HOME

Introduction

"... valuable know-how as well as excellent equipment, fitting into the constraints and limitations of poverty and suitable for genuine development, exist all over the world in the rich as well as the poor countries. But it is scattered, hidden, often very poorly documented, and generally inaccessible to those in need, when it is most needed. Countless men and women 'in the field' are trying to solve problems for which solutions have already been found somewhere else; are embarking on experiments which have already been shown to be unfruitful; are trying to find methods of working and items of equipment which may be available but they do not know where. At this level of know-how and technology there is almost total lack of effective international communication."

E.F. Schumacher, **Appropriate Technology Journal**, 1976

This book represents an attempt to improve access to information on small-scale technologies. Our purpose is to present a selection of capital-saving, labor-using tools and techniques that already have proven to be valuable in different circumstances around the world. We do not suggest that any specific technology will always be appropriate. The appropriate technology worker needs options, not a prescribed package of technology.

Appropriate Technology

What is appropriate technology all about? It is a way of thinking about technological change; recognizing that tools and techniques can evolve along different paths toward different ends. It includes the belief that human communities can have a hand in deciding what their future will be like, and that the choice of tools and techniques is an important part of this. It also includes the recognition that technologies can embody cultural biases and sometimes have political and distributional effects that go far beyond a strictly economic evaluation. "A.T." therefore involves a search for technologies that have, for example, beneficial effects on income distribution, human development, environmental quality, and the distribution of political power as well as productivity in the context of particular communities and nations.

The appropriate technology movement in the rich countries such as the United States got started due to the convergence of a variety of concerns. These included the need to find a more harmonious and sustainable relationship with the environment, identify a way out of the accelerating energy and resource crises, reduce alienating work disconnected from its products and goals, develop more democratic workplaces, bring local economies back to health with diverse locally owned and operated enterprises, and revitalize local communities and cultural

traditions. Thoughtful, careful social choices are needed to correct the excesses and imbalances of an industrial culture driven by materialism. An essential quality of the appropriate technology movement in the United States can therefore be expressed by the word "restraint".

The appropriate technology movement in poor countries has, on the other hand developed in a very different fashion. In rich countries, the investment required to create one new manufacturing job typically is in the range of $20,000-$150,000, and in heavy industry this figure is higher still. In the poor countries the small amounts of capital available have usually been concentrated in the small industrial sector, creating very few jobs due to the high investment required per workplace.

The appropriate technology movement in poor countries has come out of the recognition that industrialization strategies have not been successfully solving the problems of poverty and inequality. Indeed, in many cases "modernization" efforts have been massive assaults on local culture. The result for hundreds of millions of people has been the modernization of poverty the neglect or construction of traditional craft occupations, the consolidation of farmlands into fewer and fewer hands, and the division of communities, leaving these people to eke out an existence on the fringe of economic activity. The appropriate technology movement in the developing world has developed as "the art of the possible" among the world's poor, seeking ways to solve pressing basic problems and create jobs with resources consisting of local skills and materials but little surplus cash.

From these different origins, the appropriate technology movements in rich and poor countries have been moving towards each other. The development of renewable energy technologies has long been a chief area of activity among U.S. appropriate technology groups. It moved high on the list of priorities in oil-importing poor countries in the late 1970's, as they faced high prices and scarcity of fuel for buses, tractors, and irrigation pumps. Similarly, environmental protection has gained increased attention in poor countries as pesticides have created major health risks for farmers and farm workers, and deforestation has reached a critical level.

Criteria for Appropriate Technology

This book, though primarily oriented towards appropriate technology activities in poor countries, contains relevant materials for North Americans as well. The books and documents reviewed here describe tools and techniques that, in general:

1) require only small amounts of capital;

2) emphasize the use of locally available materials, in order to lower costs and reduce supply problems;

3) are relatively labor-intensive but more productive than many traditional technologies;

4) are small enough in scale to be affordable to individual families or small groups of families;

5) can be understood, controlled and maintained by villagers whenever possible, without a high level of specific training;

6) can be produced in villages or small workshops;

7) suppose that people can and will work together to bring improvements to communities;

8) offer opportunities for local people to become involved in the modification and innovation process;

9) are flexible, can be adapted to different places and changing circumstances;

10) can be used in productive ways without doing harm to the environment.

Some of the reasoning that underlies the concept of appropriate technology may be summarized as follows:

1) it permits local needs to be met more effectively because local people are involved in identifying and working to address these needs; for the same reasons, it is likely to be in harmony with local traditions and values;

2) it means the development of tools that extend human labor and skills, rather than machines that replace human labor and eliminate human skills;

3) it represents a comprehensible and controllable scale of activities, organization and mistakes, at which people without management training can work together and understand what they are doing;

4) it allows more economical operation by minimizing the transport of goods in an era of expensive energy, allowing greater interaction of local industry and permitting greater use of local resources both human and material;

5) it makes unnecessary many expensive or unavailable finance, transportation, education, advertising, management, and energy services; avoids the loss of local control that use of such outside services implies;

6) it helps to establish a self-sustaining and expanding reservoir of skills in the community which begins from already existing skills;

7) it provides a region with a cushion against the effects of outside economic changes (e.g., the collapse of the world sugar market or the sudden unavailability of fertilizer);

8) it helps to reduce economic, social, and political dependency between individuals, between regions, and between nations, by recognizing that people can and will do things for themselves if they can find a way. (See Tom Bender in **Sharing Smaller Pies** on many of the criteria listed here.)

Addressing Many Obstacles

Appropriate technology has special appeal probably in part because it addresses a number of problems at once. The emphasis on self-reliance and local production for local needs removes from the list of development obstacles many of the inequities of an international system that is dominated by the expensive technology and economic power of rich countries. At the same time, the lack of well-developed infrastructure and the shortage of highly trained human power to efficiently run large industrial organizations become much less important when production is decentralized. It is probably for these reasons that the concept of appropriate technology is so popular. Those who believe in small entrepreneurial capitalism, democratic institutions, decentralist Marxism, European socialism, African communalism, Buddhism, and numerous other systems can find much of value in the ideas underlying appropriate technology.

Nicolas Jequier has described the popularity of the appropriate technology approach as evidence of a "cultural revolution" in development thinking. The elements of self-reliance, local initiative, and local control that are essential parts of this approach present a challenge to conventional thinking in the development institutions.

The Village Perspective

Up to 80% or more of the population in most developing countries lives in rural villages. Many of the people in urban areas fled the stifling lack of opportunities that tends to characterize rural areas. Thus successful rural appropriate technologies might concern some 90% of the population. An important voice in the dialogue about village technology can and should be provided by educated people working in rural areas in small projects. However, many of these people seem hesitant to get involved in experiments with technology, perhaps because this is seen as the work of engineers and scientists, and therefore as too difficult for others to undertake. Yet, the development of appropriate technology in not solely or even primarily a question of engineering design it involves a wide range of considerations.

Appropriate technology work cuts across traditional lines of expertise, and benefits from the insights of local farmers, technologists, educated generalists and business people. The small-scale technologies and techniques covered in this book are not particularly difficult to understand. Village problems do not generally require the importation of licensed technology, the intervention of multinational corporations, or the use of computer printouts for their solutions. These problems are centered around basic needs such as water supply, adequate housing, increased food production and processing, crop storage, and fuel supplies. Many people with a generalist background who are now involved in running small village development projects are quite capable of studying, understanding and effectively using most of the books reviewed here on these subjects. There is a clear need for such people to think of themselves as "village technologists" who support small experiments and tests, and who try to make villagers aware of what has been done elsewhere.

