Experiences in Appropriate Technology

Edited by: Robert J. Mitchell

Published by:
Canadian Hunger Foundation
323 Chapel Street
Ottawa, Ontario K1N 7Z2
Canada

Paper copies are $ 7.95.

Available from:
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323 Chapel Street
Ottawa, Ontario K1N 7Z2
Canada

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The Canadian Hunger Foundation

Experiences in Appropriate Technology illustrates a variety of encounters between communities, governments, entrepreneurs, and consultants in the Third World, including communities in North America. AT practitioners worldwide have met an assortment of obstacles. Their experience indicates that introducing AT is much more complex than providing blueprints or equipment.

The very use of AT questions standard development theories. The case studies here go beyond this to question the current practice of AT. Low-income communities have a wealth of knowledge and are already using their resources as efficiently as their social, economic, and political environment allows. This fact is all too often overlooked in the implementation of new technologies.

Unless these communities have some control over the process, access to more resources and markets, power to make decisions, and are supported by government policies which promote community-scale production and services, a large percentage of men and women will remain on the periphery of both development and any new technologies, however appropriate.

Experiences in Appropriate Technology is a sequel to *A Handbook on Appropriate Technology* originally published by the Canadian Hunger Foundation and Brace Research Institute.

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Acknowledgements

Many people made this publication possible. The crucial input came from those who contributed information by writing and discussing their experiences of implementing appropriate technology in the field. Much of their work was on a voluntary basis or at rates well below the opportunity costs of their services.

We also thank the many people who submitted case studies which are not included here. Their projects were usually at too early a stage to draw out the many aspects of appropriate technology we wished to illustrate. The information they provided did help to amplify the general experience worldwide.

In our efforts to pool a number of different perspectives on applying appropriate technology, special thanks are due to: David Henry, Canadian Energy Development Systems International, Ottawa; Ted Jackson, International Council for Adult Education, Toronto; Warren Adams, Marilyn Carr and Stephen Joseph of Intermediate Technology Development Group, London; Tom Lawand and Ron Alward, Brace Research Institute, Montreal; Jens Müller, University of Aalborg, Denmark; Ben Ntim, Technology Consultancy Centre, Ghana; Jan van der Eb, TOOL Foundation, Amsterdam; Witold Rybczynski, McGill University, Montreal.

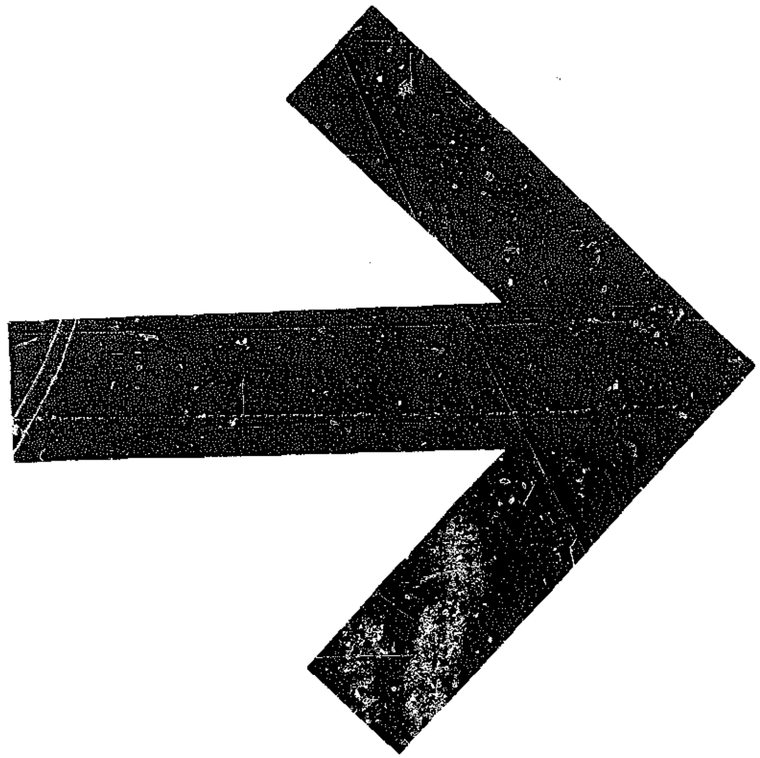
Rosemary Lewis, Ruth Anne Mitchell, Carmen Penty, Clyde Sanger, and the staff of the Canadian Hunger Foundation provided editorial assistance.

Ellen Savage diligently edited the final manuscript; Carol Blackmur typed and proofread the many draft copies. Eric Brunet drew some of the graphics and Greg Moore designed the cover and supervised the production.

Finally, the Non-governmental Organizations Division of the Canadian International Development Agency provided generous financial assistance.

Robert Mitchell,

Ottawa, 1980



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Preface

In 1976 the Canadian Hunger Foundation and Brace Research Institute published the *Handbook on Appropriate Technology* to help promote the concept and provide alternative technological choices. The handbook argued the case for appropriate technology (AT), described some options, and provided further sources of information. Many readers around the world have found it useful.

There is now much more experience in applying the concepts of AT in the field. The term "appropriate technology" appears regularly in development proposals, thousands of groups have been formed to promote it, and major decision makers use the words liberally. But it is not a concept that fits easily with the conventional methods of choosing technology as it attempts to widen the whole process of assessing and choosing technology and questions who makes the choices.

This book is a sequel to the *Handbook on Appropriate Technology*. The case studies in this book were chosen to clarify the concept of AT by showing the process of choosing better technologies in low-income communities. We selected case studies of AT which were assessed and used by local people. In our research we found it difficult (and sometimes disappointing) to find out what happened to even the best of initiatives. We also realize that there are many successful, unrecorded initiatives outside the international development and publishing circuit.

A description of a technique by itself, divorced from a social context, is not AT. The process of choosing AT is a blend of technical and social details. It is a group process which attempts to connect the resources in low-income communities with the wealth of outside technical knowledge. It is precisely this gap that AT practitioners are trying to bridge.

Appropriate technology succeeds or fails in application at the local level, not in scientific research and development institutions. In the 1970s there were many problems in applying this concept in practice. Only through discussion of real situations can the concept be grasped.

These case studies can be used as a focal point for discussion on applying technology. Why did a particular application succeed or fail? What are the constraints on applying appropriate technology? They provide examples of projects and questions for people who are funding projects. The results of these studies can be applied to any development project, large or small.

Many people still believe that AT is only windmills, solar energy, composting toilets, or water pumps. It is not so much a particular type of hardware, but a process of local people methodically choosing one that will best help generate social and economic development. Like any other technology, the hardware of AT is nuts and bolts, systems and procedures, motors and tools. It differs in its application. It is both a technology which combines existing local knowledge and resources with new information and a style of technical, social, and economic development where there is close interaction between the users and consultants. One can easily photograph the hardware of AT, but not the process of local people identifying problems, discussing options, and choosing feasible solutions. This process is the critical element often lacking in most descriptions of AT. Moreover, in many cases, local knowledge or skills are not more productive because social, political, or economic conditions prevent them from being so. An approach to AT that only focuses on adapting technology to local social and economic conditions, and not on helping to strengthen local organizations to change these conditions, is incomplete.

Three of the case studies (in Haiti, Afghanistan, and Newfoundland, Canada) provide second reports on studies in the *Handbook on Appropriate Technology*. Another initiative in India, described there, started with people rebuilding broken bits for well-drilling equipment. They are now manufacturing bits and the well-drilling equipment itself. From modest beginnings relatively sophisticated techniques may emerge.

It is no surprise that most of the case studies here describe the activities of local people and outside consultants unaffiliated with large development organizations. Experience over the last 20 years has shown repeatedly that the links between small groups and low-income communities can be much more effective and responsive to local needs. However, these small initiatives are limited unless international and national, social and economic conditions support them.

The case studies do not describe projects, but processes. Projects are written with aims, objectives, procedures, and budgets for the benefit of funding agencies. As important as these are, in practice, all of them have to be continually revised. Projects have a beginning and end. The use of AT in development is an open-ended process. At the local level the sharing of knowledge, the learning from experience, the development of local organizations and techniques are the ongoing thrusts of AT.

The concept of AT is evolving. In the 1980s as much emphasis has to be placed on developing strong local and decentralized organizations which can choose and implement the hardware as on developing the hardware. Without this dual emphasis, the concept of AT will be thrown on the scrap heap of panaceas for underdevelopment.

Introduction

The Roots of Appropriate Technology

The concept of appropriate technology emerged from Third World development projects of the 1960s. In response to the low impact and often negative consequences of insensitive applications of imported technology, many people began to question the choices of technology and the way these choices were made. Even the most optimistic observer had severe doubts when faced with the discarded tractors that farmers could not maintain; broken and abandoned water pumps; new city hospitals which treated disease in the absence of clean water supplies which could prevent it; the small diesel-powered rice hullers that put millions of women out of work; the promotion of powdered milk formulas as a substitute for breast feeding. Well-documented cases of inappropriate and, in some cases, ruthless choices abound. Many choices of technology simply didn't work in a particular Third World environment; some choices increased the gap between the rich and the poor; many were positively harmful. The fenced enclaves of modern industry have provided very few jobs and demanded heavy dependence on foreign advisors, capital, and governments. The social costs appear to be greater than any benefits.

The 1970s were marked by a growing awareness of related problems in highly industrialized countries — environmental pollution, unemployment, alienation, dependency on non-renewable energy, low-income communities on the fringe of rich societies. Many people perceived the development of a global economic system which removed the ability of individuals and communities to serve their own needs; a system whose growth was becoming increasingly expensive, tenuous, irrational, and inequitable.

These problems are both local and international in scope. New actors (OPEC, Third World governments) have appeared on the global stage to assert their rights and gain more control over their own development. Local communities have united to address local issues. Solving these problems has met with some success but in many cases neither the global economic system nor local political systems serve the needs of the majority nor allow them access to information on and participation in decisions on the choice of technology. Such decisions are usually made from the "top down" for people rather than with people. The poorest majority are somehow supposed to select and maintain better technology, and not hold these decision-makers accountable for any failures. The links between low-income communities and the few engineers, bureaucrats, corporations, and politicians who make such choices are weak. Rich people make demands through market and political systems. Low-income communities are both poor and

Development is a process of social, economic, and political change and growth where people's needs for land, food, shelter, education, health care, energy supplies, and improved techniques are methodically being satisfied.

Underdevelopment is a process of growth where the benefits are accruing to a minority; the needs of the majority are not being met. It is a particular form of malignant growth bearing the seeds of poverty, injustice, and conflict.

The Third World refers to the people in any country who are excluded from development.

powerless. In many cases the local community is too weakly organized to make decisions which would give it access to better services and increase its bargaining power with central authorities. In other instances such organization has been ruthlessly suppressed.

A number of groups formed which promoted alternative technical choices and development policies from different perspectives. Some strongly advocated smaller-scale, non-polluting, locally-made technologies. Their critics initially viewed them as anti-technology or anti-progress. In the face of formidable resistance, these alternative technologists tended to over-promote their cause. Hand, wind, and solar power became panaceas. In retrospect, these advocates generally agree that their emphasis on small-scale was only part of the solution. A network of development issues — land reform, education policies, decentralized decision-making, suitable consultants, and agricultural and industrial strategies among others — must also be addressed.

Much of the activity in developing the hardware of AT, particularly in North America and Europe, has focused on renewable energy technologies (using solar, wind, water, or wood energy), future energy supply options, and the environmental and political implications of these choices. Some of these technologies are suitable for low-income communities; others are not. Solar water heaters, a popular and cost-effective technology reintroduced into North America, are, paradoxically, not very relevant to most communities with greater solar radiation nearer the equator. There, more often than not, the problem is access to water itself.

In the early 1980s AT practitioners form a motley crew: pragmatic technologists, commune-based activists, development economists, anti-nuclear advocates, adult educators, small businessmen and farmers, anti-government conservatives, development professionals, alternate energy consultants, designers, and craftspeople both inside and outside scientific research institutions and corporations. They often move alongside, not with the mainstream of their chosen trade. These people inquire into the choice of everything from a village hand pump to nuclear power plants in large cities, and offer options. Initiatives by groups of craftsmen and entrepreneurs world-wide, who are already making the best use of local resources and skills, go unrecorded.

Behind the diversity of these people there are some unifying perceptions. They seriously doubt the wisdom of conventional international development strategies whose bankrupt practices, while more evident in many Third World countries, are being questioned in industrialized countries.

AT practitioners are dubious that the benefits of investment in technical research and development in demonstration centres, laboratories, universities, or corporations will "trickle down" to marginal income groups without accompanying financial and political incentives to link this research with the needs that local people express. In the 1960s investments in development projects based on economic theories for integrated economies generally assumed that somehow the benefits from these investments would eventually reach a broad majority. These theories have proved false and are now largely discredited. In many cases the benefits have accrued to a small minority.

Another concern of AT practitioners is that communities be allowed to define their own problems, use their ability to find solutions, and ultimately assume more control of their development. There is a strong anti-bureaucratic element in AT, a belief in greater decentralization. Among the professionally trained practitioners there is also a recognition of the limitations of their brand of "expertise" and the importance of expanding their narrow training and experience by listening to local people. AT is not something to be practised on people by experts, for if it is, its participatory, self-reliant basis disappears.

Finally, AT practitioners are concerned with choosing technologies, providing a wider range of options and benefits, and supporting local organizations in selecting these options.

Technology and Appropriate Technology

Technology is used here to include not only techniques, products and tools, but also the less tangible aspects — knowledge, management and organization of work. All are interconnected and do not exist in a social vacuum.

The term "appropriate technology" has been used very loosely. In the last five years many organizations have jumped on the AT bandwagon, some because it is now fashionable, others because they are seriously grappling with answers to the questions it addresses. Critics have dismissed it as an extremist, anti-modernization or anti-industrialization ethic. It is none of these. AT does ask what style of progress or industrialization is wanted, what balance between large and small-scale production is needed, what choices of technology will promote development, and who will participate in the selection of options. People involved in AT will not accept that the choices be monopolized by bureaucrats, consultants, and corporations.

It has been only in the past 10 years that these questions have been asked on such a scale. Previously it was assumed that the most modern technique was universally suitable. This has rendered many countries dependent on foreign advisors and capital, and made local communities vulnerable to the whims of central governments or the marketplace. Many choices are based on political expediency, choices that cannot be justified technically, economically, or socially.

People have always searched for more beneficial technologies. More technical knowledge is potentially available than ever before, but the global disparities in social conditions render generalizations on what is suitable in a particular environment impossible. Transferring any technology from one social context to another is risky. Simply dismissing traditional technology as obsolete does not indicate what is a better choice. Should one jump all the way to the most modern techniques, half the way, a quarter the way? Often, as some of the case studies here show, the most beneficial and feasible technique can be a blend of modern and traditional skills and resources. These sorts of options are too seldom avail-

The Dimensions of AT: An Approach to Development

(a) A technology designed, developed, or chosen in conjunction with local users to increase their productivity and meet their immediate and longer term needs, without significantly increasing their dependence on outside sources of materials, energy, funds, and knowledge.

(b) A social and political process of integrating better technology into low-income communities.

(c) A style of development which recognizes the fact that the potential users of any technique have significant and necessary social, economic, and technical information and resources to contribute.

(d) A technology that can promote and strengthen local organizations and small-scale entrepreneurs so that they can increasingly assume more control over the choice of improved technology and adapt outside inputs to their own resources.

(e) An approach to designing technology that promotes local economic linkages between low-income users, institutional technologists, local craftsmen and entrepreneurs, and larger scale production.

(f) A technology that will work; that local inhabitants or organizations can afford and continue to maintain and improve.

able to low-income communities. Such "intermediate" technologies are not intended to chain communities to an inferior technique but to increase local incomes and use local resources that can improve over time. The country or community becomes less dependent on outside knowledge. The engineer or agronomist should not present a technological "black box" to a remote village, leaving them dependent on his expertise and reliant on his services.

No technology, even proven ones, can be labelled "appropriate" before carefully explaining why in a particular context what options were considered, and how the choice was made. This is understandably the major omission in most descriptions of appropriate technology as choices are seldom presented for open discussion. The reasons for a particular choice are often hidden within a bureaucracy, or unclear even to the decision-makers.

The Approach to Appropriate Technology — Linking Technology and Users

Approaches to implementing AT depend on the local situation. An ideal case would have well-organized users who have clearly identified the problem and have some proven technologies to choose from. Technical assistance in helping them adapt the technology to their conditions would be forthcoming. They can overcome outside influences which might block them from implementing their choices. What has been termed a "social carrier of techniques"[1] already exists, whether it be a farmer, an agricultural or building cooperative, a village water supply committee, a government agency, or a multinational corporation.

[1] C. Edqvist and O. Edqvist, "Social Carriers of Techniques for Development", *SAREC Report*, R3 (Swedish Agency for Research Cooperation with Developing Countries) 1979.

The reality is that, more often than not, the necessary social carrier does not exist in poor communities, as shown in this book. The case studies focus on the powerless but potential social carriers and their efforts to analyse their situation, acquire technical assistance which will respect the risks they have to take in choosing a particular technology, and promote their efforts in overcoming the barriers in their way. Many of the case studies here are rooted in community development and adult education techniques rather than engineering design.

AT groups now number in the thousands. Some work on specific technical problems in a local context; others promote socio-political conditions that might reduce the power of large organizations to impose choices that serve narrow interests and thwart the development of local solutions. Between these two groups are people aware of the need for sound technical and economic information, yet are also aware of the social and political aspects that ultimately determine choices.

It has been said repeatedly that one of the major constraints in promoting AT, perhaps the greatest, is the fact that different professional biases and bureaucratic structures hinder interaction between all the participants.

