewhere suggest that we do not know nearly enough about the acceptable pace or limits to change. We need to know much more about the process by which a technologic change becomes legitimised and integrated. A strong suggestion is that technologic R&D should derive at least some of its priorities from assessed needs at the basic, village, level of society. Much of the argument for participatory planning and basic needs assessment is to help insure that technologic change is legitimate from the start, thereby reducing the need for special educational measures at later stages.

There is much that can be done to reduce the fears that technology is foreign, complicated, dangerous, beyond the control of average people to use and control. The Foxfire efforts, and the several dozen analogous curriculum efforts in the U.S. and elsewhere are examples of approaches which involve students in discovery of the accomplishments of people in their immediate social context, in understanding the technologic changes which have occurred in their contexts and in tracing the continuing vectors for change into their own lives, education and expectations for the future.

Much of the reluctance of people to accept new technology may be due to the fact that it is unfamiliar. Most people, including most of us promoting technologic development, have little 'hands-on' experience with the technologies we are talking about. 'Hands-on' and 'real-problem solving' pedagogic approaches are increasingly common and should be supported. These strategies are mainly attempts to give greater relevance to education, and in many cases are responses to the shortages of more formal teaching materials. The suggestion here is that the ISTC encourage every means possible to give people, both within school and in the general population, direct contact with old as well as new technologies and hardware of all kinds.

Museums of science and technology and other 'living museums' and exhibitions dealing with the commonplace events, tools and objects as they have evolved and been used from the past to the present in specific cultures may be valuable resources for technology education systems or strategies. They have certainly been valuable in the U.S.. Unfortunately, they have a very low priority in the plans of most countries, and there is little external assistance available for such efforts. The U.S. has much relevant experience and expertise which could be mobilised rather easily for work in this area. Such efforts could profitably be linked to attempts to support and legitimate work in the field of appropriate technology; the inventorying and assessment of indigenous technology and technologic traditions seems one of the priority tasks both for bringing local work on appropriate or alternative technologies into focus and for integrating this work into the ongoing educational and intellectual traditions. Many exemplary starting points exist such as textiles, metal and leatherworking, food storage and processing, housing, ways of pumping water ...

Another suggestion is that ISTC explore with existing primary school curriculum groups, e.g. Science Education Programme for Africa (SEPA) in Accra, to identify areas for possible collaboration on curricula within the formal school systems. SEPA currently is working with science curriculum groups in several African countries to develop science programs for out-of-school youth and to integrate the technologies of the villages with the curricula of the school. A similar effort is underway in Mexico through the National Institute of Technology. Other examples exist (Phillipines, Brazil, Afghanistan, India...) and ISTC could play a useful role by helping these country programs to collaborate and exchange ideas, materials and experience internationally.

It may be that in viewing technology as applied science and concentrating on the work of scientists and technologists we are being too utilitarian and problem oriented. Cyril Stanley Smith, Institute Professor, Emeritus, of the History of Technology and Science at MIT, maintains that technology is more closely related to the arts than to science. He cites numerous examples from metallurgy and other fields to support the conclusion that "historically the first discovery of useful materials, machines, or processes has almost always been in the decorative arts, and was not done for a perceived practical purpose. Necessity is <u>not</u> the mother of invention - only of improvement." See "On Art, Invention and Technology," Technology Review, 9/76.

While Professor Smith's purpose is to show the importance of art in the history of invention and innovation, the point may be extended to suggest the role of the artist and the artist-craftsman in social and technologic change. The ISTC may not want to extend its mandate to include working with artists as inventors, though the case could be made. However, it is recommended that in efforts to address problems of social change, to assess needs, to increase participation in programs, and to diffuse information or technologies that the ISTC explore ways to involve the artists. There are a number of examples in the fields of health and population, e.g. the use of traditional puppets and shadow plays in Indonesia and Thailand, where the arts have been used effectively to communicate new information in a familiar medium.

The lines between the artist and the craftsman and between the craftsman and the small industrialist are rather arbitrary. In terms of their contribution to technologic change or their role in training and employing skilled workers they should be considered as complementary and necessary parts of an overall capacity. Pottery, weaving, wood-, metal-, and leather-working and many other "crafts" are industries utilising art, employing skilled workers and creating much of the skill base on which more advanced technology production systems rest.

Most countries have a variety of traditional craft guilds, often holding positions of substantial social status, e.g. the goldsmiths and other metal-working guilds of West Africa. Such guilds provide a technology base in society which is often overlooked in assessments of existing capacity and in some cases which is being undercut and eroded by formal schooling and training systems. Part of the ISTC effort to understand the interaction of new technology with existing social structures should include the study of these guild systems, ways to strengthen them and ways to involve them in new technologic R&D efforts. A related issue which the ISTC might study is the tension between mass primary schooling and traditional apprenticeship training systems. This is both a commonly neglected training alternative and a commonly overlooked explanation for at least some of the drop-out or non-enrollment in primary and lower secondary schools.