It is increasingly evident that appropriate technology workers should be forging relationships and making alliances with people active in complementary development activities, such as community organizers, planners, university students and faculty, staff of small business and cooperative promotion programs, members of unions and peasant organizations, teachers in technical high schools, and librarians. All have much to share with technologists. For this reason we have added new categories of readings to this book over the years. One section is concerned with strategies for appropriate technology and local self-reliance. Discussed here are the advantages of small scale in community-based efforts, and how government policies can support those efforts. Another section reviews the literature on the successful operation of small businesses and cooperatives important vehicles for the application of appropriate technologies and the equitable distribution of the benefits. Educational strategies that support local problem-solving are necessary if local knowledge of needs and the power of community action are to be tapped. We have therefore included chapters on science teaching to support local technical innovation, and non-formal education approaches and training techniques.

The theme of people's participation runs through much of what has been said about appropriate technology. This comes in part from a philosophy, which measures development in terms of the people's skills and their ability to solve their own problems.

In northern Bali there is a village in which the people have been very active in their own self-help projects for many years. They asked an engineer in a nearby town if it was true that electricity could be produced by harnessing a small stream. They ended up getting all the technical help they needed to design a small water turbine system, which they proceeded to build and pay for themselves using money from the sale of coffee. They had to buy the generator and they had the simple Banki turbine made in a large city, but the dam construction, the turbine installation, the wiring throughout the villages and all the rest were done by the villagers themselves. This is a dramatic example, which admittedly could not have been completed without the coffee revenues. Yet it demonstrates that remarkable things are possible when villagers are organized and begin to believe that they can work to develop their own village.

The decentralization that should be part of participation also makes a great deal of sense from a technical standpoint:

"Detailed technological information in terms of local labor conditions, and the resource situation, transport facilities, etc., may well be more easily accessible to the man on the spot, but does he really know very much about the relevant technology used in other economics but not yet locally? Certainly, if he learns more about the experiences of other countries, he may well be in a better position than the man at the center to judge the local technical possibilities in the light of rural conditions."

Amartya Sen, in **Technology and Employment in Industry**

Natural Resource Conservation

While A.T. offers an approach to development that balances the various development needs of the local people, it has a similarly important role to play in minimizing ecological destruction. Forests are being destroyed around the world at a rapid and ever-increasing rate. In the last 20 years, hundreds of millions of hectares of forest have been cut or burned for timber harvesting, cattle ranching, and agriculture.

The consequences of this rampant destruction are felt around the world. People living in forest areas feel the impact most immediately. For them, deforestation has meant scarce firewood for cooking, as well as the loss of plants and animals used for food, medicine, housing and other daily needs. The impact on the global economy and environment, though less apparent, may ultimately be destructive. The loss of forest biomass is a major contributor to the process of global warming, an increase in air temperatures worldwide that could radically affect agriculture and cause flooding of coastal areas by melting polar icecaps. Forest destruction has led to the extinction of numerous plant and animal species. The loss of biodiversity undermines the resilience of the world's interrelated biological systems, posing what many biologists believe is the greatest threat to life on the planet.

A tension exists between the ambition for rapid economic development and the ultimate need to conserve natural resources. Many governments and development projects have failed to recognize the environmental costs of timbering, cattle ranching, and large dam projects in ecologically sensitive areas. After the short-run benefits have been reaped, such mega-development approaches can seriously damage the natural resource base and therefore yield low or negative economic returns in the long run.

In one common pattern, roads pave the way for colonization of forest areas by people displaced by poverty from other areas. Lacking appropriate tools, these settlers clear the forest for slash-and-burn agriculture, only to find that within several years the soil has been depleted and more forest must be cleared. The tools and techniques described in this book offer at least partial solutions to these problems. A.T. can help make agriculture and agro forestry a sustainable undertaking, halting this cycle of forest destruction. Other A.T. approaches can foster more economically stable and environmentally benign development.

Short-term thinking about these issues is as common in the world's rich countries as in poor countries. Yet the very nature of the problem, as well as relative disparity in resources available to help address it, suggest that the costs of a more environmentally sound development will be shared. Many governments and major development agencies now recognize the importance of this threat and are supporting increasingly ambitious and innovative conservation programs.

The Recent Track Record

We wish we could report that the purely technological reasons for poverty (inadequate tools and techniques and therefore inefficient use of labor and resources) are well on their way to being eliminated. Unfortunately, this is far from being true. The achievement of some respectability for appropriate technology within both the academic community and the development community over the past fifteen years does not mean that a major effort to apply A.T. concepts is underway. During the same period, the running shoe industry in the United States reached billions in annual sales. Shoe designs have improved dramatically, as large sums of money have been devoted to research and development in the race to make better shoes to protect runners from injury. In comparison, progress in appropriate technology efforts have certainly not been as well-funded. In 1985, $100 million in talking toy bears were sold to the U.S. public. This exceeded the value of all newly designed equipment promoted as appropriate technology sold in the developing world (though not the value of all the equipment that could be classified as A.T.).

A general reevaluation of the potential and role of A.T. as an important part of development strategy has been taking place in recent years. Progress has seemed slow to many observers, and aid projects intended to push appropriate technologies have often been ineffective. Yet the experience in the last twenty years, as documented by the books reviewed here and incorporated in the A.T. Microfiche Library, points to an exciting number of successes, new insights, and advances in technology in almost every field.

Much has been learned from the failures in the past, which deserve some attention. In the first ten years of widespread, enthusiastic A.T. activity around the globe, the same 15 items were built and rebuilt, and research centers acquired cemeteries of artifacts with which to impress international visitors. Most of this equipment was not very economical or practical. One common reason for failure has been that the economic viability of new technologies was not explored.

Technology is fundamentally the application of human knowledge to create a tool or technique *to perform an economic task*. To ignore the economic aspects of a technology is to ignore the main factor determining eventual success or failure of that technology in the outside world. To many readers, this linkage between technology is self-evident, yet it is widely ignored by voluntary organizations and R&D institutions in the developing world. A simple economic evaluation is an important first step in considering technology projects. It allows technologies with little or no economic value to be screened out, and those with strong economic advantages (and benefits to the users) to be more readily identified.

There are now many A.T. success stories, typically the result of long-term (five years or more) programs with strong field testing components. Hundreds, thousands and tens of thousands of units of these technologies have been sold and installed and are providing good service. Examples include improved cookstoves in Sri Lanka, Nepal, Kenya, Indonesia and elsewhere (more than 25,000 distributed); hand-operated Rower pumps for irrigation in Bangladesh

(5000-10,000 distributed); foot-operated treadle pumps for irrigation in Bangladesh (20,000 distributed); double-vault water seal latrines in India (60,000 installed); water turbines for mills in Nepal (hundreds installed, providing milling services to hundreds of thousands

of people); oral rehydration mixes to combat infant diarrhea (millions of packets.distributed). The World Bank, one of the largest of the international institutions, has made a great contribution in searching for, compiling, evaluating and field testing low-cost water supply and sanitation technologies. They have demonstrated that there are a number of economical, technically-proven alternatives to the costly municipal water and sewage systems seen in rich countries. Thousands of insightful, creative people around the world have become intrigued by the possibilities, and have conducted solid experiments that have led to a variety of maturing technologies. The 125 books added to this edition of the Sourcebook document many of these.