Given a specific problem, an engineer will usually ask questions different from those considered by a development economist or a community development worker. The desk-bound bureaucrat will have different perceptions and needs from the peasant in the countryside. As John Kenneth Galbraith said, "Farmers rightly sense that there is danger in the counsel of any man who does not himself have to live by the results." This problem is recognized, a great deal of lip-service is paid to it, but very little is, in fact, done about it. Even the call for "multi-disciplinary" approaches to problems implies a professional bias. This usually excludes low-income farmers from the ranks of professionals. Such an approach is too often divorced from the specific problems of a community whose plight is the focus of all this multi-disciplinary research, has had little input or say in the matter, and hence very little chance to implement these solutions.

Some Questions from Experience

Each case study presented here not only describes an experience, but also asks some questions. How do local people adopt better technologies? What helps or hinders this process? What style of technical, economic, or political assistance will help them? Can the organization or individuals at the local level control the choice of technical options?

Are the usual requirements of AT (low cost, labour intensive, local resources, and so on) really sufficient to describe the full dimensions of choosing technologies that support local development? Who is the AT expert? Is the dictionary definition of technology itself sufficient to describe what is happening in many of these case studies?

The answers to the questions have to be analysed in a specific situation; global generalizations are risky and misleading; many questions remain unanswered and unasked. The images of the development process presented here are much more intimate than the computer-enhanced photographs from satellites 900 km above the Earth[2] or the images at international conferences of development "experts". The case studies here focus on communities and "technology with a human face".

One case study from Tanzania shows that indigenous blacksmiths, who have always produced good farm implements, have until recently been excluded from

[2] See for example, "Economic Development", *Scientific American*, September, 1980.

rural development plans. The immediate problem is not to provide better workshops for them, but to change attitudes which dismiss their knowledge and products as backward, and to provide them with steel. In Canada, a remote Indian community is waging a long struggle to organize itself, do its own research, and install a more appropriate technology than the one imposed on it by the government. The community chose to hire its own technical consultants to help find technical options and negotiate with the government. Part of Cairo's garbage is effectively recycled by a low-income minority group operating in a sensitive social balance. Proposals to introduce "improved" waste disposal technology without an understanding of existing solutions could make this group even worse off. In Indonesia, potential users found a number of small-scale technologies neither reliable nor suitable, despite the fact that they had been labelled "appropriate" by outsiders. AT organizations in Papua New Guinea, the United States, and Ghana have developed a network of services to assess, design, deliver, and fund small-scale technical options that local people can choose from. In Lesotho the success or failure of some village water supply systems is based more on village and national politics than on providing suitable hardware. A rural development scheme in Newfoundland using intermediate-scale fishing boats will not be effective until traditional fishing techniques are revived and all sizes of boats share access to the limited stocks of fish. The other case studies amplify the basic premise of AT: people must find suitable assistance which will support their own efforts to adopt and control their choices in technology.

A Women's Toilet, Nepal

B. R. Saubolle[1]

In a walled-off space, about 250 meters square, on the outskirts of Patan near Kathmandu, Nepal, 900 local women came every morning to answer the call of nature. There were no cubicles, no doors, no water, no seats, no flooring. The place had served its purpose for ages, the accumulated filth was knee deep in some spots, and the stench was appalling! Women using this "toilet" lifted their skirts just high enough to keep them above the dirt, cautiously stepped into the mess where it was not too deep, and did their business as best they could. Then, just as cautiously, they stepped out of the area, crossed a pathway and went down to a stream to clean themselves. They did that day after day, year after year, because there was nowhere else for them unless they sat out in the open.

In 1976 a foreign volunteer working with the local Department of Agriculture decided to try to improve the situation. He proposed a biogas digester be installed, using human wastes as input to produce biogas (60-70% methane, 30-40% carbon dioxide) and organic fertilizer. A plan was drawn up to clean the area thoroughly, dig a deep, circular pit 5m deep and 4m in diameter, install a floating drum for gas collection, and pipe the gas to eight or ten nearby houses for cooking. The plan also included 18 cubicles backing on the pit to be neatly built with cement floors and squatting plates. The waste would be taken in pipes, one for each cubicle, to the bottom of the pit. Clean municipal water was planned for washing.

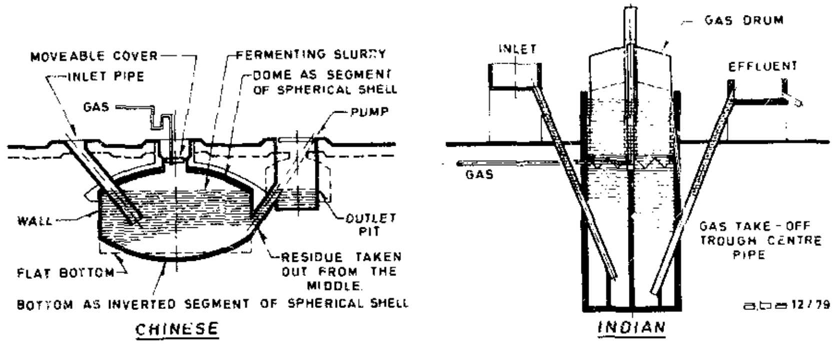
The women, delighted that something was finally being done to help them, gladly bore a lack of toilet facilities in the hope of soon obtaining a clean, hygienic toilet with the added bonus of cooking fuel. For the Agriculture Department it meant a constant supply of good, well-digested manure.

During the construction, curious women were always around watching, commenting, smiling. While the cubicle doors were being attached, there was a protest. Who wanted doors? They were utterly unnecessary! And what a strange idea to separate one woman from the next with a wall! How could they talk? For centuries they had chatted together as they crouched side by side. So the doors were done away with, and openings cut in the dividing walls to facilitate communication. Finally the women were satisfied and the toilet was formally opened.

The volunteer who designed and installed the toilet/biogas plant had built many cowdung biogas plants in Nepal and had heard of the use in China of human wastes for methane production, but he had no specifications for night-soil

[1]St. Xaviers School, Godavari, Kathmandu, Nepal. Graphics from "Biogas Newsletter", 7, Winter, 1979.

Typical Chinese and Indian biogas plants



biogas plants when he designed the women's toilet. It's not surprising that the toilet was a technological failure.

Shortly after the formal opening, problems appeared. The plant was soon overloaded as women from other areas came to use the new toilet and the number of users was somewhat larger than predicted. The pit volume should have been about 60 litres/person under local conditions where the daily input of faeces and wash water is about 2 litres/person. This estimate assumes a retention time in the digester of 30 days.

The input pipes from the toilets extended almost to the bottom of the pit. Consequently, solid matter piled up in the pipes and overflowed into the cubicles. An attendant had to push it down with a plunger every day. The input pipes should not have extended more than 0.3m below the level of the slurry in the digester.

The steel sheeting used for the gas collection drum was too thin. It corroded quickly and all the gas escaped, but not before it was found that the carbon dioxide content of the gas was too high for combustion.

It is now planned to build another toilet nearly, thus cutting the input in half. It is also proposed to build a men's toilet in the same part of town. If the technological problems noted above are avoided in the new constructions, both projects should be successful.

Further Reading:

Biogas Newsletter. P.O. Box 1309, Kathmandu, Nepal

A. Barnett, L. Pyle, S. K. Subramanian, *Biogas Technology in the Third World: A Multidisciplinary Review.* International Development Research Centre (IDRC), Box 8500, Ottawa, Canada K1G 3H9. 1978.

Michael Crook and Ariane van Buren, *A Chinese Biogas Manual.* Intermediate Technology Publications Ltd., 9 King Street, London WC2E 8HN. 1979.

M. G. McGarry and J. Stainforth, (eds.) *Compost, Fertilizer, and Biogas Production from Human and Farm Wastes in the People's Republic of China.* International Development Research Centre (IDRC), Box 8500, Ottawa, Canada, K1G 3H9. 1978.

The Persistent Blacksmiths, Tanzania

While helping to prepare a development plan for the West Lake region of Tanzania in the mid-1970s, Jens Müller[1] found that farmers were sometimes unable to buy the most important implement in Tanzanian agriculture, the "jembe" or digging hoe. It is an essential tool in a country where about 80 percent of the land is cultivated by hand and costs of importing foodgrains are high. He also came upon skilled rural blacksmiths who forged a variety of implements, including jembes. They too were often unable to obtain such essential materials as scrap iron, charcoal, and hand tools. At the same time the government was considering a number of proposals to develop the manufacture of tools for use in agricultural production. All of these proposals overlooked the existing skills of the blacksmiths.

At the request of the Tanzanian Small Industries Development Organization (SIDO) Müller proposed an alternate program which would use the blacksmiths. His research and experience highlight some questions central to the future of AT and, more important, small-scale farmers and craftsmen in Africa. They are already using the most feasible techniques, given their existing resources and access to markets. New workshops or better techniques will not necessarily improve their situation. Without much wider improvements in their economic environment and development programs, their numbers will continue to diminish.

Rural Tanzania probably has over 10,000 traditional blacksmiths. Not only do they manufacture and repair a variety of farm implements, such as axes and ox-plows, they supply 10 to 20 percent of the country's single most important agricultural implement, the "jembe", or hoe.

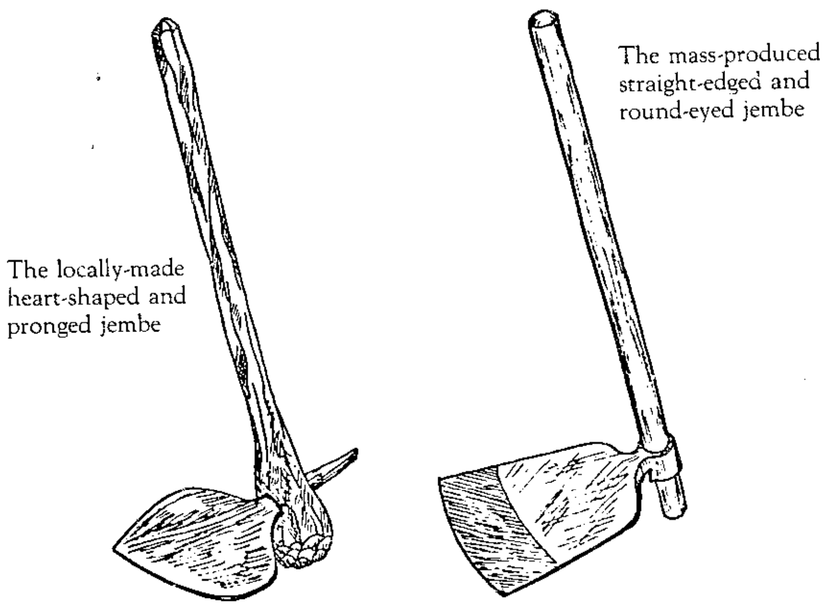
As part-time farmers, the blacksmiths know local soil conditions, crops, and farmers' preferences. Therefore their jembes vary a great deal. The sizes and weights are determined by whether they are used for digging or weeding. A different jembe exists for every crop and soil condition: some are heart-shaped, others in the form of a dish; the former is for hard soil, the latter for soft. In con-

[1]Institute of Development and Planning, Aalborg Universitetscenter, Fibigerstrade II, DK 9100 Aalborg, Denmark.

All quotations are taken with permission from Jens Müller, *Liquidation or Consolidation of Indigenous Technology*; Aalborg University Press, Denmark, 1980 (Distributor: Scandinavian Institute of Development Studies, Box 2126, S-750 02, Uppsala, Sweden). Drawings are by Gyda Anderson.

Fig. 1. Rural blacksmiths sustain a 2000 year-old tradition

Fig. 2. Examples of locally-made and large-scale manufactured jembes



trast, the hoes that are mass-produced by large-scale industry in Tanzania come only in one shape; smiths are frequently asked to modify them (fig. 2).

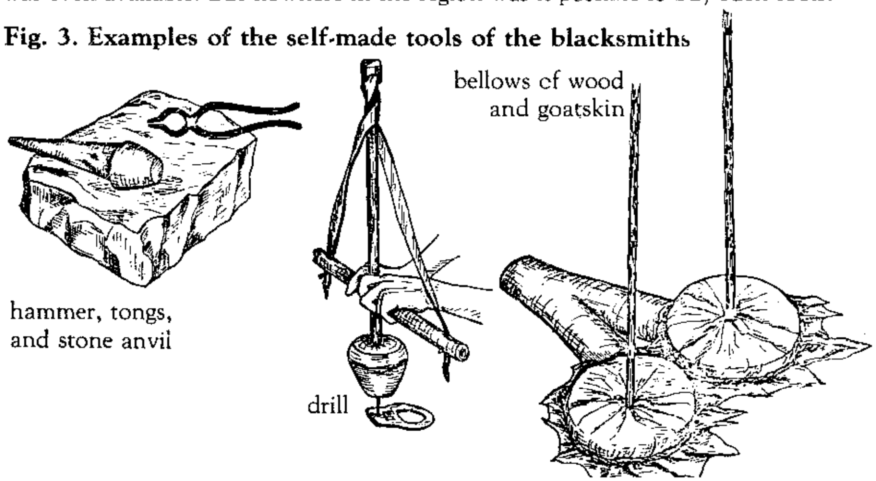
East Africa had a tradition of blacksmithing long before the Arab and European penetrations. During the colonial era, blacksmithing was often actively suppressed in order to promote the use of imported goods, maximize the production of export crops, and prevent the manufacture of guns. Blacksmiths survived because peasants needed their products for subsistence agriculture. However, as Müller writes, an attitude of secrecy and wariness remains as part of the colonial legacy:

> My survey of the smiths' workshops wasn't always easy. Let me give an example of the difficulties. During 1974 I had visited a relatively well-equipped workshop in a village. We spotted it by chance. Wanting to revisit it in 1976 turned out to be a problem. I couldn't remember exactly where it was located in the village. In fact I was first told that there was no blacksmith workshop there any more. "Try at the next village" (30 km away) I was told. After I kept insisting, I was finally taken to a workshop, which looked very shabby and had only a few tools. The blacksmith threw up his arms and complained how bad his business had been for many years. But then we suddenly recognized each other, laughed, and off we went down the hill to his real workshop. This I then recognized, and it looked almost as neat and busy as it did two years before. He confided to me that he had always kept away from "government" as much as possible.

Today blacksmiths still face numerous problems. Steel, new or scrap, is difficult to find. The Tanzanian government has been aware of the value of scrap metal for some time and most of it ends up in a scrap-recycling furnace in Dar es Salaam. Charcoal for forging can be hard to obtain; in some instances, a customer has to provide the charcoal necessary to produce the object he wants.

Smiths produce many of their own hammers, tongs of different sizes, bellows, and drills. The anvil is generally a stone (fig. 3). Only occasionally have the wood and goatskin bellows been replaced by manually-operated mechanical ones. There has been little investment in the improved tools that one might regard as sign of technical change. "In several places the wish to buy a particular tool, for example hacksaws or four-pound hammers, was expressed; the money for cash payment was even available. But nowhere in the region was it possible to buy such tools."

Fig. 3. Examples of the self-made tools of the blacksmiths



Although smiths distribute their products through local market places and networks of middlemen, they have little access to cooperative stores. The blacksmiths' jembes are competitive in price with the centrally-produced hoes, and are of better quality. However, mass-produced items are identical and sold at fixed prices, thus simplifying administration and bookkeeping.

The blacksmiths' technology has largely remained, like subsistence agriculture, at its pre-colonial level of development. Müller's studies have shown their techniques to be efficient; given their existing conditions of production they are already practicing appropriate technology. Their technical expertise could have been a fundamental part of any proposal to promote rural production or repair facilities for agricultural implements:

> The blacksmiths' knowledge is entirely based upon accumulated empirical experience, which has been 'inherited' from one generation of blacksmiths by the next. This knowledge is part of the blacksmith's senses and cannot be separated from him. If you give a blacksmith a piece of scrap, he will first test it. He weighs it a couple of times in each hand, heats it in the furnace and observes how long it takes to reach a certain colour.
>
> Finally, he beats it and looks at the sort of sparks it gives, listens and feels how the iron 'responds' and perhaps he will also smell the sparks. Meanwhile he mumbles, as if he is talking to the steel. After testing it, he knows what sort of steel he is working with, furthermore, he even knows for which purpose this steel is best suited. He cannot convert his knowledge into the percentage of carbon content, but he 'knows'.

In the past these smiths smelted their own iron; it is now completely uneconomic and smelting has virtually disappeared.

Müller found examples of the smiths' ability to innovate when provided with no more than access to an assured supply of scrap steel. For example, one group of village blacksmiths he visited had refined their technique so that they could make ox-plows:

> We left the road network and went about 20 km further along bumpy cattle tracks to reach the place. The group had three master-smiths and six assistants. Their tools were essentially the same as the tools used by the other groups in the survey. But anvil and hearth were raised so that all were standing while working, except for the airblower assistant who was half-way lying down, pedalling a bicycle placed upside-down connected to the air blower. As it turned out we got part of the explanation for why the group had diversified into ox-equipment production: they had an almost unlimited supply of steel scrap from a nearby abandoned goldmine.

It can be seen therefore that the immediate problem is not a lack of technological expertise or potential carriers of improved technology, but of support services, infrastructure, and raw materials.

Infrastructure is the network of services provided largely by the state without which a local economy stagnates. It includes roads, transportation, postal and banking services, energy supplies, and links between local producers, rural shops, and larger-scale industries. The existing infrastructure of Tanzania services the needs of large industries, state farms, and urban areas but not those of rural blacksmiths. Any improvements granted outlying areas are small in relation to those provided to large-scale industry. For example, a bus route might start passing near small industries once a week delivering scrap metal; but at the same time the large industries might have been provided with a railway link, a high-voltage transmission line, and a separate water supply. When faced with this competition, the conditions of production of small industries and their chances of survival deteriorate. Without improved services (not necessarily a capital-intensive undertaking) their outlook is grim.