The patterns of educational demand, or resistance to education, provide many clues to the attitudes and expectations of society for technologic change and improvement. However, the clues are not easily read and are often misleading. Often, they are counterintuitive. For example, the persistence of high rates of demand for education, even in situations where the education is demonstrably poor in quality, inefficient, inequitably distributed and minimally functional, may be read as prima facie evidence of technologic optimism and a belief in the possibility of change and improvement. It may equally well be read as pessimism about the prospects in the rural villages and an acceptance of the high stakes lottery which the inadequate number of jobs in the modern sector presents. Dropouts from school are usually considered "wastage." But, in some areas there is

evidence, e.g. the Guatemala highlands, that the dropouts include many of the better students. Observations in many countries have noted that the majority of entrepreneurs and innovators are relatively uneducated. Does this suggest that training institutions have misidentified their studer body, or does it suggest that potential entrepreneurs place a different value on further education? Several studies, e.g. one by Howard Wright in Guatemala concerned with entrepreneurial attitudes among participants in adult functional literacy programs, have suggested that one of the main effects of such programs is to screen or identify the upwardly or outwardly mobile 'ready receivers'. The distribution of the advantages of technologic opportunities is clearly linked to such screening, and these effects should be better understood at all levels of education. These and related question of the demand for education should be studied by ISTC.

Much of this research is also relevant for efforts to bring about innovation in the education system, and the ISTC might usefully collaborate with Institutes of Education whose primary concern is the education system while ISTC's primary concern is the relevance of education for technologic change. Richard Jolly in his essay "The Judo Trick" prepared for the Bellagio Conference on Education and Development, June 1972, argues that:

> "Contrary to loose judgments about education systems being unchangeable, the education systems in most Third World countries ... have undergone dramatic changes over the last two decades, so great as to make them in many respects virtually unrecognizable by earlier standards. ... the currently desired qualitative reforms are no more impossible, in terms of scarce resources, than the quantitative changes that have already taken place -- and taken place in spite of limited resources. ... One is tackling an educational juggernaut of enormous size, accelerating but in the wrong direction. Can one identify the crucial points of balance at which to exert new forces -- and thus to change the whole direction of its development?"

The demand structure within education gives clues to the 'judo trick' leverage needed for educational reform as well as to the points at which leverage to redirect technologic change should be applied. A particularly

good manual on ways to bring about change is Solving Educational Problems: The Theory and Reality of Innovation in Developing Countries, R.G. Havelock and A.M. Huberman, UNESCO-IBE, 1977. See especially Chapter Two on social systems and innovation systems.

The World Bank commissioned two studies: The Diversification of Secondary Education, The Centre for Educational Technology, The University of Sussex, July 1978. Implementing Innovatory Projects, Paul Hurst, Education and Science Division, The British Council, March 1978. These studies should be essential reading for all concerned with educational change and the reorientation of schooling systems to the needs of specific societies. They demonstrate both that many alternative models exist and changes are possible and that in the final analysis the differences in the social or developmental impact of schooling and training systems has as much or more to do with the political and economic choices a country makes (the context of the school) as it does with what happens within the schooling and training systems.

There is a growing body of literature in the field of human behavior and social psychology dealing with achievement motivation, risk-taking and avoidance, perception of opportunity, cognitive and analytical paradigms in specific cultures and contexts. (see the work of McClelland, Levine, Cole and Scribner and others) Little of this work has yet been applied in education and development planning. The ISTC might contribute by reviewing this work and helping to translate it into prescriptive recommendations for education and training. A few generalisations for development planning which stand out from this work:

- there is a tendency to confuse risk limiting or avoiding behavior with the lack of motivation or desire for change and improvement. The risks are often quite real but inadequately understood or addressed by central planners.

- there are significant differences in behavior and perception between the educated and the uneducated. Most planning assumes the behavior and perceptions of the educated and undervalues or ignores those of the uneducated. In some respects, those of the uneducated may

be more economically rational and functional within their specific contexts.

- achievement motivation tends to be quite strong, though often in different directions from that assumed or desired by planners. Much of the confusion lies in incentive systems which give a radically different calculus to the individual or family from that which is considered socially optimum at the center. This is seen most clearly in 'lottery' attitudes to higher education and modern sector employment.