Although funds for appropriate technology work are short, the largest single factor preventing more rapid progress is probably the lack of understanding of how organizations can combine funds and human resources to efficiently develop and market technologies. In the case of international aid agencies, the challenge is how to effectively support local groups in their work. There are, for example, a number of communications tasks or "overhead functions" that need attention. These include smoothing the flow of technical documentation, disseminating information on successful policy measures, supporting dialogue between partner institutions, and channeling small amounts of funds to grass-roots technology research and development efforts. Some of these might be tasks that existing international agencies or networks should take on or support others to take on. Other tasks are perhaps best initiated and financed by local networks or individual groups. Yet differing languages and cultural attitudes are barriers to building systems that work, and the differences in organizational forms among cultures make the challenge more difficult.

There continue to be well-funded pilot projects demonstrating too expensive "village" technology. Genuine grass-roots practitioners are scarce at conferences, where sympathetic non-practitioners, unfamiliar with the daily obstacles to technology improvement in the field, have difficulty identifying the truly useful "overhead functions" that coalitions and aid agencies could perform.

Institutional Change

Now that appropriate technology is being added to the activities of national and international organizations, it is catching the interest of those who would like to use elements from it to repair the creaking, battered bridges of development aid A.T., however, is an awkward approach to incorporate into large agency planning efforts. The concept of "local self-reliance", for example, is difficult to define or quantify and will vary from place to place. Furthermore, it is a quality that can be either nurtured or destroyed from the outside, but never created. "Self-reliance" also sounds vaguely utopian or ideologically tainted. To many planners it looks unnecessary, and out it goes.

Equally difficult is the concept of "people's participation". "Participation" is probably the most often invoked and least often attempted aspect of rural development programs. Participation is often interpreted to mean the carrying out of instructions. This kind of interpretation makes participation simply a measure of the degree of local acceptance of a project, not a strategy for success and human development. Nor does this approach to participation contribute at all to an ongoing process of community problem-solving. A higher state of participation may be reached when community reaction is sought to the activities planned by the intervening agencies. Such an approach is sometimes taken in the hope that local enthusiasm will be increased and gross mistakes (due to factors unknown to planners but evident to the community) can be avoided. Yet even this leaves the community in essentially a passive role, as Denis Goulet aptly points out:

"One may plausibly argue that to structure feedback is merely to assure that any participation elicited will be a mere 'reaction' to what is proposed. To *propose* is thus, in effect, to *impos*e, inasmuch as those who plan initial arrangements do not provide for a *feed-in* at the early moments of problem definition. Feedback prevents non-experts from gaining access to essential parameters of the decision process *before* these are congealed."

Denis Goulet, **The Uncertain Promise: Value Conflicts in**

Technology Transfe r, 1977

In true participation, community members are involved from the outset, beginning with the setting of the development priorities. Large development agencies generally lack the local contacts and rapport with community members required for project participation. They may be further constrained by a need to move quickly in project implementation.

Another important concept in the A.T. approach is that development should increase (or at least not reduce) the ability of the poor to cope with their problems. Yet the project designer is hard-pressed to insure this; no project's consequences can be fully known beforehand. Unpredictability must be kept in mind when evaluating the kinds of activities that are chosen. We should ask ourselves: What new risks come with the proposed activity? Will this project make the poor more or less capable of dealing with unforeseen problems and crises which may arise? These questions are particularly important when we consider projects that tie the poor into the world economy. Planners and decision-makers have pointed to international markets and invoked the benefits of "interdependence," but have neglected the question of who stands to lose out when times are difficult. For it is the poor, in the end, who will be hit by famine when the crop fails, be left with their equipment idle when fuel is unavailable, and find themselves on the street without work when fashions change and their exported handicraft product is no longer in vogue.

These, then, are some of the reasons why it is difficult to incorporate A.T. principles into large agency programs of action. Concepts like "local self-reliance" and "people's participation" are difficult to work with and therefore not popular with planners. Yet when the small farmer is integrated into the world economy, the roller-coaster price cycles of international commodity markets can undercut his or her chances for self-reliant advancement. Unless thoughtful attention is given to these difficult issues, projects and programs will have little about them that is really "appropriate."

Policymakers responsible for the national decisions that influence technological change also need to carefully examine whether their policies are supportive of appropriate technologies. People who work with appropriate technologies at the grass-roots levels in many countries consider governmental measures out of touch and ineffectual, and have become thoroughly skeptical of government and international agency activities labeled "A.T." In few countries have the policymakers provided evidence to change this view.

If the world were made up of autonomous communities, people could make their own choices about technological change. But the image of the completely isolated village is an illusion. In Indonesia, for example, where more than 70% of the population lives in rural areas, most have watched television and know of Honda motorcycles and Levi's jeans. The materialism of the West has very nearly reached the farthest corners of the earth, and profoundly affected the aspirations and behavior of much of humanity. In villages in which the largest killer is infant diarrhea, people save from tiny disposable incomes to buy quartz-crystal watches, cameras, and motorcycles while the need for clean water goes unaddressed. Not only the landless but also the young, and the bright, and the enterprising people are lured to the city. They leave behind village economies drained of resources by international soft drinks, cigarettes, and consumer goods, and drained of talent by the pull of economic opportunity and "modernization."

Local A.T. workers must consider these powerful forces influencing the communities in which they work. Community-based development strategies will be up against great odds where the vitality of the community has been sapped. It is just as clear that neglect at the national level will greatly increase the odds against A.T. development.

The challenge is to devise policy measures and government programs, which will support widespread local A.T. efforts instead of replacing or attempting to direct them. Nicolas Jequier notes that the A.T. movement does

"... not really know how to handle A.T. on the scale that is required by the needs of hundreds of millions of poor people .... The problem in effect is not simply to develop more appropriate types of technology, important as this may be, but to start redesigning the existing system of planning, investment, and development ...."

"Appropriate Technology: The Second Generation," 1978

Who Are the Innovators?

There is a widespread misconception that new technologies are produced by large groups of people working in government research centers. In fact, this has rarely been true. The great majority of technological innovations have always been the products of individuals and small groups of people. Small businesses, not government R&D centers or large corporations, are the major sources of innovations even in high-technology products such as microcomputers. For example, in 1986 a new world record for the longest airplane flight without refueling was set by the Voyager aircraft. This plane was designed by one man and built and flown by his brother and a friend.

What kinds of individuals originate successful technological innovations?

The answer to this question is important in choosing a strategy for village technology research and development. It has been commonly recognized that engineers, scientists and foreigners have made significant innovations in a variety of settings. Each of these sometimes overlapping groups has its own strengths: engineers are versed in the fundamentals of design; scientists have powerful conceptual and methodological skills; foreigners bring ideas from the outside and insights from a different way of looking at problems.

It is not commonly recognized that craftspeople, farmers, and other villagers have been contributing to the village technology innovation process for much longer than the professionals and outsiders. The idea that poor farmers and craftspeople are not inventive is an unfortunate misconception held (often unconsciously) by people who have had little direct contact with villagers in their own or other countries. In fact, the poor in both rural and urban areas around the world show considerable ingenuity in using the materials available to them to solve their problems. Recycling industrial materials into shoes and oil lamps, imitating natural ecological interactions in small farming systems, and keeping vehicles running for decades without proper spare parts are just three of thousands of possible examples.

A person convinced of the existence of lively inventive activity among the people of rural areas and urban slums of the developing world may still be inclined to dismiss this as too small in magnitude to be relevant to appropriate technology efforts. But is it? Suppose we assume that roughly 2% of any human population acts in ways that deserve the label "inventor." This is the figure used for the San Francisco Bay Area of California by a regional inventor's council. If this is accurate, there would be 1.7 million "inventors" among the 85 million inhabitants of Java!