Müller adds another dimension to the problems faced by craftsmen: a prevailing ideology hidden in development planning dismisses these craftsmen as "lazy, crazy, and backward" and their products as unskilled. Without changing these attitudes, there is little hope that the blacksmiths will survive, let alone improve their present contribution to agricultural production. Müller believes that if they disappear, subsistence agriculture will probably suffer.

Tanzania is moving slowly toward more mechanized agricultural production and World Bank studies indicate that a mix of hand and oxen cultivation methods is the most feasible policy for the immediate future. The potential contribution of existing blacksmiths has been largely overlooked by development planners. Müller does not suggest that their technology be preserved, as in a museum, or that it is the only way to produce hoes, but that conditions be provided for it to gradually develop more diverse products and operations such as tractor repair. Nor does he recommend that the smiths be the only means of producing farm implements. However, given their close connection with existing farming methods, they form the best base for serving rural areas in the near future.

In the mid-1970s a number of rural industrialization proposals were put forward by various international and Tanzanian development agencies.

> . . . the reports all contain narrowly defined analyses. Yet, practically all are trimmed with remarks about the "urgent need" for an "integrated approach." This would have been all right if the various analyses supplemented each other and made up a whole. But this is not the case . . . Some of the explanation for this could be that they all, except (one) have been made by a foreign aid agency, expressly for the purpose of designing some aid project. Invariably they all end up with a project design. Reading the reports, one gets an inkling of competition between (aid) donors, a competition which seemingly results in paralyzing the implementing authorities in the country.

By and large the reports assumed that new village blacksmith workshops had to be established and outside "experts" imported. That existing productive workshops were suffering from lack of raw materials and that new workshops would probably suffer the same difficulties were overlooked.

It is instructive to look briefly at the approaches of these proposals, particularly since some have come from organizations which advocate AT. Listed according to Müller's classifications, they are:

1. **Start-from-scratch**

   This stresses modern methods. It proposes the establishment of government-managed farm implement workshops (at approximately $500,000 US each). Workshops of this kind which have been set up in Tanzania face distribution problems and under-utilized capacity. Village blacksmiths are still ignored.

   > At present there is no worthwhile village or small-scale industry which can undertake manufacture of hand tools and manually-operated machinery in appreciable numbers. Due to the conspicuous absence of the traditional artisans and basic workshop tools, with the existing skills and

resources, only very limited quantities of crude hand tools of poor quality can be manufactured.

2. **Over-boasting**

As in the previous approach, this assumes that the blacksmiths are unimportant, producing axes and jembes that are "crude but improvable." It is proposed that each of the approximately 6,000 villages in Tanzania require a new workshop, extension services, and expert advice. If one percent of the Tanzanian budget for development were devoted annually to this plan it would take about 100 years to reach all the villages.

> We are thus faced with a typical case of . . . an idea being spoiled by expanding it into near impossible financial and administrative dimensions. The idea is consequently easily abandoned.

3. **Thorough-direct support**

Lack of skill and new product designs are seen as the immediate problem. It therefore recommends investment in one large cluster of workshops, costing about $800,000 US, to provide training and develop new products.

4. **Start-below-scratch**

This proposes that rural industrialization has to start "with virtually nothing, except men and the things that they find around them." There is no recognition of indigenous technology. Details are given on how to make simple tools and agricultural equipment in 225 pages of instruction written in a foreign language. This approach might be worthwhile in situations where metal-working has never existed or has disappeared entirely.

5. **Cart-before-the-ox**

This proposes the establishment of village technology demonstration centres. After learning prototype products from the demonstrations, people can return to their own villages to start their own workshops.

Most of these proposals are highly dependent on outside advice and assistance, and not economically feasible. There is little appreciation of the reasons why existing skills are not as productive or innovative as they could be. In the long run, some of these schemes might be worthwhile either after the existing blacksmiths have been consolidated or in areas where the local craftsmen have already disappeared.

Müller spent several years helping design a program, called "Utundu," to develop the indigenous blacksmith workshops. It approaches the problem of rural industrialization, particularly the production of farm implements, according to the following perspective:

1. Some rural blacksmithing already exists and the blacksmiths, being in direct contact with the market, know best which items to produce.

2. Small-scale production is fully exploited within the existing infrastructure (the blacksmiths are not "lazy, crazy and backward"). Production improvements are not possible without a simultaneous development of this infrastructure.

3. Large-scale industry has to support small-scale industry; for example, by providing raw materials. This would require changes in national industrial strategies.

"Utundu" is the Swahili word for "stubborn", used here in its positive sense: insisting, inventing, and trying again. The program is modest and realistic. The first period lasts five years and costs about $350,000. It is a consolidation phase, designed to counteract a further decline of the trade, and provides direct support to 300 groups of blacksmiths, about one-third of the established blacksmith population. During this time access to raw materials is established. Only after the blacksmiths form groups and have assured support will they be able to progress to the mastery of new techniques and products, which makes up the second phase.

The most obvious departure of Müller's proposal from previous ones is that no technical assistance, training, or new workshops are to be provided in the first phase. The program proceeds at the pace of the infrastructural support. He feels it would be a waste of investment resources in the first phase to provide equipment, techniques, or new designs dependent on external advice or input not readily available.

The existing workshops would be roughly classified according to the type of tools they use and what they produce (figs. 4, 5, 6). In the first phase the simplest workshops would be supported so they would continue to make and repair their existing products, integrate their activities, and strengthen their existing links with small farmers. Outside assistance would be catalytic, not a method of controlling the craftsmen's production process.

Fig. 4. Examples of possible products of a type C workshop

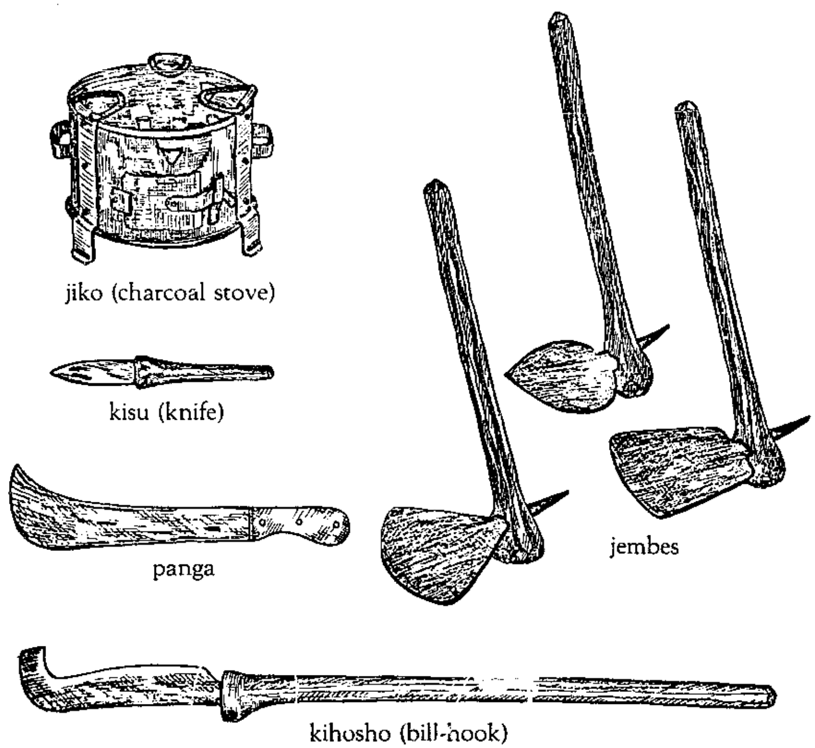


Fig. 5. Examples of possible products of a type A workshop

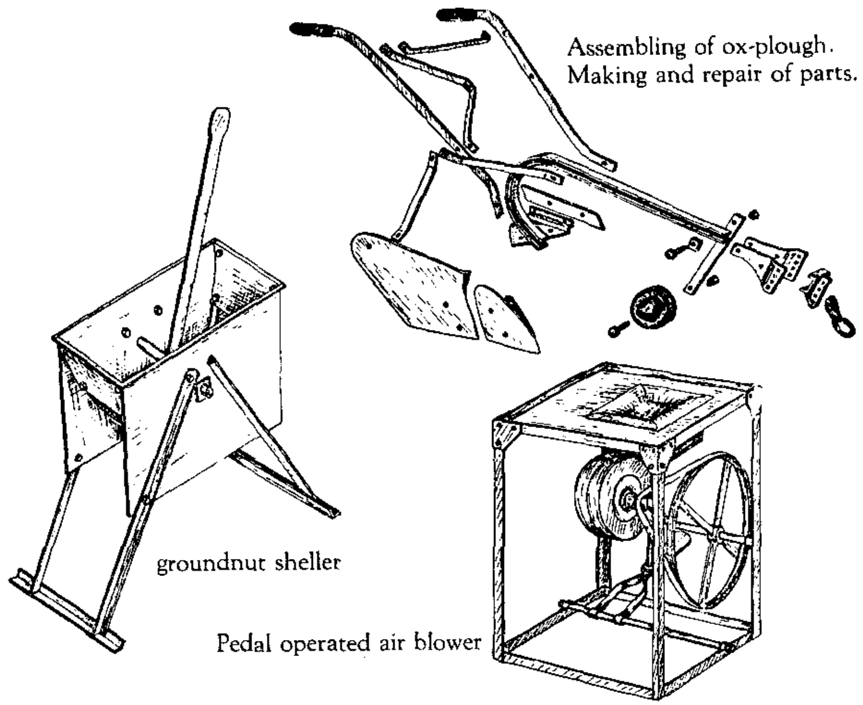
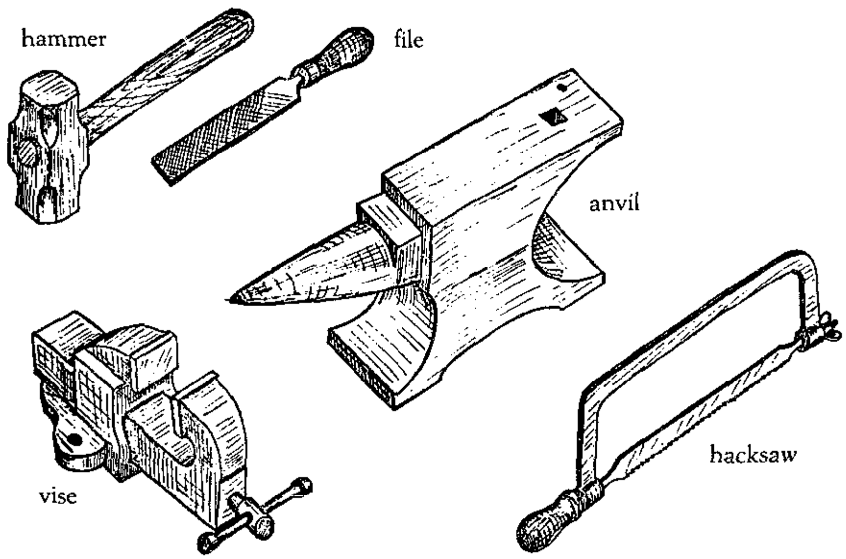


Fig. 6. Examples of tools proposed for type C workshops



With assistance from an international industrial development agency, the program was initiated by SIDO in 1977. Over two years later Müller assessed both its status and its prospects for the future; neither are particularly clear nor optimistic.

So far there has been no arrangement for the delivery of raw materials to the smiths. The implementing authorities have requested feasibility studies of a model blacksmith's workshop to determine profitability even though the smiths can determine this themselves.

The program is straying from its original philosophy. The development agency has assigned an expert in industrial engineering to the program to "teach the blacksmiths how to use the (simple) tools delivered":

> Most technical extension service experts invariably end up behaving as instructors, and in the hope of helping the poor ignorant people as much as possible they often start ordering all sorts of tools and machines for the programme. If this happens, we are moving into a start-from-scratch/over-boasting/thorough-direct, "I-tell-you-what-to-do" approach, which under no circumstances benefits the blacksmiths nor in the last resort the peasants.

If the experts are needed at all they should be concentrating on getting steel to the blacksmiths and new markets for their products.

Fig. 7. A master smith and his assistant

In the future there will be increasing competition between the rural smiths and larger-scale government hoe factories, with accompanying competition for scrap metal. It is not certain that the rural infrastructural support will be forthcoming; larger factories and agricultural estates still get priority. Also, there is little coordination or cooperation between the government agencies in charge of large and small-scale industrial policies, particularly when large industries are requested to supply semi-finished steel to the blacksmiths.

Despite the fact that the blacksmiths are already answering an agricultural need, and could be a basis for rural industrialization, their future is bleak. Economic forces have replaced the direct suppression of the colonial era. Müller argues that although the Utundu program is economically and technically practicable it is not socially or politically feasible. He also finds that programs such as Utundu are simply not compatible with the present organization of production in Tanzania and it is impossible for development agencies to execute programs not based on the conventional approach of bringing in foreign experts.

Müller attempts to shatter the belief that one can actually choose and implement a so-called appropriate technology when under existing conditions local producers are already using the most feasible technology. In the immediate future as well, they will not need better techniques.

Many initiatives in AT focus solely on new techniques without questioning the existing conditions of production that hinder the evolution of existing techniques. The Utundu program addresses this and reveals some contradictions in implementing rural technology, given existing development practice in Tanzania.

Designing With Users: Developing the Lorena Stove, Guatemala

Donald Wharton[1]

The Lorena cookstove is one appropriate technology that is gaining acceptance in rural households in Central America. Most of the printed information on the stove is of the "how-to-build-it" variety. This is necessary, but often insufficient for people introducing woodstove projects elsewhere. The particular materials or the local craftsmanship used is not always available. What is more important than the technique itself is the design and diffusion process described in this case study. This process is more universally applicable than blueprints showing how to construct better stoves.

The mud cookstove was originally developed by the personnel of the Choqui Experimental Station, a small independent organization dedicated to promoting culturally appropriate technologies in the rural highlands of Guatemala.

An open fire surrounded by three rocks as pot supports has been the cooking method for generations of peasant families. In the morning the countryside is a landscape of houses serenely wreathed in smoke, but inside the houses smoke is a constant harassment and a danger to health. The incidence of respiratory disease and eye problems is high among women.

In rural Guatemala, as in very many other countries, the primary source of cooking fuel is an ever-decreasing supply of firewood. Over 70 percent of this country's six million cubic meters of annual wood harvest is cut specifically for cooking purposes. The demand for wood in a region with the densest population in Central America has led to serious soil erosion of the loose volcanic soil. Erosion, however, is not considered the primary problem by the people who are more concerned with the high cost of wood. The average rural family in 1978 spent approximately one-quarter of its yearly income on the purchase and transportation of firewood.

[1]Formerly at the Choqui Experimental Station, Quezaltenango, Guatemala; now a consulting engineer in Calgary, Canada.

Supplemented with information provided by the Aprovecho Institute and Larry Jacobs. Drawings are by Michael Boutette.

The development of the Lorena stove (a contraction of the Spanish words for mud and sand) responded to this energy crisis by providing a more efficient alternative to the traditional method. Other options included expensive cement stoves, topped with cast-iron plates, which consume more wood than an open fire, or kerosene burners.

In 1976 women complained to the Station about the increasing expense and smoke of the open fire cooking methods. Several members of the Station undertook a six-month project to build and test prototype stoves on a research budget of only $1,000. Design constraints were largely self-imposed by the team: cookstoves should be more fuel efficient, smokeless, very inexpensive, and built from local materials with local technology. A stove of mud was chosen because it fitted well into a culture using sophisticated adobe technology, and the designers were aware of similar mud stoves in both India and West Africa.

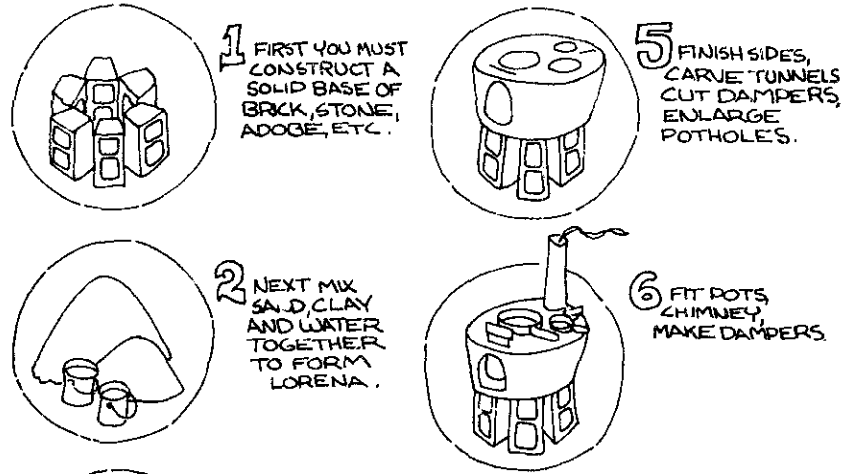
The design program followed a plan used with some success by the Station on prior projects. First, a number of experimental models were constructed according to the design constraints. Then the stoves were shown to the large number of visitors for comments on construction and use. The stoves were then refined on the basis of these comments, and several of the better models were selected for field trials. For example, the first design was a low floor model which local women were invited to try. They were polite, but uninterested. After several changes they finally provided some definite feedback. One woman demanded to know why they were trying to make a stove on the floor. "We women are no fools," she stated. "We know that a stove is higher than that." So the next models were made between 75 and 90 cm in height, and the women showed more interest on the next visit.