An example of the use of such behavioral research to guide education and technology strategy is a current health project in Colombia. Research in Colombia revealed remarkably high degrees of underperception of illness, particularly of anemic conditions. (see "Perception of Anemia: A Case Study," J. Sanchez et al, mimeo, 1977) The implication was that before any expansion of health services could result in increased use of the services (care-seeking behavior) an educational effort was needed to help people improve their perception of illness conditions. The problem here is that basic health perceptions are to a great extent perceptions of normality or abnormality. Where a condition is endemic it tends to be treated as part of the norm, thus underperceived as a problem. Similar problems of normality and perspective undoubtedly exist with regard to other basic needs.

The above notes and suggestions are necessarily selective and do not begin to cover all aspects of the complex interaction of technology with social change. There is a major debate with many points of view over the balance to be struck between technologic means and social ends. The literature on the various theoretical and practical contentions is vast, complex and growing daily. There are however two points of consensus. First, virtually all writers agree that the debate is about both the technologies and the societies and, second, virtually all agree that the two debates are synergetic. It is not possible to discuss choice of technology without having made assumptions about societal ends and values. And, it is not possible to speculate about the feasibility of societal ends without making assumptions about the kinds of technology which are likely to be available and without understanding the uses to which the technologies may be put. This is what

is meant by the bumper sticker wisdom, "technology is the answer, but what is the question?"

This leads to two central considerations for ISTC: First, any assumptions or statements as to the appropriateness and applicability of any technology necessarily carry with them acceptance of certain social results and impacts. Second, to the extent that choice and adaptation of technology requires an understanding of social dynamics, values and desired ends, any approach to the training of the technologists who will be responsible for such judgments must include an emphasis on these social aspects and choices as an essential part of the education.

The ISTC is strongly advised to include studies of the social context and the social impact of technology in its technologic cooperation programs. This is not so much a recommendation that ISTC undertake a scholarly effort to study the social contexts as it is a recommendation that ISTC place such questions and concerns prominently among its priority criteria for designing, implementing and assessing all of its programs. These contextural judgments will not be easy to make, and for most situations there will not be unequivocably "right" solutions. The most acceptable solutions will grow out of a process which questions (and learns from) both the societies and the technologies and which values the views and priorities of those people most directly affected by the technologic changes. This is the essential reason for the ISTC adopting a highly collaborative approach to program planning and implementation, with as much contact and participation as possible with technologists, social planners and representative groups in the countries or regions with which the ISTC will work.

Section Nine Overview of an ISTC Program

The ISTC will be concerned with technical training in three ways:

First, as part of its concern for strengthening high-level scientific and technologic capacities in general, and in selected priority problem areas in particular. These are expected to include: increasing agricultural productivity and rural income; major health problems; population programs; information and communications; non-agricultural employment; environmental protection and natural resources management; energy planning and new energy supplies; nutritional improvement in poor families; plus other problem areas and sectoral focii expected to emerge as the ISTC program matures. Each of these concerns will require attention to the training of key scientists and technologists, to the training of the supportive and complementary technical staff these specialists require to work effectively (ranging from lab technicians to surveyors to administrators to data processors) , and to the linkage of high-level R&D capacities to training capacities in a system which can effectively be brought to bear on priority problems.

Second, as part of its concern with the application of these capacities in appropriately designed or chosen programs, services, investments and development strategies. In each of the areas in which ISTC supports or encourages new initiatives one of the priority concerns both in the design and planning of the initiative - the choice of technology - and in the implementation will be the supply of skilled technicians in the appropriate numbers and skill mix, with appropriate training and experience, and with appropriate incentives and motivations. ISTC can have a substantial impact on the choice of technology and on the effectiveness of technology applications through efforts to improve the assessment and planning of intermediate skill needs, to coordinate demand with supplying training programs, and to link skill training institutions more effectively to field experience and ongoing R&D.

Third, as part of its concern with the processes of technologic change in society and the tasks of improving the capacities of societies to utilise the scientific and technologic capacities which exist in ways compatible with the needs and desires. [illegible]. The concern here is with the general societal

context in which any effort to strengthen capacities or to apply capacities must be carried out. It is at the same time both one of the essential starting points for analysis, planning and development and one of the primary objectives of any development or technology strategy. Part of the need is for continued expansion and improvement in the public education systems at all levels as part of the long term process of raising the skill, literacy and numeracy levels of society. In addition, there is need for improved understanding of skill formation and utilisation in the informal sectors; for better understanding of the cultural norms, behaviors and perceptions which affect entrepreneurship, occupational choice, risk-taking or avoidance, and the acceptance or resistance of technologic change; for extension and other outreach services providing needed support and information to communities; and for development strategies which begin with and build upon the skills, organisations and perceptions of needs which already exist in society. The relevance or appropriateness of all ISTC efforts and concerns will be determined by their applicability and integration within specific social contexts.