Obviously, these population groups are quite different. The San Francisco Bay Area has a reported 100,000 inventors in a population of 5 million. The Bay Area contains a large number of highly educated people, and is the heart of the rapidly growing electronics industry. On the other hand, the mostly rural population of Java has a greater daily involvement with tools and materials, a great range of traditional technologies, and a larger immediate survival problem. Even if the figure of 2% is reduced by a factor of ten that would leave 170,000 people informally involved in day-to-day village technology adaptations in Java. This figure dwarfs the number of researchers involved in formal programs on the same tasks. Appropriate technology efforts should be designed to take advantage of this large and creative group of people and support them, with technical assistance when necessary and with formal and nonformal education programs, to put such inventive activity on a firmer technical footing and accelerate it.

We must keep in mind that craftspeople and farmers commonly have a knack for devising tools. They also have a firm grasp of acceptability, affordability, and usefulness that is sorely needed in institutional research and development (R&D) programs. The magnitude of the potential contribution by craftspeople and farmers in an innovation process is at least as great as that of the professionals and outsiders. This suggests that programs for the indigenous development of appropriate technologies should draw on the different perspectives and innovative talents of each of these groups, by giving special attention to imaginative ways to directly include the beneficiaries.

The Structure of R&D Efforts

Most research and development institutions in the developing world today are structured in ways that work against the development of appropriate technologies. This continues to be true even when the content of R&D activities has been changed to "appropriate technology." Most of these institutions have staff from an urban elite, who look to their peers for recognition. Facilities are located far from villages and trials of new technologies are conducted in artificial environments. In this kind of institutional setting, there is generally little place for (or interest in) input from farmers and other villagers.

For years, observers from around the world have been pointing to the need for direct involvement of farmers and other villagers in any technological research intended to benefit them:

"The farmers in a land parcelization project complained of little or no corn response to fertilizer even though it was required in the complete credit package .(Subsequent) results from Farm Trials indicated response in some cases, especially in some of the hybrids tested, but in none was it profitable; conventional wisdom, coupled with the natural tendency to consider fertilizer necessary in any complete recommendation, had created a situation in which the farmers were being forced into unprofitable investments ...."

Peter Hildebrand, "Generating Small Farm Technology," 1977

"The challenge before us is to establish a system which will produce machines that will make poor people more productive machines that will work, will last, and are affordable. In developing the system, we must ensure that the villager becomes an active member of the research team. For it is the villager ... who is the focal point of all this activity, and ultimately it is the villager who will judge if we are making a serious effort to solve his problems, or if we are merely continuing to tinker with his future."

David Henry, "Designing for Development: What is A.T. for Rural Water Supply and Sanitation?", 1978

Several of the books reviewed in this edition discuss and detail the necessary steps for small farmer involvement in R&D work. They provide mounting evidence that successful programs work with users beginning early in the process. Those institutions and programs that continue without user involvement are not succeeding in producing technologies that people want. In industry, the same pattern holds: those companies that work closely with users when developing new products are generally successful, while companies that do not have poor results.

With the cart still serving as the primary mode of transport of goods in many countries around the world, virtually no systematic design work to improve these had taken place until the last few years. Such neglect is not simply the result of oversight but part of a pattern in which the research content and application of science has been heavily biased toward the needs of industrialized countries. The everyday pressing problems in poor countries have rarely been sufficiently unique or "interesting" to attract the attention of the scientist eager to investigate some phenomenon never before researched. This complaint is a fundamental one, and a major reason for the existence of the appropriate technology movement.

How might research become more responsive and related to everyday problems? One way, mentioned above, is to involve people who will use the fruits of research in the research process itself, and in decisions about research content. An alternative approach to research, already evidenced by some committed scientists and technical people in the developing world, also offers promise. Whereas commercial research and development has responded to the promise of economic gain for the innovative firm (as in the case of the running shoe industry), the "social entrepreneur" identifies needs and organizes responses primarily in hopes of finding a better way to do things that will benefit many people. These investigators choose to study new roofing materials and productive, ecologically sound small farming systems, while their counterparts in the rich countries study such things as the mating behavior of exotic fish.

"The prime criterion for good research should be that it is likely to mitigate poverty and hardship among rural people, especially the poorer rural people, and to enhance the quality of their lives in ways which they will welcome; that in short, priorities should be arrived at less by an overview, grounded in the reality of the rural situation. Starting with rural people, their world view, their problems and their opportunities, will give a different perspective. To be able to capture that perspective requires a revolution in professional values and working styles; it requires humility and a readiness to innovate which may not come easily in many research establishments."

Robert Chambers, "Identifying Research Priorities in Water Development," in **The Social an Ecological Effects of Water Development in Developing Countries**, 1978

There is a wide range of very low-cost village technologies that require little more than local materials and labor for adaptation work, which could be carried out by small organizations with few resources but close ties to users. Included here are such important technologies as improved cook stoves and grain storage bins. Moreover, many of the technological improvements involving the lowest cash investments hold the greatest potential for spreading quickly in poor communities.

Science Teaching

The experience and natural inventiveness of local people have been identified as key elements in relevant research and development efforts. Improving basic science education could also strengthen and broaden the local capability to do research and design work, harnessing the systematic methods of scientific inquiry to the creativity and experience which people already possess. Yet education in developing countries is rarely intended to promote a basic understanding of scientific approaches to problem-solving, nor does it offer students skills that are relevant to their daily lives. This is true in the secondary schools as well as the primary schools, which provide the only years of schooling for most rural people.

Major problems include the lack of affordable texts and lab equipment, the lack of written or printed materials in the local languages, the failure of curricula to show connections between science (with its odd lab apparatus) and the natural world, and the meager science background among teachers. Most importantly, the basic purpose and method of science is lost in the developing world's educational systems. With little or no chance to participate in simple experiments, students do not learn to take systematic steps in testing hypotheses and prototypes. Science is presented to them as a set of abstract concepts to be memorized. Educational systems geared to the needs of the few students who pass to subsequent levels (instead of the larger numbers who leave school at the end of each level) make science courses primarily tools for screening students rather than for developing a basic scientific literacy throughout the population.

A way out of the dilemma may be found by relating science more directly to the natural processes going on around students in their daily lives, by making low-.cost lab equipment

(see the SCIENCE TEACHING chapter), and by using devices and materials that are normally found in the community (such as bicycle pumps and market scales). Students could then become directly involved in the systematic procedures of science, learning valuable problem-solving skills. They could begin to escape the deadening effect of rote schooling, where memorization rather than skill development and understanding is the goal. Courses on simple machines and agriculture, directly related to farm activities, could be included. This has been tried with success. Special curriculum development and teacher training are crucial for the success of such efforts.

This kind of shift in science education may be similar to what Albert Baez

(director of UNESCO's division of science teaching from 1961 to 1967) had in mind when he observed: "The inquiry mode of science and the design of mode technology should both infuse the science education of the future." ("Curiosity, Creativity, Competence and Compassion Guidelines for Science Education in the year 2000," by Albert V. Baez, June 1979.) In that 1979 paper he went on to note that both Einstein and Edison were stifled and powerfully alienated by their early contact with rote schooling. An essential part of a new approach to science education, he argued, is the fostering of creativity. He cited a study, which indicated that creative people "challenge assumptions, recognize patterns, see in new ways, make connections, take risks, take advantage of change, and construct networks."