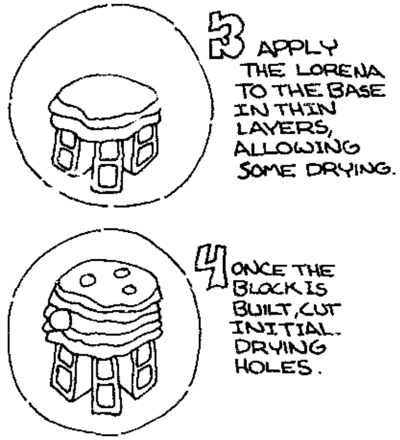
The evolution of the design was characterized by field experimentation rather than a strictly scientific approach of measuring such factors as temperatures and heat loss, which would have required more instrumentation and time than was available to the designers. (Also, there is still some controversy on methods of testing woodstove efficiencies.) The versatility of the mud/sand mixture allowed the designers to excavate the fire box and pot holes out of a block of this material instead of building up a structure around frames or forms (fig. 1). Therefore, new models and design changes could be made quickly during the development stage and tested against each other. Experimentation with firebox shapes, flue sizing, and burning efficiency was done while cooking with the stove. Improvements which reduced the cooking time for a pot of beans, for example, or which used less firewood to boil a litre of water, were adopted. Flue sizes were determined not only by how well and how long the fire would burn, but also by what sizes of chimneys were available from local suppliers.

There is no exact formula for the "correct" proportions of sand and clay in the Lorena mixture. Constructing stoves from such materials requires considerable practice and local experimentation to obtain a mixture which will not crack. Additives to strengthen the material such as cow dung, a mud binder used worldwide, and rice husks have been successful elsewhere.

The stove itself consists of a block of clay and sand mixed together with water which is supported by adobes, blocks, or any other locally available solid base (fig. 2). The tools required to build a stove are a hoe or shovel, a large knife, and a spoon for excavation. The stove design is basically a firebox with internal tunnels to the pot holes on the top of the stove and the chimney. The pot holes are formed by carefully fitting various sized pots into the body of the stove. The

Fig. 1. A Simplified Look at Lorena Stove Building





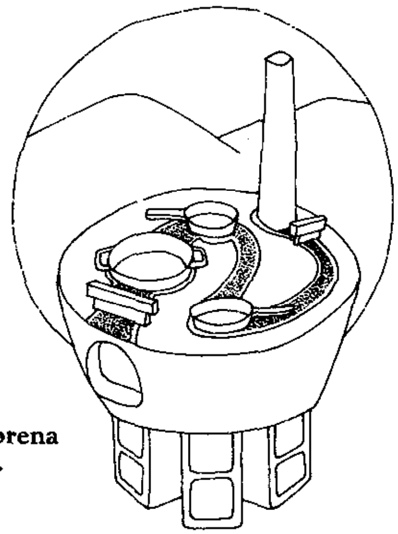
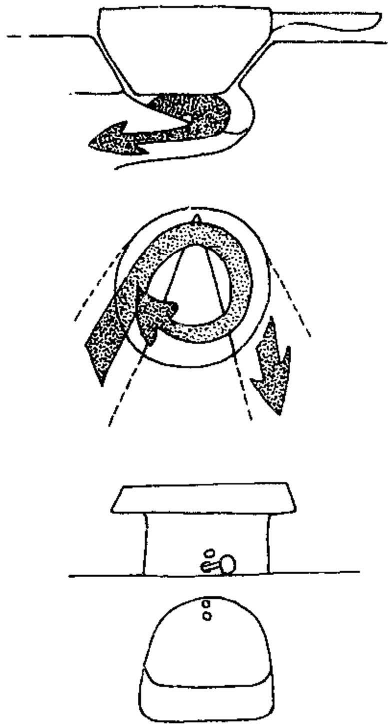


Fig. 2. A basic Lorena cookstove.

perfect fit ensures that little heat or smoke will escape. Heat is controlled by means of vertical sliding dampers of sheet metal (fig. 3).

Since the fire is enclosed in a massive brick-like structure and the induced draft can be controlled, more heat goes directly to the pots. Moreover, slow-burning fuels such as sawdust and other wastes can be substituted for wood once a wood fire is started.

Fig. 3. Stove Details



Side view of pothole showing tight fit of pot. Shape of the bottom of the tunnel forces hot gases against the bottom of the pot while spreading the heat out across the bottom.

Top view of pothole which shows that decreasing the angle between the inlet and outlet to the pothole creates a vortex which keeps the heat under the pot longer.

Front view of the firebox illustrating the simple sheetmetal damper controlled by a nail placed in a hole in the damper itself.

Efficiency tests were conducted in local households on a 24-hour basis over a one-month period by a Station member who lived with families during the testing. Three local women who had been using the Lorena stove for a month were asked to return to using the three-rock fire for two weeks. By estimating and comparing the true volume of wood used during this period with a subsequent two-week period using the Lorena stove, and bearing in mind that the efficiency of any low-cost wood stove is largely dependent on the skill of the user, it was calculated that wood consumption with the Lorena decreased by about 35 percent compared to the three-rock fireplace. Other tests using similar methods (though not on a 24-hour basis) at the Station indicated savings of up to 50 percent.

To a technician in a well-equipped research centre these testing methods may not have much scientific validity. Such factors as the varying moisture or energy content of woods and the actual efficiency of the stove (percentage of available wood energy converted to cooking energy and space heating) are not accounted for. However, theoretical results are frequently unobtainable when the stoves are used in low-income households and the results of the Station's tests indicate significant monetary savings to local people — one of the criteria of any new technology.

Local families saw the stove as the answer to a recognized problem and adopted it quickly. It was built from familiar materials, easily maintained, and, perhaps most important, was easily understood. The low cost of the stove played a large part in its rapid acceptance. Station members originally calculated that the cost of a stove was approximately $4 if the clay and sand were free and families built their own stoves. In many locations, however, suitable sand or clay was not locally available. A more accurate average cost of materials, considering transportation, may be $10.

About two to three days of labour are required to build and finish a stove. Some maintenance is also required to fill cracks which may occur and to replace the chimney about every three to four years. The life span of the Lorena mudstove is not yet known. The best models have been operating continuously for three years without signs of breakdown.

Stove users perceived different benefits. Many considered the savings in firewood to be the principal benefit. The amount of money spent on wood has been reduced by about $4 to $5 per month, a large portion of the local monthly income. Other benefits were generally secondary to the wood savings, and included the following:

1. Ease of cooking. Many people stated that the fire required much less attention than an open fire; for instance the fire would not go out easily and required little fanning. The raised Lorena stove also allowed the cook to get off her knees, handle the pots without risking burns from the flames, and place the pots without worrying about them falling over.
2. Decreased smoke. Smoke was greatly reduced or eliminated completely in all cases. Women often commented that they enjoyed cooking more without a constant haze of smoke and tears.
3. Hygiene. The raised platform kept dirt and animals from getting into the food.
4. Safety. Because the pots are almost completely enclosed by the stove body, there is little danger of small children spilling boiling food on themselves. Many people considered this a very important feature.
5. Cost. The low cost of building the stove made people feel confident about constructing them.

A more general benefit was the emergence of local artisans who became proficient at stove construction and created small enterprises in a number of villages. Even among the rural poor, people were frequently prepared to hire a stove builder for about $15 who, in turn, would provide all the materials and build the stove. In some cases, these entrepreneurs gave courses in the villages on stove construction techniques. The introduction of the stoves also provided an opportunity for government health workers to discuss home hygiene, nutrition, and health care.

One unforeseen disadvantage came to light as more stoves were built. A number of users disliked the stoves which did not heat the house as much as the traditional open fire — an important consideration in the temperate highlands where the night temperature frequently drops below freezing. Some resolved this problem by building separate open fires for warmth on cold nights. Other users said that the Lorena stove did indeed heat the house as well as an open flame. In any event, though most people missed the sight of the fire and its direct heat, the majority felt that this drawback was more than compensated by the savings in firewood and the reduction in monthly expenses.

Despite pressure from various national and international groups to launch an intensive promotion of the stove, the Experimental Station allowed the idea to spread on its own, without being forced. This is not to say that the stoves were not publicized. Efforts were made to build demonstration stoves in different communities, make instructional literature widely available, show the stoves at fairs and public places, and conduct workshops on stove construction. Usually members of a community learned of the stoves by word-of-mouth. Once sufficient interest had been generated in the community, a course was arranged. The Station often provided trained promoters or helped the group contact a person in the area who was proficient in stove construction and could give two- or three-day courses in the villages.

This slow, gentle method of introducing the stove was necessary due to the limited resources of the Station, and beneficial because it allowed individual communities and artisans to adopt a technology, absorb it at their own pace, and adapt it to local needs and preferences. This served to create a strong feeling of participation in the project among the trainees rather than mere passive acceptance.

Certainly some mistakes have been made. The greatest deficiency has been the lack of follow-up by the Station or other trained stove-builders in the communities where stoves had been built or courses given. As with many new ideas introduced into traditional cultures, if the initial technology was poorly built or unused, the sentiment of an entire village could be negatively affected. In one case the stove was rejected because the type of clay was incorrect, and small particles of mud were getting into the tortillas. The initial emphasis was on construction, often the role of the man of the family. Unfortunately, in some cases the husband was excited about the stove but the wife was still unsure. The result, of course, was that there were some well-made stoves which were never used and eventually fell into disrepair. To avoid this, more women are now involved in the program.

The overall popularity of the stove has proven the Station's belief that if the stoves are truly appropriate to the needs of the rural people, then the project will carry on on its own without continued financial or technical support. After three years this goal is now in sight, and the Station is slowly withdrawing from promotion of the stove and is moving on to other programs in appropriate technology.

Further Reading:

Some Performance Tests on Open Fires and the Family Cooker. A report from the Woodburning Stove Group; Departments of Applied Physics and Mechanical Engineering, Technical University of Eindhoven and Division of Technology for Society, TNO, Apeldoorn, The Netherlands. June, 1980.

Ianto Evans, *The Lorena Owner-Built Stove.* Volunteers in Asia, Box 4543, Stanford, California, 94305, USA. 1979. Detailed instructions on construction.

S. P. Raju, *Smokeless Kitchens for the Millions.* The Christian Literature Society, Post Box 501, Park Town, Madras, India, 1953. An earlier booklet on how to construct similar stoves in India.

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Two Professionals: Complementary Skills and Cast Iron Stoves, Afghanistan

Claus Christensen[1]

One case study in the first *Handbook on AT* described three years of work to improve the traditional technology of an iron foundry in Herat, Afghanistan, which produced plowshares. Local foundrymen, in conjunction with a group of Danish engineers, designed a cupola furnace which was more efficient and produced grey cast iron — a more versatile and better quality casting material than the white cast iron obtained previously. With the new technique the foundry could produce a wider range of better quality products at a lower cost.

The new furnace is made from three oil drums lined with refractory clay (fig. 1), and uses a gasoline-powered centrifugal blower. It is charged from the top with coke, limestone, and scrap iron. It can operate at temperatures up to 1350°C, for about four hours, and can hold 1 to 1.5 tons of molten iron. The furnace was recently modified for easier maintenance of the refractory lining.

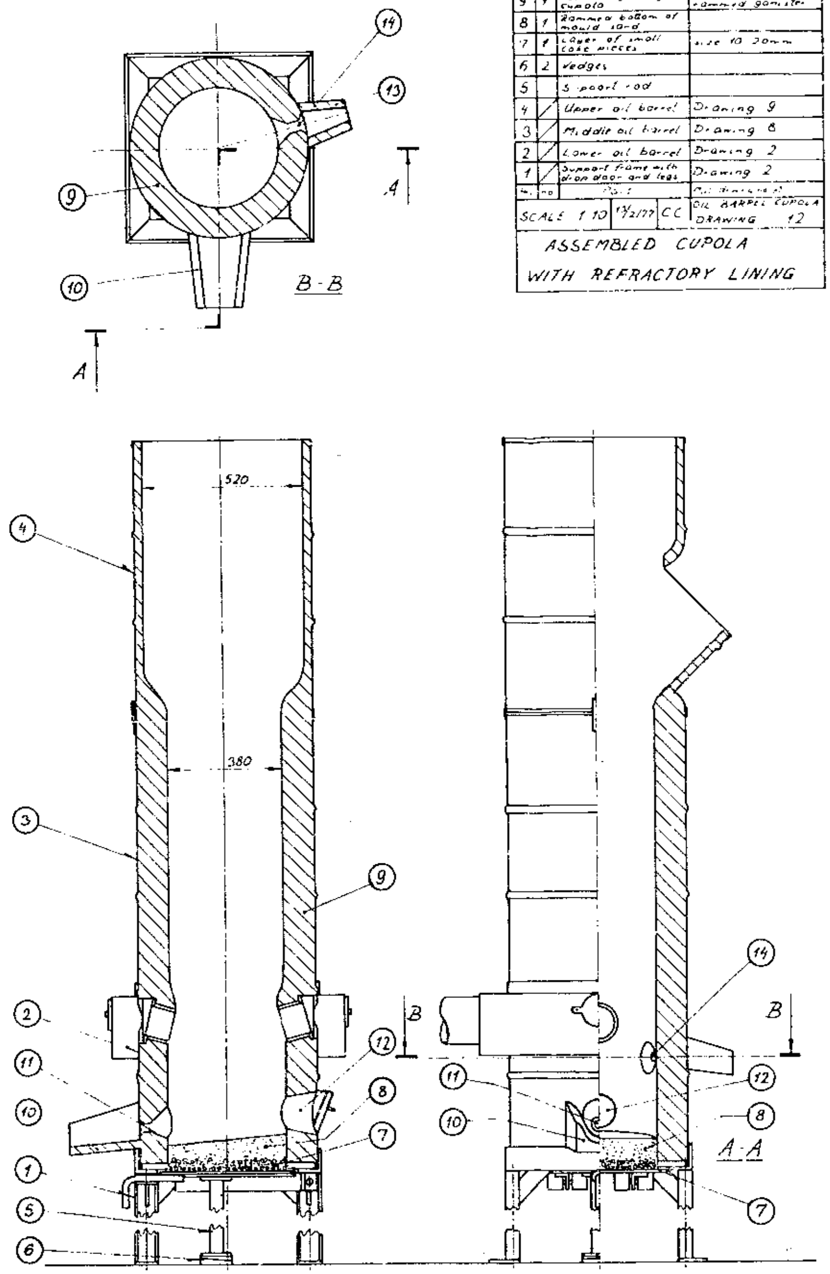
The design criteria heavily emphasized the basic concepts of AT: reasonable costs and close collaboration between the users and the outside advisors — in other words, it was feasible. With the help of a prototype furnace built in Denmark the outside advisors acquired a practical expertise comparable to that of the Afghans and could therefore appreciate the remarkable level of skill required to use this process. A prototype of a large six-man manual bellows made in Denmark proved impractical.

This case study is an example of sensitive technical advice given in the context of the user's reality, not that of the outside advisor. The original case study was terminated only after initial technical problems had been solved and a new furnace constructed.

Now, after another five years of operation, some pertinent questions may be answered: Did the design really prove itself in practice? Did the foundry fulfill its potential to produce new products? Was the

[1]A consulting engineer, Virum, Denmark.

Fig. 1.



14	1	Slag hole in refractory lining	Ø 30mm
13	1	Refractory lining of slag spout	rammed ganister
12	1	Light up hole in refractory lining	
11	1	Tapping hole in refractory lining	Ø 25mm
10	1	Refractory lining of tapping spout	
9	1	Refractory lining of cupola	Bricks (chamotte) or rammed ganister
8	1	Rammed bottom of mould sand	
7	1	Layer of small coke pieces	size 10 20mm
6	2	Wedges	
5		Support rod	
4	/	Upper oil barrel	Drawing 9
3	/	Middle oil barrel	Drawing 8
2	/	Lower oil barrel	Drawing 2
1	/	Support frame with drop door and legs	Drawing 2
[illegible]	no	Part	[illegible]
SCALE 1 10	13/2/77	CC	OIL BARREL CUPOLA DRAWING 12
ASSEMBLED CUPOLA WITH REFRACTORY LINING			

improved technology adopted by other foundries in Afghanistan or elsewhere?

The results in Herat have been impressive. The Noor foundry now produces a variety of coal stoves, pressure cookers, pots and pans, spare parts for local industry, and most of its own capital equipment. Claus Christensen, the original "rapporteur," has continued to provide informal technical assistance to Mr. Nureddin, the foundry owner, and his sons. His description follows.

I visited the foundry again over three years later in late 1977. I was amazed to see that all the equipment was in working order. The cupola looked well used; more recently a new cupola of similar design has been put into use. Cast iron is still poured from a ladle into moulds set in the ground (figs. 2, 3). Although many of the machines and tools had occasionally broken down, all had been repaired because they were useful and because they could be repaired locally. Nureddin had invested a lot in raw materials, patterns, and new products.