The ISTC will have to consider all of these training issues and needs in its internal planning, and should proceed carefully in any of its cooperation initiatives to insure that the problems are addressed systemically. At a minimum the ISTC will require sufficient internal expertise, or expertise readily available to it, to enable it to provide a staff overview of the training and educational needs, innovative possibilities, and policy options with regard to each of the selected ISTC problem areas.

Questions for ISTC planning include:

- to the extent that internal staff expertise on training and educational issues and policy options is agreed to be needed, what division of labor is appropriate between the staff expertise within the selected problem areas and the expertise in a distinct problem area focused on technical training problems?
- should the ISTC accept a role as a major contributor to the state-of-the-art on technical training and manpower utilisation - supporting research and experimentation programmatically - or should it view itself more as a consumer of existing expertise and experiential knowledge, seeking means of applying what is known in new or expanding programs with which it collaborates?

- should the ISTC confine its concerns with training and education problems to the problems which arise in connection with the selected problem areas of the ISTC program or should it go beyond them to concern itself with problems of other sectors, with systemic problems of the public education and training systems, or with learning needs resulting from technologic change such as the skill and social coping needs of urban immigrants?

- considering the limitations on ISTC program funds for at least the first year or two, the work already underway by other organisations and assistance agencies - and by the countries themselves - , and the necessity for local leadership and initiative on many of the problems, can an ISTC program in technical training be defined which is both additive to what is currently being attempted and implementable with the resources likely to be available to the ISTC?

These questions are somewhat beyond the scope of this paper, though they are touched upon inferrentially and are obviously among the first order questions which will determine how much of what is suggested here can be considered for implementation. The basic judgment of this writer is:

- The ISTC will need to complement the expertise within the selected problem areas with an internal staff capacity to work across all the problem areas on the planning and integration of training systems, extension and information systems, and manpower utilisation policy. The staff attention to education and training problems might be split something like 60:40 between the selected problem areas and the training and education problem area.

- The ISTC should be primarily a consumer of state-of-the-art knowledge, concentrating on the application of existing knowledge and expertise in improved planning and program implementation. Its main contribution to the knowledge and experience base will come in improving access to and transference of existing knowledge and training models, through direct collaboration with local planning and experimentation, and through knowledge which will emerge experientially through ISTC support for the application and implementation of new approaches. The one area in which ISTC may want to support new research is on the social and cultural factors affecting technologic learning and adaptation.

- The primary ISTC concern should be with training problems related to the selected problem areas. However, at least part of the concern within these problem areas will necessarily spill over into larger systemic problems. Further, many of these problems will be addressed within integrated development programs. Thus, even though the problem area concern may be narrowly defined, the training and implementation tasks will require a high degree of integration and coordination with other efforts.

- An ISTC program can be defined which is both additive and implementable with modest resources. However, even the selected problems and areas for inquiry suggested here will be substantially greater than the program likely to be supportable with the resources likely to be available to ISTC at least in its first year or two. Further, though the ISTC may confine its work initially to program development and collaboration with policy and planning activities, its leverage in these activities will be greatly increased when it has at least a modest amount of program funding available to it.

<u>In FY 1980, the following program planning and policy review activities are suggested:</u>

- a state-of-the-art review of skill needs and existing training capacities in one or more productive sectors, to be followed by a program planning workshop in a country or region in which increased investment in that sector is anticipated. Examples of such productive sectors include the marine resources sector, the forest industries sector and the energy industries.

- a working group on the education and training implications of appropriate technology policies, with participation of specialists on manpower planning and utilisation and key appropriate technology practicioners from the U.S., from Canada, from Europe (particularly UK and the Nordic countries) and from developing countries. At least two workshops should be planned, one in the U.S. and one in a developing region such as South Asia.

- a review of the experience in the fields of public health and agriculture in training and utilising paraprofessionals and auxiliaries in the delivery of basic extension services. A parallel review should identify examples of analogous approaches and program initiatives in other fields. At least one workshop should be supported in collaboration with a developing country institution seeking to develop extension services and/or utilise paraprofessionals for other purposes -- e.g. for rural technology and engineering, for environmental management, or for the support of small and artisanal industries.

- a state-of-the-art review of what is known about the factors which influence occupational choice and career mobility. This should be combined with support for tracer studies of the career patterns of recent graduates of selected LDC technical training institutions.

- a state-of-the-art review of current theory about the cultural behaviors, attitudes, practices and perceptions which influence receptivity to technologic change. This should be combined with, and perhaps contrasted with, a review of the experience of projects stressing "bottom-up" needs assessment and program development strategies and attempting to maximise the participation and implementing roles of individuals and groups at the village or community level.

It is also recommended that during 1980 the IFTC explore the need for one or more coordinating or clearinghouse mechanisms to assist in inventorying and mobilising U.S. technician-level training capabilities. This exploration should be coordinated with ASEE, NAS, NAE, AACJC, NATTS and other representative organisations.