It may be possible to create a corps of people who can use both "the inquiry mode of science and the design mode of technology" to help solve the technological problems of their communities. These people would receive special practical training in addition to the new science courses. They would play a role similar to that of the "barefoot doctors" who have been successful in China and an increasing number of other developing countries. These "barefoot engineers" would not replace other engineers, but would greatly increase the availability of technical skills for problem-solving at the grass-roots level. In rural Colombia, the FUNDAEC program has been training such a corps of "barefoot engineers" (see review of **The Rural Universit**y). These young people, coming from the rural communities with a sixth grade education, go through a three year training program. A university based group distills and combines concepts from a variety of technical fields, to arm students with a set of skills relevant to the problems of their communities.

Basic Steps for R&D

From this discussion, we can identify at least four basic steps that are likely to increase the relevance and productivity of appropriate technology R&D efforts:

1) Change the criteria for "good" research. Good research should be that which is likely to reduce poverty.

2) Seek to understand the viewpoint of the poor their perceptions of problems and opportunities.

3) Actively include the poor, especially small farmers and crafts people, in both decisions about research content, and in the research itself.

4) Offer basic relevant science education geared to the challenges of local problems, with curricula adapted to employ available materials and common devices to illustrate principles, and to provide young people and farmer-inventors with a more scientifically sound basis for their innovation efforts. Offer related courses on simple machines, how they work and how to fix them.

Education and Training

Relevant science education might accelerate the process of generating useful and affordable village technology adaptations. There are other potential links between educational efforts and improved tools and techniques as well.

Increases in the material standard of living come with advances in productivity. This is accomplished through upgraded technologies, which embody human knowledge, and increase the skills of the people. When better technologies and skill development opportunities are widely available, increases may be seen in the local standard of living.

Conventional development strategies and programs tend to concentrate resources on a narrow range of activities. Scarce capital and R&D funds are channeled to industry, which employs only a very small part of the work force. Costly training programs yield small numbers of graduates for a few sectors of the economy. A high rate of economic growth may occur in these sectors, but most of the benefits reach only a few people. At the same time, the vast majority of economic activities remain stagnant, experiencing no (or very slow) increases in productivity. Important sectors of the economy may decline, as traditional materials become scarce and some of the more capable workers move to the cities.

The appropriate technology approach therefore includes the question, "How can we create conditions in which productivity in most important activities will increase?" With the resources used to train one engineer, it would be possible to train 10-50 or more farmer-inventors who would have incentive to focus their efforts on raising productivity and earnings in the traditional sectors of the economy. Such a shift in the emphasis of technical training could mean that people would no longer be forced to simply wait for industrialization to make them either prosperous or destitute. Instead, they could become involved in the development of new tools and skills that emerge from the old, setting into motion a dynamic process of productivity increases that actually involves the whole society.

Educational and training opportunities are also more than a strategy for raising the productivity of ordinary people. They have intrinsic value too, in that they broaden the intellectual and technical perspective, widen the horizons of general knowledge, and help liberate individuals from the oppression of drudgery tasks, poverty, and political domination. This "humanistic" perspective, which asserts that relevant learning opportunities are inherently worthwhile, can be seen at work in non-formal education efforts offering reading and vocational skills to groups of out-of-school adults. Such an orientation favors promotion of technologies and programs, which have educational consequences for the poor majority. Too often, however, development planners are not interested in the widespread development of skills and knowledge that comes with decentralized technology and participatory community development programs. Any extra effort required to initiate an educational process may be seen as an obstacle to achieving the more measurable goals (e.g., the number of wells and hand pumps installed or the number of patients examined). The disregard of informal training effects when pursuing narrow goals can be seen regularly in the way large programs are organized.

The benefits of informal training, community organization, and an increased local level of experimentation and problem-solving do not show up in the calculations of categorical programs (which focus on one kind of development objective, such as improved health or housing). These benefits are effectively invisible, and they are not taken into account except by the few categorical programs that focus on these as their own particular objectives.

The example of the 2800 small-scale cement plants operating in the People's

Republic of China illustrates how widespread training benefits can follow directly from choice of technology. These cement plants provide cheap cement for local infrastructure construction projects such as irrigation canals; they employ ten times as many people (per unit of output) as the conventional rotary kilns; and they provide workers with a range of practical technical and administrative skills which serve as a valuable foundation for other small industry activities. In this ease, the skills of the rural population have broadened significantly more than would have been the case had the centralized "higher technology" rotary kiln been chosen.

Valuable informal training effects can also be seen in a wide variety of private, day-to-day activities. For example, while in most poor countries managerial and entrepreneurial talent is thought to be in short supply, children of ethnic groups controlling particular economic activities (e.g., shipping or retail sales) become exceptionally talented and successful business people. They do this without enrolling in formal business training programs. Rather, they participate in daily business activities, and have a high motivation to learn. Informal "learning by doing" can also be seen when communities undertake their own development projects. Mistakes are more evident and more likely to occur on a scale, which is correctable by the participants. Appropriate technology advocates should be aware of these natural informal educational processes, and should think about ways to open them up to more people.

Local Resources

"Personal and local resources are imagination, initiative, commitment and responsibility, skill and muscle power; the capability for using specific and often irregular areas of land or locally available materials and tools ; the ability to organize enterprises and local institutions; constructive competitiveness and the capacity to cooperate."

John Turner, **Housing by People**, 1976

Formal and informal learning opportunities whether science education offered in the classroom or the chance to acquire managerial skills in a factory or business are crucial in mobilizing these local human resources. Skilled, creative local people will, in turn, be able to better use local material resources often the only alternative in poor countries:. "To construct using renewable resources is not a sentimental fad in an area without exportable products to pay for imports .... In a low cash economy it is the interactions of human resources with the immediate materials of the land that provide for the richness and fullness of life."

Peter van Dresser, **Homegrown Sundwellings**, 1977

We noted above that learning opportunities are often overlooked in the calculations of development planners. Likewise, the local labor and materials are frequently ignored when planners consider the assets of a poor community.

One of the prime considerations in the development of appropriate village technology is to find ways in which people can invest their unemployed labor to produce something of value. If these people are not fully participating in a market economy (which is commonly the case), it is not a question of what manipulations an economist can suggest to maximize the yield on their time and capital; capital, in this case, is not easily measured because it is in the land and the trees and the bamboo. Conventional economic analysis has little to say in such a situation because such capital is generally ignored.

The investment of cash has the effect of mobilizing the efforts of other, distant people; money for sheet metal, for example, pays for the efforts of the workers in the mill and the miners who extract ore and coal, along with the transport and "middle" workers necessary to bring this material to the community. If we can accomplish the same task by mobilizing our own effort (e.g., building effective grain storage bins using our own labor and locally available basket materials and clay), we can avoid spending cash on sheet metal for bins. In other words, labor and local materials can be converted into capital, without any cash input. Which we choose (or are forced) to do depends on whether we know about alternatives, whether opportunities to earn cash are available, what skills we have, and which use of time and effort will most easily accomplish the task at hand. Whenever jobs that pay cash are few but local materials and labor abundant, a reliance on cash investment poses an unnecessary obstacle to the construction of more effective grain storage bins, basic houses, or new agricultural tools.

The use of local materials not only offers opportunities for action where money is scarce, but has other advantages as well. Nicolas Jequier has pointed to a distinction between what he calls "systems-dependent" and "systems-independent" technologies (see "Appropriate Technology: Some Criteria" in **Towards Global Action for Appropriate Technolog**y, 1979).

"Systems-dependent" technologies are those which require, for example, a supply line of materials, spare parts, fuel, maintenance and repair skills to be efficiently used. Any break in the chain of related elements results in the idling of a "systems dependent" technology.