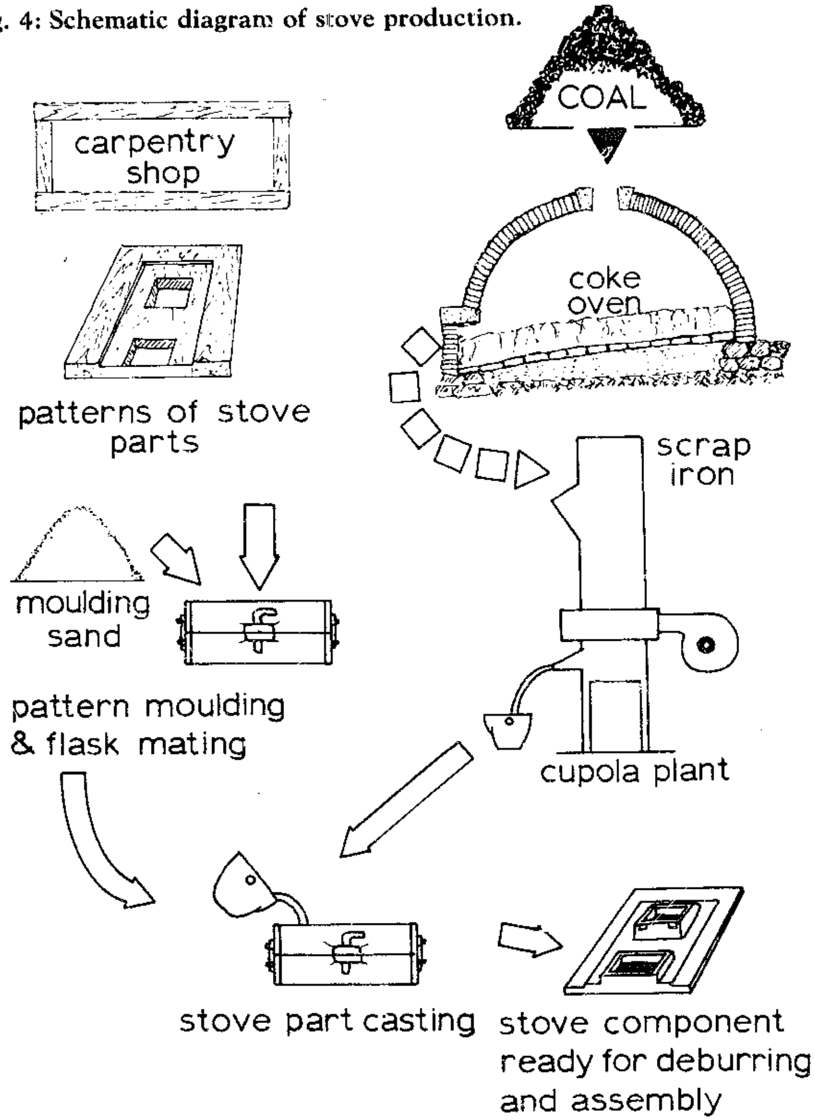
The new furnace is fueled with coke. The traditional fuel, charcoal, will not produce high enough temperatures. Nureddin now has a coke oven made from locally-available brick (fig. 4). He does not produce high quality coke: the local coal is not entirely suitable for this purpose, nor are good refractory bricks available for making ovens; but the coke he does produce is of sufficient quality.

Visually and technically, the stoves produced by the foundry are most impressive (fig. 5). Nureddin was producing four different types for space heating, water heating and cooking — and made about 300 stoves since 1974. These stoves can use local coal which is much cheaper than wood. Deforestation is almost complete in the region. Stoves made of mild steel sheeting, sometimes lined with clay, are also available but they deteriorate rapidly when fired with coal. On the other hand, they cost about one-third of the price of the cast iron stoves.

Fig. 2: Tapping molten iron from the cupola furnace.

Fig. 3: Pouring iron into moulds.

Fig. 4: Schematic diagram of stove production.



The first stove design was done mainly by me during my last stay with them in 1974, but it was based directly on a pattern which his sons had made. Their idea was based on a scrap piece of an old stove, probably Russian. Their design, however, suffered from two major faults: it was too large to make moulds for it with the weak local moulding sand, and assembly of the stove would have been difficult. We improved the design and introduced a new casting technique, using patterns made by a carpenter employed at the foundry. From there, Nureddin has been able to develop and produce three other kinds of stoves, one of which is round.

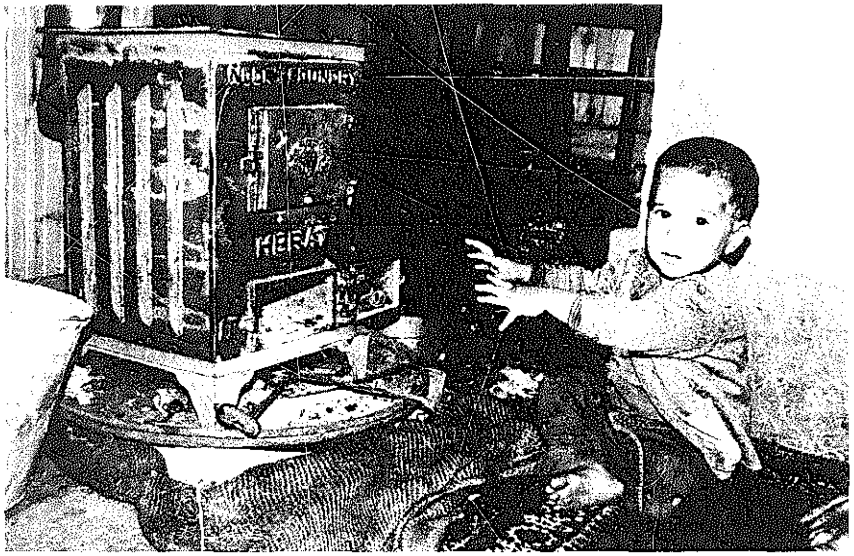


Fig. 5: Nureddin's son and Noor Foundry stove.

All four stoves have one set of cooking rings on top. During my visit in 1977 they showed me a scavenged kitchen stove with an oven and two sets of cooking rings, which they were considering as another new product. This stove had some design mistakes which they themselves could see. I had earlier mailed them some sectional views of an old Danish stove, a better design; however, the drawings I sent were difficult for them to understand. So I made a model out of cardboard; three months later I was informed by mail that the prototype was finished.

Originally the doors of the stoves were made with adjustable screws to regulate the air supply; but this feature was not appreciated by the customers who simply open the door a little. Now the foundry makes the doors with a flower pattern instead.

The stoves have only been sold from Nureddin's own shop in the bazaar of Herat. If he could export to the capital, Kabul, which is very cold in winter, he would have a booming business. A trade connection is not easy to establish. The normal connection would be a trader who personally purchases the stoves in Herat and follows them to Kabul where he himself or his close relatives would sell them.

The production of cast iron stoves which can burn locally-available coal is an important step. Oil and gas are not available at a price most people can afford. I have never had the opportunity to measure the efficiency of the stoves but they burn cleanly when hot, and the combustion looks efficient.

Besides stoves, the foundry still produces plowshares, cooking pots, cast-aluminum pressure cookers, and a variety of spare parts for local industries and the foundry (fig. 6).

Plowshares are now very easy to make; they are almost a byproduct of stove production The iron used is from the beginning of the melt and from what is left over after the stove moulds are filled. In addition, Nureddin sometimes uses his old furnace to refine some poor quality scrap. Because of the long retention time in

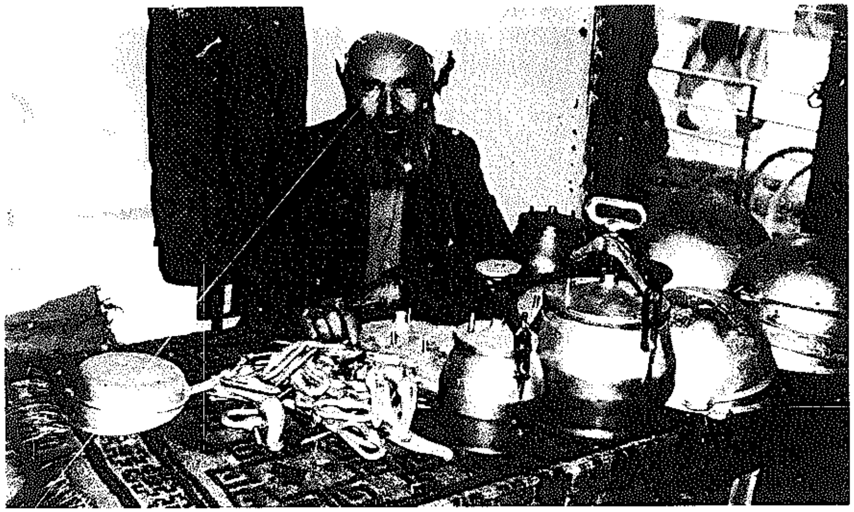
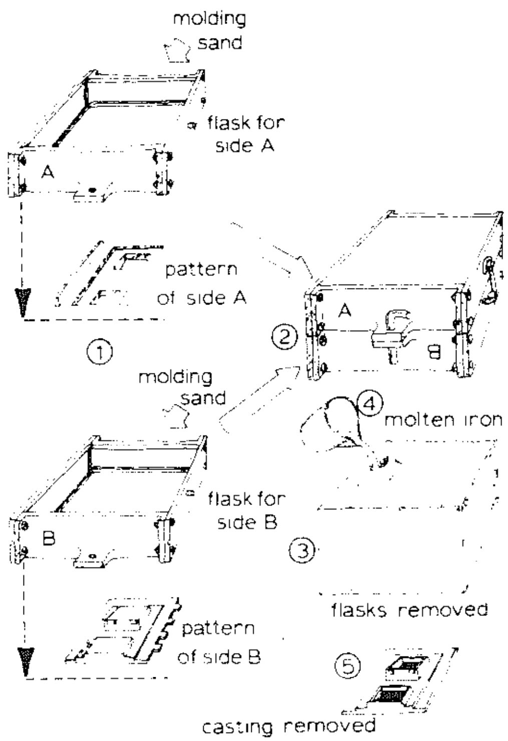


Fig. 6: Nureddin with aluminum pots and pressure cookers.

Fig. 7: New casting technique.



the old furnace he can cast plows, and only plows, from otherwise useless material. In one melt with the old furnace he can produce 500 to 1000 plows. He produces about 3000 plows annually.

The cooking pot shown in your first handbook was made by me in Denmark. Although Nureddin has tried many times, he has never been successful with this very thin iron casting. It is more or less a joke between him and me that he tries, because he does not believe anybody would like the Danish design. The pattern was donated by a Danish pot foundry. To produce aluminum pots he uses mainly aluminum pistons from scrap engine blocks which he melts in a crucible. For the pressure cookers I developed a polishing method in Denmark and taught it to Nureddin by correspondence with success. He also makes rough castings of spare parts for a local cotton factory, which the factory then machines to size in its own workshop.

The traditional technique for making moulds for plowshares was highly developed but it could not be improved without introducing real moulding machines, nor is the technique easily adapted for manufacturing other products. Moulds for pots or mortars were made individually on a rotating turntable, a slow technique not suitable for mass production.

To make new products such as stoves required a new casting technique (fig. 7). We introduced mouldboxes, or iron flasks, which can be made at the foundry, to cast the relatively large and flat stove components. To make the sand mould for one component, a flask is set on a wooden pattern plate forming one face of the component and sand is packed on top. After turning, the pattern can be lifted off without breakage of the sand; this flask is then mated with another flask containing the mould of the other face (fig. 8). Wooden patterns are made in the carpentry shop. Circular patterns such as those for stove cooking rings are made on a pedal-powered lathe and sanding machine (fig. 9).

While Nureddin's foundry has successfully adopted new techniques, his competitors have not adopted either the cupola foundry or the flask moulding technique. One other foundry is using a gasoline-powered blower, made by the same blacksmith who made Nureddin's (fig. 10). A few people who used to operate the hand-powered bellows were put out of work but only temporarily. At that

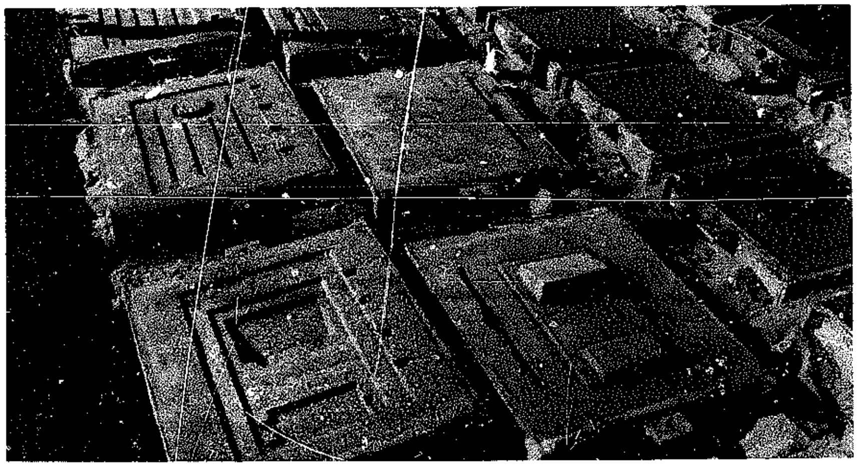


Fig. 8: Sand moulds in flasks before mating.

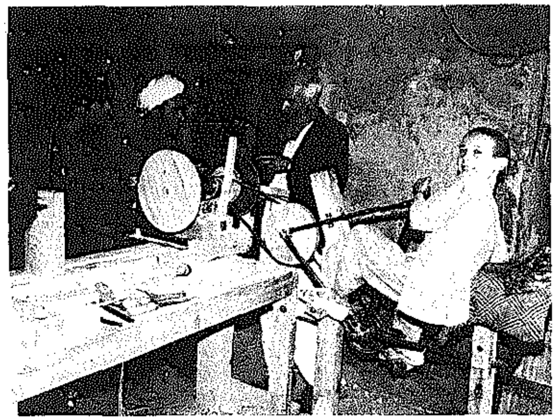


Fig. 9: Pedal-powered lathe and sander.

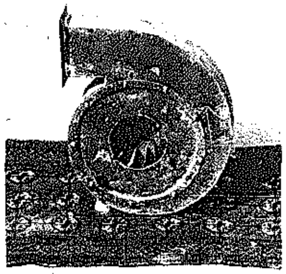


Fig. 10:
Locally-manufactured blower.

time there was very little surplus labour in Herat because of the economic boom in neighbouring Iran.

The man who implemented a blower on his traditional furnace refuses to adopt anything else; but his son frequently visits Nureddin's foundry to discuss new techniques. This is a departure from local tradition where everyone ardently *keeps his "know-how" to himself. Nureddin is a remarkable man who under*stands the transfer of knowledge, and sees traditional attitudes as the main impediment to development. I expect the coming generation to spread the technology. With the exception of some help from one government official, the process of introducing new techniques has been Nureddin's initiative alone.

In other countries, to my knowledge, only one other cupola of our design has been introduced. This foundry, a cooperative with the support of a small industries development organization, installed a cupola furnace. They had access to much more equipment than we had in Herat, and claimed to be experienced and were highly educated, but the foundry is now closed. This project was heavily dependent on government officers for advice and funding; their experience with mould-making was inadequate and they could not organize themselves for mass production. There have been other requests for information on the design of the cupola foundry but its capacity was too large for the intended use.

In retrospect, the success of the new techniques in Herat rests mainly on Nureddin's enthusiasm and his skills, both with techniques and people. These abilities have to be present before such a project is started.

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Development Workshop: A Local Catalyst, Iran

Julia Williamson[1]

For the last seven years the Development Workshop, a group of architects, town planners, and researchers, has been concerned with shelter and settlement needs in Asia, Africa and the Middle East. Working with local builders, they help improve local materials and methods for setting up small-scale building industries such as lime and brick kilns, and implementing building and planning projects.

The efforts of the Workshop are guided by the following general perceptions:

1. Indigenous housing systems are being neglected, if not actively undermined. Since traditional systems are outside the international market economy, they cannot compete with the large construction firms which create a market by discouraging self-reliance.

2. Local people have the best understanding of their own areas, even though they may have difficulty articulating this.

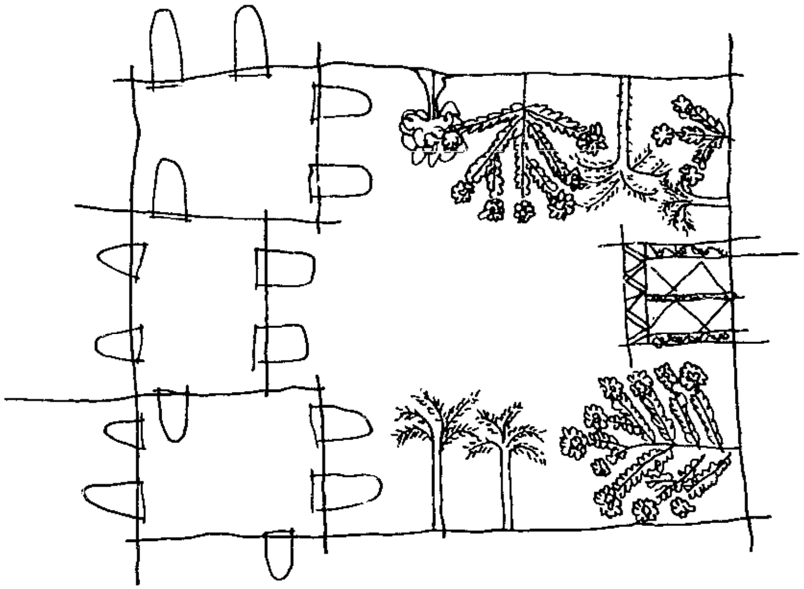
3. Where locally available answers to a particular problem are unclear because of changing conditions, one should look at solutions arrived at in similar socio-economic and environmental conditions.

The experiences of the Workshop in Iran, described here, demonstrate its catalytic methods of encouraging self-reliance.

In Iran, over the last few decades, a disproportionate amount of investment went into urban rather than rural areas. One result of this was a vast discrepancy between regions in available education, medical care, employment, services, food, and energy suppliers. With the migration of workers to cities, the passage of legislation allowing only registered contractors (usually urban based) to construct public building projects, and a heavy-handed government policy of capital intensive development, indigenous methods of building were disrupted. Local materials such as mud brick, an excellent insulator against extremes of heat and cold, were ignored in favour of expensive concrete and steel generally imported to Iran. In the north, metal sheeting replaced roofing tiles, creating unemployment at the kilns. Throughout Iran, the traditional narrow streets which protected inhabitants from sun and wind were ripped open by wind-swept boulevards which offered no shelter from the elements.

[1] A member of the Development Workshop. Drawings are by Allan Cain.

Fig. 1. Village builder's drawing of his house



In 1974, the Development Workshop was invited to participate in the large Selselsh Integrated Development Project in the mountainous western province of Luristan. The majority of the province's inhabitants, the Lurs, had a short history of permanent settlement and their agriculture, building, and settlement planning were not highly developed. While their nomadic tents were skillfully designed, their permanent housing was of extremely poor quality. The ambitious project sought to improve public health, literacy, agriculture, roads, water supply, building, and planning, with Development Workshop involved in the latter two.