"Systems-independent" technologies, on the other hand, can be efficiently used without such supply lines; they include tools, techniques, and structures that are made of local materials.

Local materials are thus often the key to what members of a poor community can afford to do. "Affordable," in this context, has a very different meaning than "economically competitive." A technology is termed "competitive" if, over time, it is cheaper than the conventional approach used to accomplish the same task. This does not mean, however, that it is cheap enough to be affordable and a better choice for the poor than what they currently use. For example, a windmill designer once told us that he was pleased that windmills were soon going to be economically competitive with diesel-driven pumps for water lifting, since oil prices were going up. To a poor person who couldn't afford to buy or rent the engine-driven pumps when oil was cheap, a steel windmill is equally out of reach. This is not to say that steel windmills do not have a place in appropriate technology efforts; they may be an excellent product with good prospects for replacing engine-driven pumps in some areas. The windmill designs that are most likely to reach the poor, however, are those that emphasize the use of local materials in their construction, and thus minimize the cash investment required.

Similarly, a careful calculation of what constitutes an "affordable alternative" should he made when we look at investments in improved cooking technologies from the point of view of poor women. Because firewood used in cooking is the major form of energy consumed in rural areas, fuel-efficient stoves could be a major tool in the effort to increase available rural energy supplies (and reduce deforestation). Yet most firewood is gathered (not purchased), and traditional cooking stoves usually require little or no cash investment. Therefore, regardless of how fuel-efficient an improved stove may be, it must also be very inexpensive to be attractive and affordable.

A.T. and Income Distribution

Saving labor serves no purpose if it is your own job that is "saved" and no other real employment and thus income opportunities exist. In China, in l9th-century

England, and in the developing world today, a central question regarding mechanization and industrialization has been: Whose labor has been saved? Who will benefit and who will simply lose any opportunity to earn a living?

In the industrialized countries, new jobs are theoretically created to replace those that are destroyed. The fact that this has been an awkward, unequal and demoralizing process is generally overlooked, while much is made of productivity increases leading to benefits for all. (The stubborn persistence of high unemployment and increasing inequality of wealth and income in industrialized countries like the United States suggest that this process may finally come to a halt.)

Much mechanization and industrialization in the developing world has simply cut people out of the production process, changing who makes the goods (and thus who ends up with some purchasing power) without changing very much the amount of goods produced or their prices. For example, when aluminum pots replace clay pots produced by villagers, the result is a) a marginally better product, b) the same number of pots in use, c) perhaps a lower price when calculated over the life of the pots, d) a lot of unemployed potters who now have no purchasing power, e) a smaller number of new jobs in an urban-based industry, f) an enriched industrialist, g) a shift away from the products of village industry previously bought by potters (e.g., tools produced by local blacksmiths) towards a smaller number of highly processed foods, transportation services, and imported goods bought by urban residents. In this example "productivity" (as measured by the amount of product created per worker hour) has gone up, although total product has not. More people are unemployed, income inequality has increased, and village development has been set back. This process of destroying crafts has been repeated all over the world. Without a political commitment to full employment and the sharing of the benefits of technological change, the great technological gap created by the sudden arrival of

Imported technology can thus quickly increase poverty. It is in grappling with this kind of problem in societies shot through with inequalities that labor-intensive, decentralized, productivity-increasing technologies have a role to play. The need is for both national productivity increases and individual worker participation in production and consumption.

The need is acute in the agricultural sector of poor countries, where most of the people earn their livelihoods. To help the small farm family better use their resources, a program to adapt agricultural tools and equipment could be aimed at several categories of activities. One group of needed technologies are those that speed work at the points in the agricultural calendar when all available person power is released. Another tactic, one that the Chinese have used effectively in the commune system, is to mechanize the particularly low-productivity activities that are major time consumers in the rural sector, and shift this labor to other activities, such as making threshers, pumps, and hand tractors. (The production of agricultural machinery in the rural areas of China has meant that the equipment made is responsive to technology needs and that mechanization does not necessarily replace agricultural jobs with jobs in urban industry. This situation is virtually unique in developing countries [see **Rural Small-Scale Industry in the People's Republic of China**, by Dwight Perkins, et. al, 1977]).

When land ownership is heavily concentrated in a few hands, this labor reallocation process is likely to be incomplete, leading to technology choices which may not benefit the majority of the population.

"To maintain ... a rational growth of capital use in a low income economy, small farmers do not experience the same pressure to substitute capital for labor; *no one wants to mechanize himself out of his job*. Large farms are in fact the least economical, in social account, in the use of scarce capital and underemployed labor. Land reform countries generally exhibit a better record of a resource use that is rational in social account."

Folke Dovring, "Macro-Economics of Far Mechanization," 1978, in **Agricultural**

Technology for Developing Nations: Farm Mechanization Alternatives for 1-10

Acre Farms, 1978, emphasis added, see review.

Farmers who hire labor to carry out low-productivity activities are likely to substitute machines when possible, thereby replacing a number of farm labor jobs with a smaller number of machine operation and maintenance jobs. If farm labor is in short supply, wages may rise with productivity and everyone benefits. This is rarely the case in poor countries, however. More likely, the landowning farmer reaps the benefits and some laborers lose their jobs.

The tenant farm family is less likely to be hiring labor, and has less capital in any case to invest in machines. These families are faced with the possibility that new technologies that raise the productivity of the land may lead to rent increases that capture the gains. There are of course many ways they can invest their own labor, through composting, tree planting, and general soil conservation work that pays off over a long term. But they probably will be unwilling to make this investment, fearing that they will not be around to reap the benefits.

These considerations make it unlikely that improved tools and methods for increasing agricultural production can be targeted primarily for the tenant farmer.

The landless laborer is even less likely to be able to directly increase her or his income through field crop technologies, unless production increases create more work (e.g., at the processing stage). More to the advantage of tenants and laborers would appear to be technologies for small-scale crop processing, drying, and storage; home gardening; and household needs.

Of course, in many communities, most of the people own or have guaranteed access to some land as individuals, through extended family ties, through legislated communal family ownership, or through secure tenant-landlord relationships. In these places there may be great scope for the application of small-scale agricultural technologies which would increase the viability of small farms and result in broadly distributed benefits. In many other communities, however, vigorous land reform efforts may be necessary before much can be accomplished through agricultural technology change.

Systems for renting machinery can be an important means of distributing costs and benefits of new equipment among a large group of farmers. Such systems work best when competition keeps the charges reasonable. Otherwise, rental systems can be a means for owners to make monopoly profits; this is unfortunately quite common. Cooperative ownership, by contrast, usually involves more management problems but ensures a broader distribution of benefits. Cooperatives too, however are frequently taken over by elites.

We cannot automatically assume that new or adapted low-cost technology will be "accessible" to the masses or equitable in its distributional effects. Many small-scale machines imported into poor rural areas (such as Japanese engine-driven rice mills to Java) are affordable only to the wealthiest of rural people. Such machines may be accessible and small, but they are not accessible or small enough. Use of such machines can destroy jobs while providing benefits primarily to the owners. On the other hand, such machines may provide a valuable service at a reasonable price, in which case most of the community will benefit.

The foregoing discussion suggests that there can be fundamental political qualities associated with scale and cost of technology. Large-scale expensive technologies and centralized production systems tend to concentrate wealth, and can be vehicles that destroy the livelihoods of the poor majority in developing countries. Conversely, while village elites are quite capable of consolidating their positions with "intermediate" technologies, small-scale tools and techniques are less likely to contribute to the destruction of village economies. This is why technology policy the set of codes, incentives, and restrictions affecting the direction of technological change is such an important political matter. In almost all poor countries, government policies are determined by a narrow group of urban-based elites; thus the resolution of this important matter will not necessarily be in the interests of rural people, much less the poor majority of rural people. Those who govern, it seems, may perceive little benefit for themselves in wholeheartedly instituting policy measures needed to support a small-scale technology strategy.

An equally important related political question is whether with or without substantial policy support community organizations can exist or be created to serve as mechanisms for technological improvements that benefit everyone. The answer here seems to be a qualified "yes." Community organizers are becoming interested in A.T. because some technologies offer the opportunity for substantial benefits through community action, and thus encourage organization building. Technologists, on the other hand, have become increasingly aware of community organizing as a crucial activity (and even a requirement) for success of their technology programs; a climate of community awakening, self respect, and cooperation, and a chance to participate in a two-way dialogue, can have a major effect on whether improved tools and techniques are applied successfully. Thus appropriate technology and community organizing work are seen by many as mutually supportive, each contributing to the progress and growth of the other.

Community organizers, while not seeking conflict for their own sake, recognize that the small communities of the developing world are often riddled with inequalities of wealth and power. An important step in community organizing is to awaken a community to its own political, economic, and technical problems and opportunities. Then the challenge is to find mechanisms which allow progress for all, and prevent elites from taking over new community institutions. The promotion of small-scale technologies faces the same hurdle either strong community organization or a very careful technology group (or both) may be needed to ensure that a new technology will not become controlled by elites. (Elite control is most likely with crop processing equipment, pumps and tillers, vehicles, and equipment for small industry; it is least likely with household technologies improved stoves, home crop storage units, sanitation systems, and new construction materials.) An important strategy for both appropriate technologists and community organizers may be to concentrate initially on technologies which will benefit all, regardless of differences in wealth and power. On this point, a training team in rural India observes:

"Today there is much talk about 'total revolution' and radical transformation of society. But what really matters are the changes taking place in the socioeconomic reality of the villages where poverty crushes the poor. In this stark reality of life the rural pool can hardly envisage more than creating for themselves some free space in society where they can breathe more freely and begin to stretch themselves. What is crucial at the moment is to create a base for joint action which is relatively free from control of the locally powerful. Wherever this has been achieved, people begin to move."

Moving Closer to the Rural Poor, MOTT, 1979

Crucial "breathing space" for the poor may be created, without local political opposition, through the use of improved stoves which save one third of the fuel normally used in cooking, low-cost grain storage units that can significantly reduce losses of grain stored in the home, or by water supply and sanitation systems that can markedly improve human health. Properly chosen and developed, such very low-cost technologies can provide a crucial entry point for community organizing efforts. At a later stage, great inequalities may have to be confronted directly or neither community organizing nor technological advance can proceed.

Those who have overlooked the importance of community organizing should bear in mind that in addition to helping spread benefits of new technologies, community organizations open up other possibilities. Community technologies, such as water supply and sanitation systems, commonly fail when there is not a high degree of participation (i.e., a local committee for maintenance and repair). Technology adaptation and skills acquisition can also often be effectively pursued by community groups. In addition, cooperative community organizations offer members the chance to share resources and consolidate buying power. These intertwining functions can be seen at times in the more successful farm cooperatives:

"It was the farm co-op that got America's farmer out from under the oppressive crop-lien system, which kept nineteenth century farmers in hock [debt] to local merchants and distant brokers. Co-ops gave farmers an equal measure of bargaining power in the marketplace. With co-ops, farmers could market their crops directly, and could also do away with the hated middleman to purchase their supplies."

Jerry Hagstrom, "Whose Co-op Bank?", Working Papers, July/August 1980

The links beginning to form between appropriate technology and community organizing should lead to ideas for organized cooperation on higher levels.

Community organizing, appropriate technology, and other allied groups from different nations, for example, would find much in common and benefit greatly by learning about each other's experiences. How might this come about?

Communications

The concept that improved village technologies should be based upon local human and material resources, and be in harmony with local culture, has gained great acceptance within the appropriate technology movement. As a result, prevailing models of the role of communications in development have become increasingly inadequate for A.T. advocates. The "diffusion of innovations" theories, on which so many extension programs have been based, have assumed that centralized agencies would determine which technologies to promote. For the most part the task of communications has been defined, therefore, as the persuasion of the poor "target" population to accept these solutions. This process has not left room for input from the poor as to what solutions might interest them, nor has it allowed for the fact that some needs are more pressing in one community, while entirely different needs have priority in nearby communities. The extension agent has typically been assigned to a vast area due to funding shortages, and has found his or her impact seriously diluted. In addition, errors and misunderstandings have been compounded as information passes from trainer to extension agent to "opinion leader" to the rest of the farmers.

Two of the most serious problems with this kind of approach are: 1) there is little room for "participation" by the beneficiaries except in the most minor sense carrying out instructions; and 2) information flows almost entirely one way, from the central agency to the poor. It is therefore essentially impossible for the villager to get technical assistance with anything except what the extension agent is promoting. Not surprisingly, the technologies provided through this process have not been notably "appropriate," nor have most extension programs achieved the success rate (measured in numbers of people adopting the prescribed technologies) expected.

What are some of the elements that should be incorporated into communication strategies to make them more consistent with A.T. concepts? If we agree that an active level of participation in problem identification and solution by the members of poor communities is highly desirable, this requires that they have:

a) access to information in a form in which it can be of practical use;

b) the ability to initiate communications in search of relevant experience and information from other communities, including information on the successful technologies that have been developed nearby, within the region, and around the world;.

c) support from those with more advanced scientific and technical skills, through technical assistance centers that respond to requests.

A key local informal communication mechanism is the network, created by the social ties of a community that lead people to help each other with skills and pass on information. When new skills and information get into such a network they become available for all members to tap. Car repair, home improvement and many other skills in the U.S. are usually shared this way. Individuals pick up skills and ideas from each other and pass them along to others. An approach designed to take advantage of this phenomenon has been used effectively in teaching people to build solar water heaters in the United States (see review of **A Solar Water Heater**

Workshop Manual, by Ecotope Group, 1978). A weekend solar training workshop was regularly offered to members of social clubs natural networks. Later these people were in a good position to help each other properly complete solar water heater installations for their homes.

On local, national, regional, and international levels, networks of appropriate technology people are exchanging ideas and information in a highly active, decentralized fashion. Mimeographed newsletters can be low-cost vehicles for information exchange among groups across some distance. Grass-roots radio programs produced on cassette tapes can be used as a forum for questions and ideas about common problems (see review of **Grass Roots Radio**, by Rex Keating, 1977). In this way, people at the grass-roots level can listen to each other. Some of the other low-cost technologies for horizontal communication strategies, many of them affordable at the village level, are documented in the LOCAL COMMUNICATIONS chapter.

Organizations trying to help the poor find out more about technology options should consider the possibility of producing and distribution catalogs to document widely relevant technologies that are traditional and efficient, or new, or from outside the country. (Many examples of such catalogs are contained within this book, which itself is such a catalog. Perhaps the best examples of catalogs with information selected for a particular developing country are the **Liklik Buk**, from Papua New Guinea, and **The People's Workbook**, from South Africa.) The cost of producing such a catalog is much less than the extremely high cost of operating a technical information data bank that gathers information from all over, stores it for retrieval, and responds to individual requests. Even in developing countries, when the total cost of running a conventional technical information data bank is divided by the number of requests, the cost per request can easily be $100-300 equal to the annual per capita income in many countries (see Nicolas Jequier's discussion of this in **Appropriate Technology: Problems and Promises**, 1976). Catalogs, by contrast, can be produced at a cost of a few dollars each when several thousand are printed. They should be designed to anticipate and offer answers to many commonly asked questions, in addition to stimulating new thinking. This will not eliminate the need for information banks, but it should reduce the costs of having skilled staff respond to routine questions.