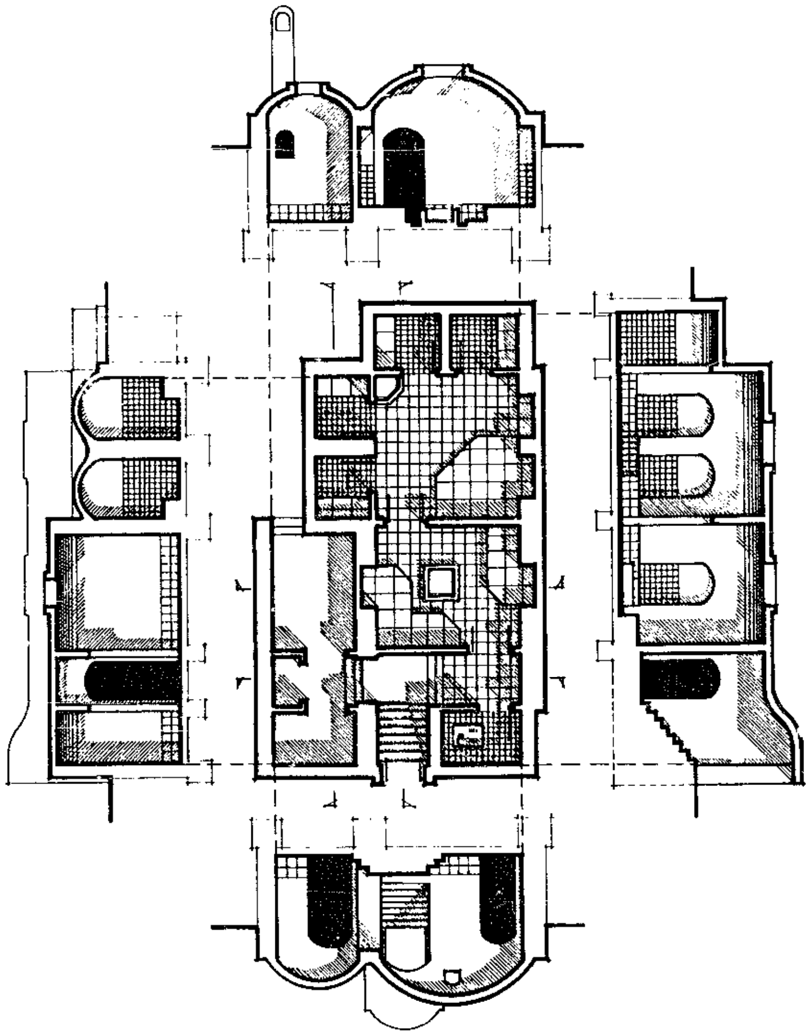
Development Workshop researched local techniques, assessed the potential for development, and decided what could be done at regional and village levels. The Workshop decided that the following should be established to develop self-reliance and keep capital within the region:

1. A building team to do contracting on a cooperative basis with local labour.
2. Small industries such as kiln manufacture for making bricks and lime.
3. A building team to handle community projects such as schools and clinics.

Training was directed to that group of men who, in the relatively short period of permanent settlement, assumed the task of building for other villagers.

These men were generally from a landless class of the area. In a society where land is the prime investment and the only security, these people represented one of the poorest economic classes of the community and had little technical specialization. Despite their lack of skills, however, they were able to identify the problems and resources of the area, and the appropriateness of suggested solutions.

Fig. 2. Village Bathhouse: Drawing technique adapted from local technique



Training was assisted by traditional master builders from central Iran, where vault and dome building is among the most technically sophisticated in the world. Kiln-fired and sun-dried mud bricks were their basic material.

Development Workshop acted as a catalyst between the two groups. In the winter of 1977 when the project area was snowed in, they organized a training workshop in the desert city of Yazd. This city maintains an active tradition of building which still responds to today's needs. As well, Yazdi master builders had been employed in Luristan in public building projects so a precedent for a "technology transfer" had already been set. Discussions took place indoors in a makeshift classroom, while an outdoor yard was used for testing and practising.

In the chilly mornings the builders sat in discussion around the classroom stove. The workshop leader made an effort to draw out even the most reticent participants.

In the afternoon different designs for such things as arches and foundations were taken out to the yard, constructed, tested, and compared. In this way, the builders tested a variety of techniques that they could adapt independently in their own work and continue to improve upon. The evenings were devoted to literacy classes which incorporated the building terminology encountered in the daytime technical sessions.

Early in the instruction a cross-cultural problem emerged: how could the villagers, master builders, and Development Workshop members communicate ideas? Each had different methods of designing buildings. The village builders did not use drawings. The master builders only used graphics to show the intricate patterns of their tile and brickwork, but not the form of the building. Development Workshop used modern drafting plans, sections, and elevations. Some standard practice was needed, particularly if the local builders were ever to compete for commercial contracts. Modern techniques had to be adapted to local drawing skills and perceptions.

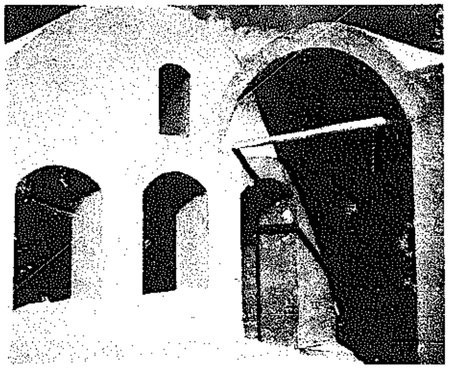


Fig. 3. Mud Brick Vault and Dome Housing, with Wood Tie Beam

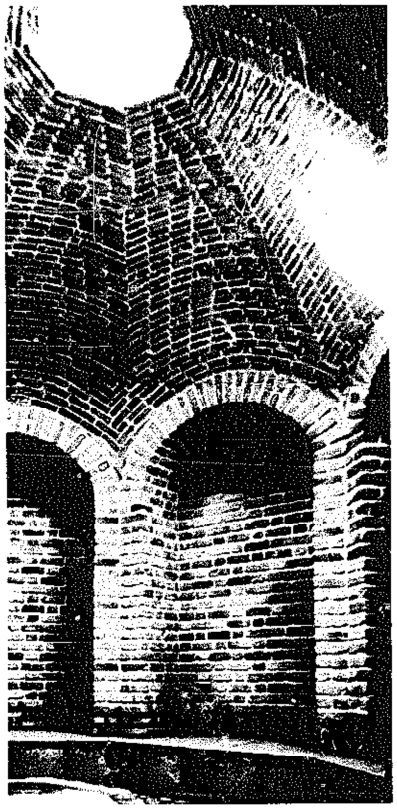


Fig. 6. Interior of Village Bathhouse

The village builders were asked to draw their houses and all produced the same sort of drawing (fig. 1), a combination of a building plan and elevations of doors, windows and trees, as if these were folded flat. There is much more emphasis on the main door, the courtyard space and trees than on the physical structure. One can view this drawing from any direction; there is no top or bottom. This drawing technique reflects the way in which buildings are designed in the project area: customer and builder walk around a building site, roughly sketching the form on the ground. Construction details were not drawn, they come out of the builder's head. Likewise, the trainees could sit around a sketch and discuss it, unlike the modern draftman's drawing which can be read from one side only.

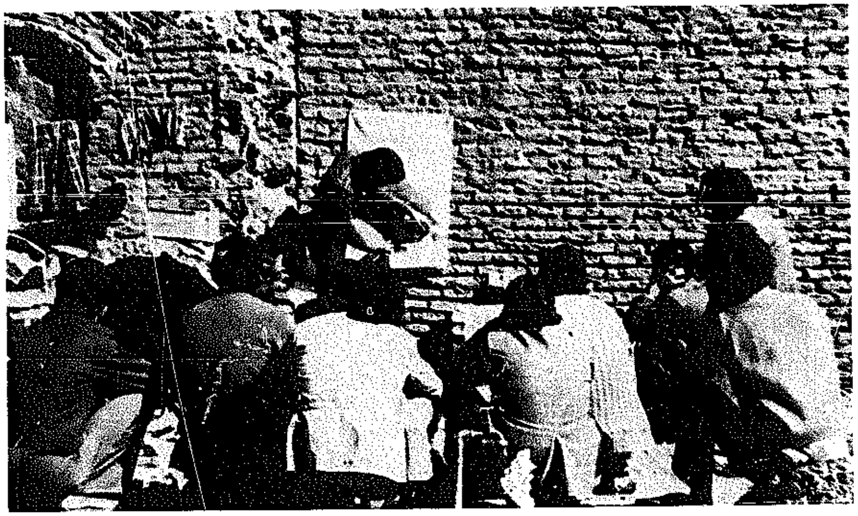
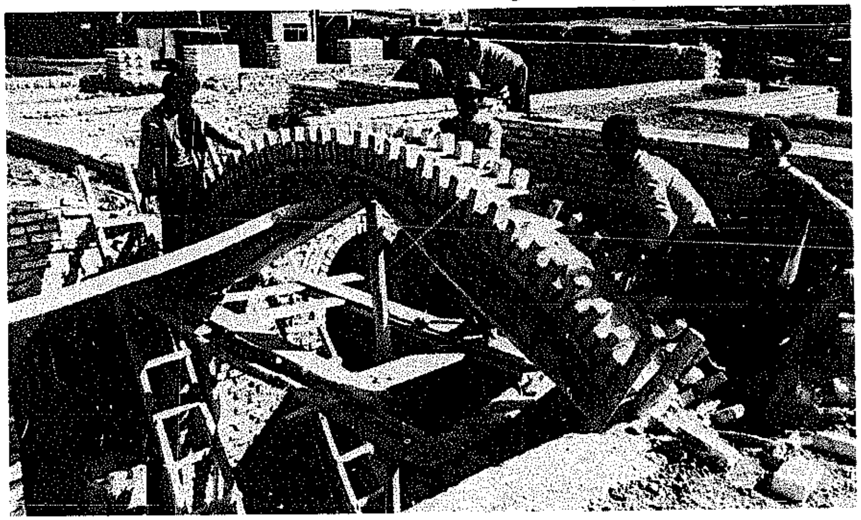


Fig. 4. Workshop discussions and training

Fig. 5. Building a Community School



Development Workshop combined the local approach with more formal drawing techniques (fig. 2) for a village bathhouse later built by the workshop participants. Four sectional views are folded out from the plan drawing in the centre; like traditional drawings, it can be viewed from any side. The concept of sectional views was explained by cutting sections in cardboard models.

Other simple and affordable techniques were introduced. Though Luristan is a region with frequent major earthquakes, few people built houses resistant to them. The possibility of strengthening traditional vault construction with wooden ring and tie beams was tested and later incorporated into construction projects in the villages (fig. 3). An ordinary soft-drink bottle was found useful for testing soils: local soils and water were mixed in it. When the components settled, the proportions of sand, clay, and silt could be determined and the soil's bearing strength estimated to determine if more sand or clay needed to be added for a particular application. Buoyed by a new-found spirit of inquiry, the trainees experimented with adding stabilizers such as lime, bitumen, or cement to mud-wall coatings to improve their weather resistance.

The three-month workshop completed, the builders went on to on-the-job training in community projects (figs. 4,5,6). Armed with new technical solutions and a training technique all within the abilities of the builders, the following winter they conducted their own workshop on their own initiative. They took on more apprentices, roughly followed the previous curriculum, and doubled the size of their team to about 30.

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Social Structure and Solid Waste: An Adventure in Problem Analysis

Tom D'Avanzo[1]

Trash can be valuable — literally, as a source of livelihoods and, figuratively, as a source of insight into defining development problems.

Solid waste disposal in most of the swelling cities of the less-developed countries is poorly served by public facilities: dumptrucks, trash compactors, and other modern means are lacking. The result is an impulse to intervene with bureaucracy and technology.

An analysis of solid waste disposal in Cairo started with conventional assumptions. But an anthropologist and an operations research specialist combined their talents to look at the social and economic aspects of the city's waste processing system. The aim was to avoid a conventional technological/bureaucratic "fix" for a problem that could better be defined in other terms.

An analysis of Cairo's solid waste management needs illustrates an obvious and often ignored fact: Defining a problem sets the context for its solution. Socially-oriented analysis may complicate a problem, introducing factors that resist technological manipulation. But the results may be worth the trouble.

The solid wastes of a big city must be disposed of -- buried, burned or reused. Reuse requires a production system and a market for the products. Waste management in Cairo is based on materials reuse. Cairo has no elaborate waste disposal system. In poor areas of the city, residents and goats dispose of what trash there is. In middle and upper income areas, which produce potentially valuable trash, scavenging has been developed into a large, elaborate system. It is motivated by self-interest, rooted in powerful social structures, and is impressively effective in keeping important parts of the city clean.

The traditional Cairo system depends on two groups: Muslim Wahiya and Coptic Christian Zabaline. The Wahiya act as brokers. They purchase waste collection rights from building owners, paying commissions that vary with the size of a building and the value of its waste. The Wahiya brokers collect fees from the residents. They also rent to the Zabaline the actual right to pick up the trash.

[1] Reprinted with permission from "Pasitam Design Notes" No. 13, 1979. (Indiana University, Bloomington, Indiana, USA 47405) This is a summary of an analysis of the Cairo solid waste disposal system by Kingsley Haynes and Sherif M. El-Hakim, "Appropriate Technology and Public Policy: The Urban Waste Management System in Cairo," *The Geographical Review*, 69:1 (January 1979).

The Zabaline Christians are socially-marginal people in a Muslim country. About 40,000 Zabaline families live in 11 shantytown satellites of Cairo. They derive their income from collecting and sorting waste into marketable components, and by breeding and selling pigs (pigs are not unclean to Christians).

Nothing is wasted. About 2,000 tons of paper are recycled every month. Cotton and wool rags are reprocessed for upholstery and blankets. Tin is pressed and soldered into vessels, toys, and spare parts for machinery. Glass and plastic are reused. Organic matter is fed to pigs or used for compost. Bones are used to make glue, paints, and high-grade carbon for sugar refining. Hundreds of workshops and factories within the city depend on the Zabaline for raw materials.

In terms of sanitation, the Cairo system is efficient. Solid waste is collected and reused. The Christian Zabaline also sell about ten tons of pork each day. The Zabaline make money out of trash. Some retire in financial security.

But the system is not without its costs. These include a high infant mortality rate — estimated at 60 percent — among the Zabalines who live amid wastes in the desolate fringes of the city, and are often uprooted as Cairo's borders expand. Health centres, schools, water, electricity, and other municipal services do not exist.

The Governorate of Cairo has considered importing incinerators, waste collection vehicles, and other sophisticated waste disposal technologies. These could satisfy immediate waste-disposal needs. At least one development agency has considered the Cairo trash situation as an opportunity for a technology-based waste-disposal project. Trucks with trash-compactors would collect solid waste. But the Zabaline and Wahiya would be deprived of income, and Cairo would lose a source of raw materials.

The Zabaline's high infant mortality rate poses a problem of public health. Social services, potable water, and other public facilities might resolve it — at a cost. How would such interventions affect the waste collection system? What aspects of the system are most sensitive to intervention? In short, how does the system work and what factors must be considered when trying to improve it? What, in the final analysis, is the problem?

In modern Western urban settings, waste disposal problems are chiefly economic/technological and environmental. The high cost of labor impels capital substitution. (The high costs of public labor have in some places stimulated the use of contractors for waste collection and disposal.) Sheer volumes of trash plus the high costs of recycling create problems of where to put it. And trash has become the subject of elaborate specialized technology, a high-capital technology of materials handling, compaction, and disposal.

To transfer such technology to Cairo and other cities of the developing world is fairly simple — and not unlikely, if trash technologists (solid waste management system specialists) are invited to define the problem.

But the appropriateness of a technology is never just a technological question. A technological fix could be costly and inefficient in social, organizational, and economic terms. Here, as in any effort to define a system design problem, the crux of the matter is not to rely on technological intuition or to copy an arrangement that works somewhere else. It is instead to ask and answer certain essential problem-defining questions.

1. What is currently going on? How does it work? What are its apparent costs and effects? (What, in other words, is the initial system?)

2. What is good and what is bad about this system? (What values will be served and hurt by changing or replacing it?)
3. Then, and only then, what might be done and how?

Somewhat fortuitously there was a multidisciplinary examination of these three questions in the case of solid waste disposal in Cairo. The analysis looked at social and economic factors as well as the narrower topic of technology. It discovered a waste collection system that is labor intensive; that does not have to be ordered, managed, and capitalized by the public sector; that recycles materials efficiently; and that incurs grievous health costs.

The Cairo analysis established the basis for an intelligent definition of some significant problems. It illustrates an important point: Many development problems can be defined in alternative ways. The effectiveness of a definition will be determined by the kind of analysis that is made. Too often such analysis is constrained by preconceived solutions. This case offers if not a model, then at least an argument for using more than technological intuition in defining certain kinds of developmental problems.

Who's Listening?

Ken Kesey

A description from *One Flew Over the Cuckoo's Nest* of the insensitive weight of bureaucracy coming to bear on a remote community is more eloquent than non-fictional accounts. Here the government is going to install a large hydroelectricity dam;[1] the case study following describes the installation by the Canadian government of a sewage disposal plant.

The first man stops and looks the village over. He's short and round and wearing a white Stetson hat. He shakes his head at the rickety clutter of fishracks and secondhand cars and chicken coops and motorcycles and dogs.

"Have you ever in all your born days seen the like? Have you now? I swear to heaven, have you *ever?*"

He pulls off the hat and pats his red rubber ball of a head with a handkerchief, careful, like he's afraid of getting one or the other mussed up — the handkerchief or the dab of damp stringy hair.

"Can you imagine people wanting to live this way? Tell me, John, can you?" He talks loud on account of not being used to the roar of the falls.