The A.T. Microfiche Library

An even more powerful tool for A.T. information is the library. If a high quality technical library is available, A.T. practitioners can find answers to the great majority of technical problems encountered in the field. The possibility of quickly finding a solution to the problem at hand, rather than waiting weeks or months for a book to arrive, means that far more questions will be researched, and fewer opportunities missed. Unfortunately, few A.T. groups have a good library. The cost of purchasing the books ($5,000 to $15,000 or more for a well-rounded collection) and organizing, indexing and housing the collection makes such a library too expensive for most organizations.

With this problem of cost in mind, we took our own A.T. library, upon which the A.T. Sourcebook is based, and reproduced the books on microfiche, to form the

Appropriate Technology Microfiche Library. Microfiche are plastic cards, 11 cm by 15 cm, which contain very small photographic images of the pages of books. Each microfiche card can hold 100 or more pages of information. A microfiche "reader," which operates much like a slide projector, is then used to view the pages.

By reproducing our 1000-title library in microfiche form, we are able to produce and sell copies for 1/20 of the paper cost. This has enabled hundreds of development groups with limited resources to have excellent libraries in their offices. Each book included in the A.T. Microfiche Library is reviewed and indexed in this Sourcebook.

Another powerful tool for information collection, storage and retrieval is the computer. Unfortunately, computerized systems for controlling and providing access to the information are ill-suited to a situation in which end users are scattered about the globe in remote parts of poor countries. In addition to high cost, the fundamental problem with such systems linking microcomputers to a centralized computer database is that the information going into the database has to be screened for relevance and accuracy. Unless this is done well by experienced and knowledgeable people, the computer system will become a processor of "garbage in, garbage out." A related approach is for the local group to tap into international networks of microcomputer users for answers to their informational needs. The problem here is that someone at the other end needs to have the time, knowledge and resources to respond. Unfortunately, few people are in a position to volunteer such assistance, leaving this role to the high-cost technical information data banks mentioned above. Most productive applications of microcomputers in developing countries are going to be for data manipulation, record-keeping, and word processing, not technical information access, at least in the near future. Eventually,

CD-ROM technology will have a role to play.

Tasks for International Efforts in A.T.

By their very nature, appropriate technology organizations working at the community level have few "disposable" resources to spend on anything but their immediate activities. Lower priority is therefore usually given to experimentation that is not linked to direct applications, careful preparation of documentation on successful and unsuccessful work and searches for other groups with relevant experience. Yet taking the opportunity to innovate at the community level and take stock of useful information and experiences (including that from other groups), is an important step towards the decentralization of technology choice and the strengthening of community self-reliance.

There seem to be two categories of needs in international A.T. cooperation.

One is for grass-roots groups to know more about what other grass-root groups are doing, both in terms of technology adaptation and strategy within the community. A second need is for large agencies to better understand the aims and activities of grass-roots groups so that assistance to them will be of greater value. One tactic which has been used extensively in attempting to address both of these needs is the international conference. Unfortunately, few if any people with direct experience working at the community level are included in such meetings because they are unknown to funders and conference organizers. Also, in many cases community workers are understandably reluctant to attend meetings at which, all too often, little is accomplished. Those who do attend risk being vacuumed up into a planning, advisory, or administrative role which takes them away from work in their communities. The more common conference-goers are expatriates and officials from developing countries for whom international trade is (an expensive) part of a way of life.

Regional and international networks and coalitions often suffer from the same problem seen in international conferences. When those involved are a step or two away from real grass-roots A.T. practitioners, the connection to real problems and needs rapidly dwindles and may disappear altogether. Currently the greatest need appears to be for more decentralized local networks and coalitions, whose members may have more of immediate relevance to share with each other, and who are less likely to face language and cultural barriers. Once local networks are established and healthy, regional and international networks can be strengthened. A.T. support programs might try to identify and support several kinds of people. One is the "social entrepreneur," a creative individual who can recognize social needs, overcome obstacles, and find ways to perform needed overhead functions. Equally important is the business entrepreneur (and her or his counterparts in cooperatives and worker-owned enterprises) who can create, produce and market tools at affordable prices.

The following are examples of specific functions in international cooperation, which could be supported by regional, national and international groups.

Communications, Documentation and Reference

Functions

1) Compilations of documentation on successful traditional technologies within a country: of interest in the same country, in the region, and in the world; published in book form.

2) Catalog publishing for low-cost dissemination of commonly relevant technical information, and to provide access to additional, more specific assistance (some examples are **Liklik Bu**k, **People's Workboo**k, **The Whole Earth Catalo**g, and the former **Sears and Roebuck Catalog**s; the last of these had wide circulation among North American farm families before World War II).

3) Assembly or production of simplified basic technical reference books, translated and adapted where necessary and made available at low cost. **A Farmer's Primer on Growing Rice** and **Where There is No Doctor** have proven the value of this approach.

4) Keeping unique and valuable reference books in print, by acquiring the publishing rights and reprinting books that are out of print due to low commercial sales. (For example, we have produced on microfiche more than 100 out-of-print books.)

5) Library grants sets of basic books (including those mentioned above) totaling 50-100 volumes and distributed (for example, through national coalitions of development organizations) directly to small A.T. groups, along with small discretionary accounts through which these groups can pay for additional published items acquired from around the world. (The A.T. Microfiche Library, which includes most of the books reviewed in this Sourcebook, is such a low-cost basic library.)

People-moving Functions

1) Staff exchange programs among appropriate technology groups in different countries to share skills and perspectives.

2) Short-term tours of successful A.T. programs, by groups of A.T. people, including village crafts people and inventors.

3) International training exchanges of farmers and craftspeople; e.g., tapping Javanese farmers to teach techniques of training and handling water buffaloes for plowing and other field preparation work in areas where these skills are unknown.

4) In-country training exchanges among allied appropriate technology, community organizing, nonformal education, and other groups.

Small Grant Programs

1) Seed capital to help equip small community-based appropriate technology groups with workshop tools and libraries, involving young people and local crafts people.

2) Operating funds for the R&D or adaptation activities of small appropriate technology groups.

3) Block grants given to establish appropriate technology organizations and coalitions with proven records, distinct from grants for their own use. These groups would identify new appropriate technology groups and pass on this money in small amounts.

4) Small venture capital investments in enterprises to produce and market appropriate technologies.

Funding Specific Technology Research

1) Pilot project testing and accelerated further refinement of specific technologies identified as most urgent by a panel of A.T. activists; carried out whenever possible by those who have done some of the important initial work. Selected would be technologies that are broadly relevant to the daily needs of poor people in developing countries. Where possible, several lines of development would be pursued, so as to generate options that include a maximum of commonly available local materials as well as options that require purchased materials.

2) National and international annual competitions with prizes awarded to the innovations most likely to help alleviate poverty. The best entrants would be documented in a catalog. Most of the examples listed here have already been successfully tried at one time or another. All of them deserve more attention than they are presently receiving. In the pages that follow, you will find reviews of more than 1000 books and documents, on specific technical subjects as well as on many of the topics discussed in this introduction.

The Editors