John's next to him, got a thick gray mustache lifted tight up under his nose to stop out the smell of the salmon I'm working on. He's sweated down his neck and cheeks, and he's sweated clean out through the back of his blue suit. He's making notes in a book, and he keeps turning in a circle, looking at our shack, our little garden, at Mama's red and green and yellow Saturday-night dresses drying out back on a stretch of bedcord — keeps turning till he makes a full circle and comes back to me, looks at me like he just sees me for the first time, and me not but two yards away from him. He bends toward me and squints and lifts his mustache up to his nose again like it's me stinking instead of the fish.

"Where do you suppose his parents are?" John asks. "Inside the house? Or out on the falls? We might as well talk this over with the man while we're out here."

"I, for one, am not going inside that hovel," the fat guy says.

"That hovel," John says through his mustache, "is where the Chief lives, Breckenridge, the man we are here to deal with, the noble leader of these people."

"Deal with? Not me, not my job. They pay me to appraise, not fraternize." This gets a laugh out of John.

"Yes, that's true. But someone should inform them of the government's plans."

[1] From *ONE FLEW OVER THE CUCKOO'S NEST* by Ken Kesey. Copyright© 1962 by Ken Kesey. Reprinted by permission of Viking Penguin Inc.

"If they don't already know, they'll know soon enough."

"It would be very simple to go in and talk with him."

"Inside in that squalor? Why, I'll just bet you anything that place is acrawl with black widows. They say these 'dobe shacks always house a regular civilization in the walls between the sods. And *hot*, lord-a-mercy, I hope to tell you. I'll wager it's a regular oven in there. Look, look how overdone little Hiawatha is here. Ho. Burnt to a fair turn, he is."

He laughs and dabs at his head and when the woman looks at him he stops laughing. He clears his throat and spits into the dust and then walks over and sits down in the swing Papa built for me in the juniper tree, and sits there swinging back and forth a little bit and fanning himself with his Stetson.

What he said makes me madder the more I think about it. He and John go ahead talking about our house and village and property and what they are worth, and I get the notion they're talking about these things around me because they don't know I speak English. They are probably from the East someplace, where people don't know anything about Indians but what they see in the movies. I think how ashamed they're going to be when they find out I know what they are saying.

I let them say another thing or two about the heat and the house; then I stand up and tell the fat man, in my very best schoolbook language, that our sod house is *likely* to be cooler than any one of the houses in town, *lots* cooler! "I know for a *fact* that it's cooler'n that school I go to and even cooler'n that movie house in The Dalles that advertises on that sign drawn with icicle letters that it's 'cool inside'!"

And I'm just about to go and tell them, how, if they'll come on in, I'll go get Papa from the scaffolds on the falls, when I see that they don't look like they'd heard me talk at all. They aren't even looking at me. The fat man is swinging back and forth, looking off down the ridge of lava to where the men are standing their places on the scaffolding in the falls, just plaid-shirted shapes in the mist from this distance. Every so often you can see somebody shoot out an arm and take a step forward like a swordfighter, and then hold up his fifteen-foot forked spear for somebody on the scaffold above him to pull off the flopping salmon. The fat guy watches the men standing in their places in the fifty-foot veil of water, and bats his eyes and grunts every time one of them makes a lunge for a salmon.

The other two, John and the woman, are just standing. Not a one of the three acts like they heard a thing I said; in fact they're all looking off from me like they'd as soon I wasn't there at all.

And everything stops and hangs this way for a minute.

I get the funniest feeling that the sun is turned up brighter than before on the three of them. Everything else looks like it usually does — the chickens fussing around in the grass on top of the 'dobe houses, the grasshoppers batting from bush to bush, the flies being stirred into black clouds around the fish tracks by the little kids with sage flails, just like every other summer day. Except the sun, on these three strangers, is all of a sudden way the hell brighter than usual and I can see . . . *seams* where they're put together. And, almost, see the apparatus inside them take the words I just said and try to fit the words in here and there, this place and that, and when they find the words don't have any place ready-made where they'll fit, the machinery disposes of the words like they weren't even spoken.

Users Making Choices In A Fragile Environment, Canada

Most of the case studies in this book describe a style of interaction, a sharing of knowledge between local people and outside consultants. This case study illustrates a variation of this process, termed "participatory research."[1] Briefly, participatory research is a method of social investigation, an educational process, a means of taking action involving a whole community, including the most powerless.

It has long been recognized that there is an under-utilized stock of indigenous technical knowledge, particularly in agriculture, in many Third World communities. In some cases, local people are more capable of providing background data on the social and economic aspects of the problem; in others, they can provide accurate technical information, though not necessarily in a formal manner. But in many development initiatives this local expertise is not respected. The outside experts have a monopoly; only they can sell their knowledge, local people are not in the international knowledge market.

Participatory research attempts to involve a broader base of the community by promoting local control of the research process and putting the tools of inquiry into the hands of the community. It attempts to demystify the process of social or technical research by having investigation and analyses of alternative solutions conducted by the community itself.

In some ways, participatory research is an extension of earlier work in community development by Paulo Friere and others who have looked for a variety of techniques to promote community action. At a theoretical level, participatory researchers are trying to clarify the conditions under which this process is possible.

> Is real local control (of this process) ever possible, and if so, under what conditions? Does this approach ignore the inertia of a state apparatus which, in most countries boasts access to huge amounts of capital and labour relative to individual villages, and which history has shown with few exceptions, favours urbanization and industrialization to the neglect of rural production?[2]

[1] Adapted from the sources listed in the references. Graphics were provided by Witold Rybczynski.

[2] Ted Jackson, "Rural Sanitation Technology," *Assignment Children*, 45/46, UNICEF, Spring 1979.

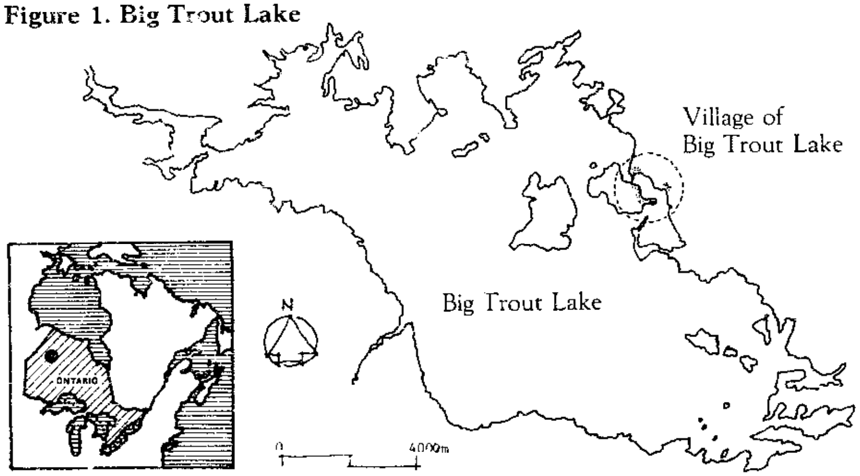
The last section of the *Handbook on Appropriate Technology* discusses the necessity of community participation and the role of an AT "catalyst" — whether a community development worker, an adult educator, a technologist, or a group of such people — who is willing to discuss and assess options with the local people and help them implement their chosen solutions.

Sometimes, though not often, the community itself chooses consultants who are willing to blend their knowledge with local ability. But what is the "catalyst" to do when local or central government officials block the discussions of options or hinder the implementation of community choices? Are the outside consultants generally willing to go beyond simply applying technology and enter into negotiations with authorities on behalf of their clients? Are the consultants able to view the immediate project as part of a larger process of change? Clearly the consultant is not always in a position to do this. Frequently he or she is chosen and paid by an outside agency which does not have a base in the community and the community is not the direct client of the expert's services.

The following case study illustrates a unique experiment in Canada's "Third World." It provides no definitive answers to the above questions but it does indicate why it is necessary to ask them. An Indian community in northern Canada has been trying for over four years to overcome an imposed and inappropriate answer to a water pollution problem. It is an uncommon situation: the Indians hired their own technical consultants.

Big Trout Lake is a small Indian reserve in a remote region of Northern Canada which needed an improved water supply and sewage disposal system (fig.1). The lake, the main source of drinking water, had become seriously polluted by human wastes. To solve this problem, the Canadian federal government devised a scheme which is a classic application of unrealistic decisions, insensitivity to cultural concerns, and indifference to local opinion, social or economic costs.

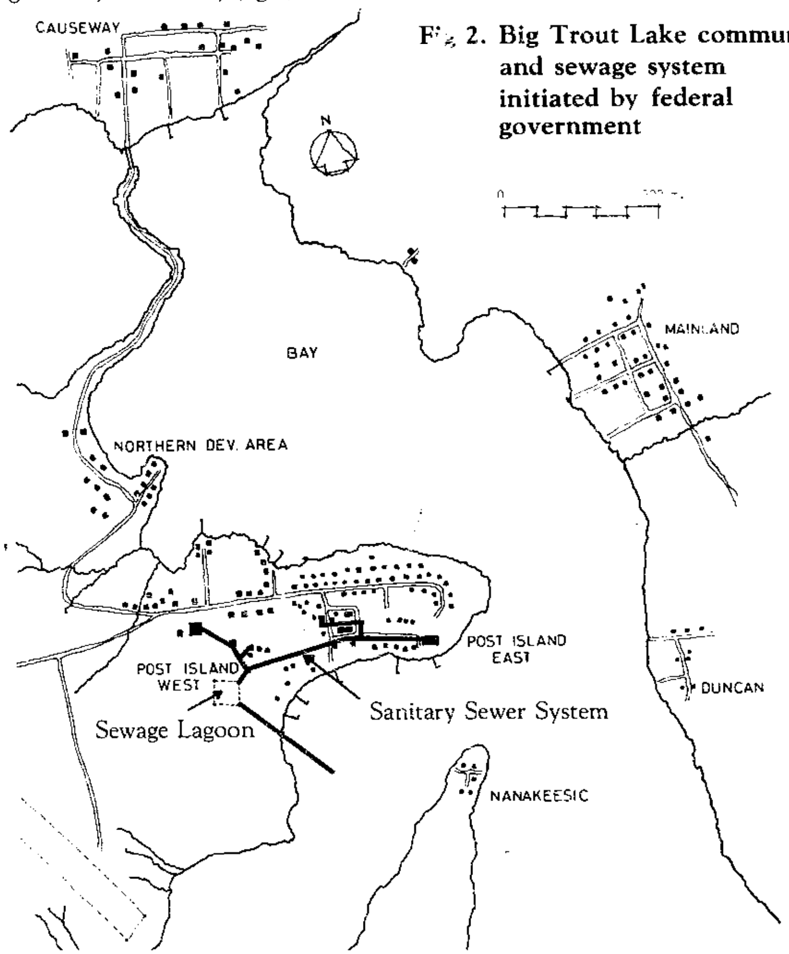
Figure 1. Big Trout Lake



One of the reasons for the failure of the government solution is a century of federal government control of Indian affairs. Little, if any, emphasis has been placed on working with Indian communities, particularly those dependent on government funds. Government bureaucracies have traditionally resisted local participation when allocating government resources and this has become a common plight of low-income communities worldwide. Only within the last 15 years have Canadian Indians had a chance to participate in managing their own development and choosing more suitable technologies. Recently, both within government and Indian organizations, it has been recognized that a less dependent structure is needed to strengthen Indian institutions and change the government's traditional "top down" approach. New initiatives are proceeding but the inertia of the past remains.[3]

The Big Trout Lake community consists of a number of settlements linked together by a causeway (fig.2). Its 600 inhabitants are Nishnawbe (Cree) Indians,

Fig. 2. Big Trout Lake community and sewage system initiated by federal government



[3] See The National Indian Socio-Economic Development Committee, "To Have What Is One's Own," October 1979, for a summary of past initiatives and new proposals for change.

with the exception of 60 government employees who run the school, nursing station, weather station, and air strip. The reserve is inaccessible by road or boat and is serviced by regularly-scheduled small aircraft. Most supplies and personnel must be flown in, making transportation and travel costs a major expense.

The region is flat, rocky, and sparsely forested. The climate in winter is severe with average high and low temperatures of between -20° and -30°C. By mid-summer the temperature has climbed to between 10° and 20°C. Snow covers the ground for more than half the year.

Over the last few decades, the traditional local economy of Big Trout Lake, based on hunting, fishing, and trapping, has been eroded by the change from a nomadic to a settled society. The Indians now have a welfare economy dependent on government funding for development programs. Even so, permanent wage employment is normally available for less than 10 percent of the Indian community.

The Nishnawbe of Big Trout Lake, though isolated, do have access to the most modern consumer technologies (the 150 households buy nearly 300,000 disposable diapers a year). However, they have had only limited access to the production or service technologies which they need to develop their agriculture and forestry resources.

In the last decade, the locally-elected Band Council has been granted the authority and some resources to administer its own affairs. The older leaders and younger administrators now realize that they must control local development projects. Local leaders have had trouble translating international AT jargon into Cree, but the Indian people do have a concept of AT which is largely intuitive: "They are simply technologies which make sense to local people." One women's group meeting decided that AT is compatible with the Indian philosophy that "what we see is created for us to use and not destroy."

Most of the Big Trout Lake area consists of bedrock covered by a few feet of soil. The Indian households have outdoor pit latrines and when an outhouse is located near the lake, contaminated water can be carried underground along the rock shelf to the lake. Most of the water used domestically comes from the lake and, after use, it is returned to the lake along with fecal pollution from septic tanks and outhouses.

The population was well aware that the water was contaminated, and that its quality, clarity, and taste were deteriorating yearly. For this reason, they obviously prefered to fetch chlorinated drinking water from the "safe" taps at the school or weather station, or take water from far out in the lake. In winter, blocks of lake ice are cut and hauled ashore by snowmobile.

The homes of the non-Indians, on the other hand, are provided with a piped water supply. Furthermore, almost all non-Indian households have septic tanks and indoor plumbing with flush toilets.

The spring run-off of rain and melting snow increases the pollution and the incidence of diarrhea, dysentery, and hepatitis, particularly in the Indian community. In the early 1970s, eight bore holes equipped with hand pumps were installed; seven of the hand pumps failed after a few months of service. (In a later study, a consultant noted that the same make and model of pumps were installed in a large water supply project in West Africa and broke down on average after two weeks of use.)

In 1971, federal government studies proved what the residents already knew, that the lake was severely polluted, and placed the blame on the malfunctioning septic tanks in non-Indian buildings and the existing sewage lagoon which services the school. Engineering consultants from southern Canada were hired by the government to prepare plans for a new sewage system, and final plans were accepted by the Department of Indian Affairs and Northern Development (DIAND) in 1976. A sewage pipeline would collect waste water from government buildings (in effect the non-Indian community), and transport it via two pumping stations to an extended aeration plant for treatment and subsequent discharge into the lake (fig.2). This system, common in more temperate southern Canada, had serious shortcomings in a remote sub-arctic region. Subsequent studies showed that:

1. The proposed system would not eliminate all the major sources of pollution. It would service only the small number of houses with piped water. To use such a system requires indoor plumbing. The Indian houses could not be connected to this system.

2. The system is complicated, expensive, and difficult to maintain in such a remote location. The chance of breakdown and subsequent discharge of untreated sewage into the lake is high. The operating record of similar systems elsewhere in northern Canada has not been good.

3. It does not consider the need for a better water supply system to complement any waste disposal system.

One consultant later noted that such sewage systems are expensive under the best of conditions and Big Trout Lake offers some of the worst. Another consultant bluntly called it "technological apartheid." As later studies showed not only were the government's terms of reference faulty but also the recommended solution was technically and financially regrettable.

Construction on this project began in 1976 but was halted as soon as the Indian community discovered what the DIAND plans included. While dynamiting trenches for the sewage piping, government work crews entered the Indian cemetery in the path of the pipeline and blasted marked grave sites. The Band Council was horrified. Since it is empowered under existing legislation to prohibit access to the Reserve, it stopped the project. After a strongly-worded resolution from the Band, a flurry of interdepartmental meetings in Ottawa between the three government ministries now involved in this project, and delays of over one year, the Band Council decided to initiate studies, using its own funds to hire its own consultants.

The Band Council hired the Participatory Research Project (PRP) of the International Council of Adult Education, with whom they had worked before, to act as their consultants. This group is not in itself a technical organization. It is primarily involved in developing new methods of non-formal education using such things as theatre and radio to help low-income communities identify problems and promote the control of their own development.

Members of PRP had seen enough outside "experts" impose inappropriate solutions on the Third World to realize that a unique kind of technical consultancy was needed: competent technicians were required who could present a range of technical options that are not normally found in the southern Canadian engineer's design notes and local people should participate in the research and design process and ultimately choose the technology. It should be noted that this style of consultancy is rare for low-income communities: paternalism is more common. In Canada, the few consultants with the necessary technology and philosophy have worked abroad in communities where lower-cost alternatives are preferred to existing high-cost techniques. DIAND has in practice been unaware that the development problems and experience of low-income Third World communities are relevant to the situation of the Canadian Indians they are presumably serving.

PRP recruited five specialists: an engineer and an architect who specialized in low-cost sanitation and water supply systems, a limnologist, an ecologist, and a participatory research consultant. Their terms of reference included an overall technical, ecological, economic, and social assessment of the DIAND sewage system. At Big Trout Lake the problem of waste disposal was inseparable from the provision of safe water as both are linked to enteric disease. The consultants were therefore required to present alternate, intermediate water supply and waste disposal options that would service the whole community.

The consultant-client relationship was unambiguous. The Indians, rather than a government agency, were the clients. The team of specialists could contact government agencies only after clearance from the Band. Community participation was achieved through public meetings held to discuss problems, criticize options, and heighten the village's awareness of the study. It was agreed that the community should be involved in both the planning and implementation of the work. It was also to be an educational process of direct benefit to the Indians by improving their existing research and problem-solving skills.

In 1978, the team visited the Indian community several times and conducted interviews and general meetings organized by the Band. They discussed present methods of water collection and use, and waste disposal. All aspects of the DIAND solution and alternative options were discussed while the team completed a chemical analysis of water supplies and identified sources of pollution In late 1978, the consultants' first report was drafted with the Band Council, and a summary was translated locally into Cree.

In accordance with the consultants' philosophy of "Users Making Choices," the title of their report to the Band Council, they made no single recommendation. Instead, a matrix of feasible options was presented for discussion to the Band and the community (fig.3). Choices ranged from existing, unsatisfactory methods of waste disposal and water supply to the more sophisticated option of a trucked sewage and water system. Other options such as chemical toilets, septic tanks, bucket toilets, incinerating toilets, and small composting toilets were considered, but soil conditions, the need for water or power, and the problems of disposing of treated or untreated wastes make these options unfeasible (fig.4).

The consultants' assessment of the DIAND sewage system was that, on the basis of costs alone, it was simply too expensive for the Indian households to ever be part of it. If the DIAND solution were completed, a marginal improvement would be obtained at enormous cost. With construction still incomplete it was estimated that the system had already cost the federal government about $1.8 million.

The PRP water quality studies showed many sources of pollution: seepage from the existing sewage lagoon, septic tanks, outhouses, the town garbage dump, and oil and gasoline from aircraft and motor boats. The point was emphasized that, due to the isolation, severe climate, and vulnerable ecosystem of the reserve, the community should avoid adopting any technology that relied heavily on maintenance and electricity, or on chemical treatment.

The trucked sewage system uses all-weather, tracked vehicles with two separate insulated tanks, one to deliver potable water, the other to carry away liquid wastes (fig.5). Such systems are used successfully elsewhere in northern Canada. Unlike the DIAND sewer system, it could service the whole community,

Fig. 3. The Waste Disposal/Water Supply Matrix

Water Supply Options / Excreta Disposal Options	OUTHOUSE $0 ($0)	IMPROVED OUTHOUSE $40-50 ($0)	IMPROVED OUTHOUSE PLUS LINER $300-350($50)	MOULDERING TOILET $500-600($0)	TRUCK SYSTEM
BUCKET FROM LAKE, SCHOOL $0 ($0)	$0 ($0)	$40-$50 ($0)	$300-$350 ($50)	$500-$600 ($0)	X
RAINWATER $150-200 ($0)	$150-$200 ($0)	$190-$250 ($0)	$450-$550 ($50)	$650-$800 ($0)	X
HAND-PUMP $80-$100 ($15)	$80-$100 ($15)	$120-$150 ($15)	$380-$450 ($65)	$580-$700 ($15)	X
STREET-TAP $2000-$2200 ($25)	$2000-$2200 ($25)	$2040-$2250 ($25)	$2300-$2550 ($75)	$2500-$2800 ($25)	X
TRUCK SYSTEM	X	X	X	X	$1800-$2000 ($500)

Capital cost per household , estimated operating cost per household per year is indicated in brackets.

Fig. 4. Waste Disposal Options Not Recommended

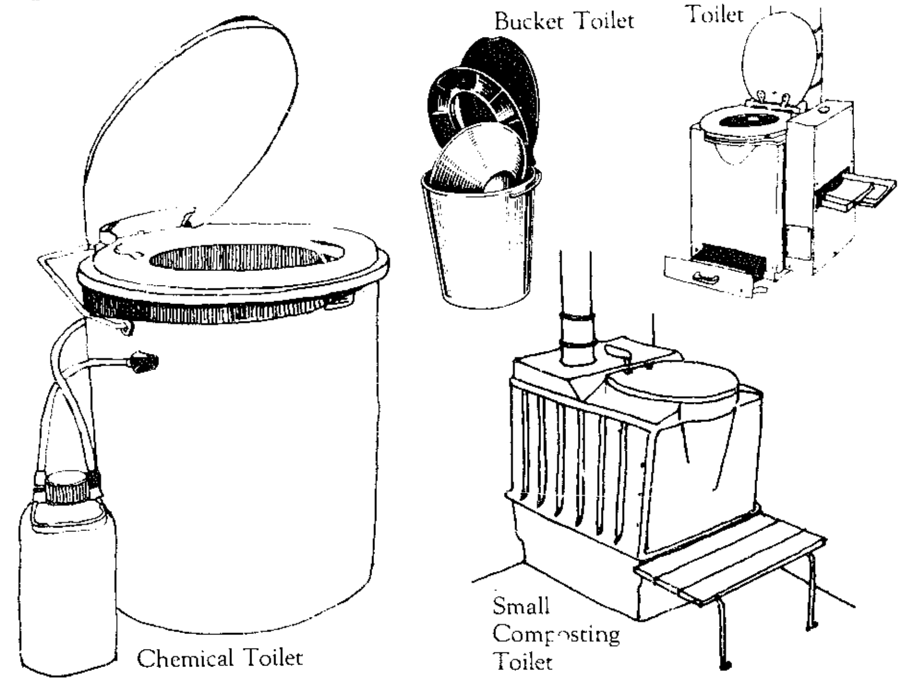
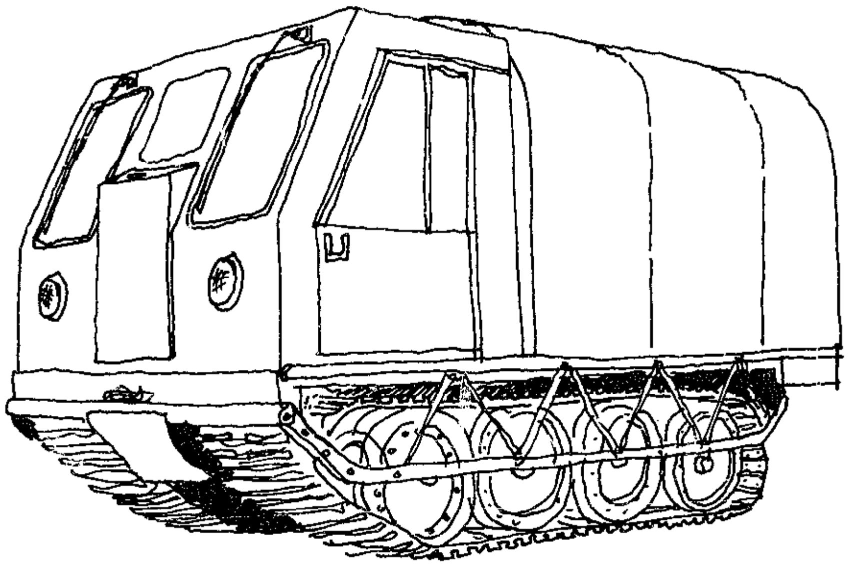


Fig. 5. Vehicle for distribution of potable water and collection of wastes



provide employment, and be implemented gradually. The system is self-contained and the circulation of potable water and the related quantity of waste water in the small community can be controlled. The sewage can be trucked to oxidation ponds where it would decompose organically.

The moldering toilet functions without external power (fig.6). Excreta and kitchen wastes are stored for up to two or three years while they organically decompose into an excellent fertilizer. Unlike smaller composting toilets, they can accept peak loads and intensive use. This option is still being experimented with in northern climates as it requires the redesign of houses to protect the toilet from frost.

The team explained that the latrine, despite its problems, was still the best immediate solution for collecting human wastes. Its disadvantages could be minimized by better construction and the use of a rubber liner to contain wastes (fig.7). Using the truck system, such a latrine could be periodically pumped out.

The residents felt that hand pumps would be the best immediate method for supplying an increased amount of water to native households. As increased water use meant more waste water to be disposed of, a modest increase, such as that provided by hand pumps or a truck system, was preferable to the enormous increase which would result from a piped water system servicing the entire community.

In mid-1979, two members of the Big Trout Lake health committee, an elder woman, and a PRP consultant flew 1000 km north to Baker Lake, an Inuit (Eskimo) community about the same size as Big Trout Lake, where the community council was administering and maintaining an effective trucked water and sewage system.

Fig. 6.
Sectional View of Mouldering Toilet and House Design Incorporating Mouldering Toilet and Water Storage

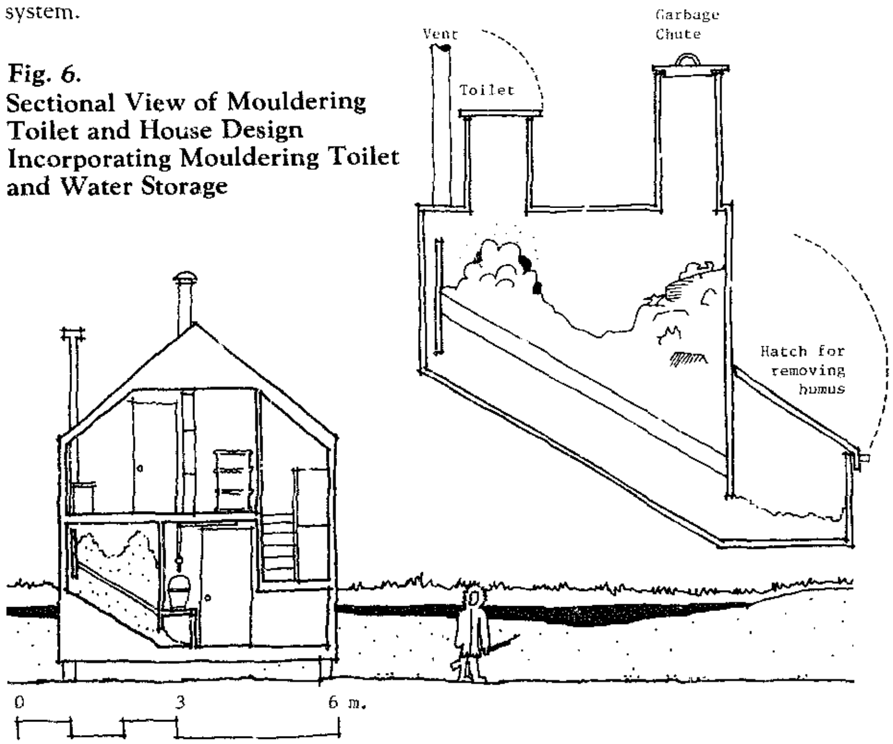
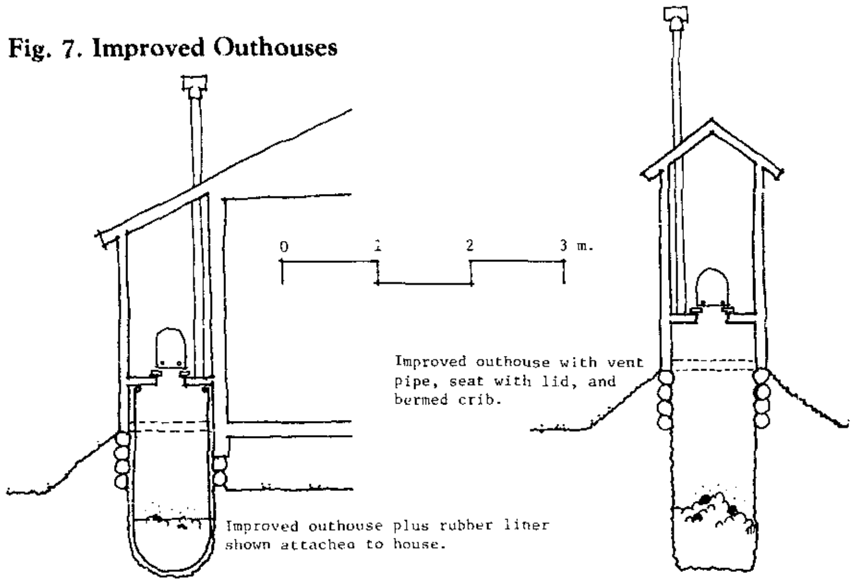


Fig. 7. Improved Outhouses



This allowed the research team to assess this option and identify potential problems if such a system were used in Big Trout Lake. The research team found out how the council, mechanics, and users organized their system, collected fees, and trained maintenance personnel. Some problems with the Baker Lake system were identified: holding tanks located on the colder north side of buildings sometimes froze, as do the sewage lines pumping wastes to a sewage lagoon. Photographs of the researchers' findings and their favourable assessments were then reviewed by the Big Trout Lake inhabitants.

The Band continued to extend the decision-making process beyond the Band Council. The women of the community believed that earlier meetings were not productive because they involved only men in the discussion of what was essentially women's work; that is, carrying water and disposing of wastes. Thanks to the efforts of one woman who summarized, translated into Cree, and explained the extensive PRP report, community women were able to express their opinions. They pointed out that using water tanks would require structural improvements in the houses, and additional space for cooking and washing. They also wanted proof that a moldering toilet would work in Big Trout Lake before they would consider adopting it. The women drew diagrams of their houses and the architectural modifications needed to incorporate some of the new methods.

The community also wanted the hand pumps repaired. Two men visited the pump manufacturer for a short course on well installation and maintenance. At the same time a proposal to fund new pumps and repair the old ones was submitted to DIAND.

By study and discussion, the community began to centre its interest on the trucked system, hand pumps, and improved outhouses.

The Band's consultants met with a government committee in the spring of 1979 to discuss the PRP report. The government, while expressing agreement with the title theme, "Users Making Choices," insisted that their sewer solution be completed, allowing for the possible inclusion of hand pumps and improved outhouses.

Given the government's past record and present intractability, the Band decided to delay any further meetings with the government until more aspects of the design of the trucked water and sewage system had been refined.

Research continued during the summer of 1979. With the assistance of a consultant on truck systems, the community identified an excellent site for oxidation ponds, 5 km away on a different watershed. The Band and its consultants prepared an addendum to their original report based on more recent data on water quality, the comparative costs of the options, and the opinions voiced at community meetings. It strongly recommended that all human effluent be kept from the lake. For this reason the DIAND sewer was judged unsuitable as effluent would eventually be returned to the lake.

The addendum also noted an apparent technical bias in government guidelines for financial assistance to Indian communities. Sewage lines, pumping stations, and lagoons are subsidized at a rate of 90 percent; whereas truck systems, wells and hand pumps are subsidized at only 50 percent.

The next meeting of the Band, PRP consultants, and the government was held in October, 1979. Again it appeared that the government was not willing to alter its commitment to completing its sewage system. The Band remained adamant that no effluent should enter the lake. Since there was a quorum of the Band Council present, the Band passed a resolution to proceed with the design of the truck system and immediate improvement of hand pumps and latrines, reserving for themselves the right to select their own consultants. Under existing legislation DIAND is obligated to follow this resolution. However, the Band is dependent on assistance from DIAND for obtaining funds from the federal Treasury Board to meet the objectives of the resolution.

At the time of this writing (May, 1980) there has been no official reaction from the government to the Band's resolution. Over the last year the government has been operating in a period of "fiscal restraint," compounding the normal bureaucratic delays, but has found funds to hire its own consultant to look further into the choice of technology. In any event, it has shown considerable creativity in delaying a process inimical to its own interests. The struggle over "who makes the choices" continues.

Unfortunately, for all the effort, there has been little improvement in the situation at Big Trout Lake. Some rubber liners have been installed in latrines and a few hand pumps repaired but community leaders in Big Trout Lake are involved with many other projects and have had problems maintaining interest and expanding it to involve more members of the community. The Band committees are dependent on a few people who are under heavy administrative pressures. Many hours are spent soliciting project funds and accounting for their expenditure. Work is held up by the normal delays inherent to bureaucracy and negotiation. Travel by air to the centres where the most important financial decisions are made is a heavy burden on the Band's funds.

It is no wonder that the process is slow. Five years elapsed between the time of the first government study of the pollution problem in 1971 and initial construction of the ill-fated sewage system. One cannot expect an over-extended Indian community, without access to the same amount of funds and manpower, to install a sewage disposal system and a better water supply system and involve the total community in a development process in even the same amount of time. It becomes obvious that to relieve excessive government control it is more important to know how decisions are made than to know which technologies are chosen.

The Big Trout Lake case study raises some fundamental questions relevant to the future of appropriate technology. Will users participate in technical choices or are they to be excluded by the state? Will marginal communities ever have the option of hiring their own consultants, particularly those who can provide them with appropriate information and are willing to enter into negotiations with the central government? Even in Canada there are few consultants with dependable knowledge on low-cost sanitation and water supply systems. Fewer still are technical consultants who will participate in the development of a negotiating strategy to bargain with government authorities. How do you extend and sustain the process of participation? What kind of political system will allow this process to happen? Will a central government or an international development agency try to "package" this approach and still remain effectively in control of decisions on technical choice? Some of the participants in this case study feel that this approach is not possible in most countries. As one of them said, "It would be dangerous to attempt to apply the model anywhere without care and caution. The risks are not those of the professional. The risks are the risks of the people."

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The Politics of Water, Lesotho

The three case studies quoted from here are part of a large interdisciplinary study done from 1975 to 1977 to evaluate and improve rural water programs in Lesotho.[1] They illustrate the complex village-level realities which determine the outcome of such programs.

The technology employed in these case studies was a gravity-fed, piped water system from a protected spring to standpipes in the village. In a general survey of water systems in Lesotho, investigators found that about 90 percent of the gravity-fed systems were working properly, compared with 40 percent of the pumped supplies. However, in the mountain districts only about half the gravity-fed systems were working, partly because of frost at higher altitudes and less access to technical assistance. Nevertheless, in searching for the reasons for the success or failure of these systems, the authors found that they had to look beyond the technical factors and take into account the turbulent political situation of the new nation, combined with the different expectations of the users, managers, funders, and designers of new water systems.

Lesotho is a small mountainous nation, the enclave of the 1 million Basotho people, and is surrounded by the Republic of South Africa. About half of the male Basotho labour force is usually absent, working in South African mines. Their migrant labour earnings exceed Lesotho's gross domestic product. In their absence women in the small rural villages, where most of the population lives, have had to shoulder many responsibilities. Carrying water from distant sources is one of them. Conveniently located safe water supplies can save them considerable time and help prevent disease.

Villages were often the victims of conflicting expectations. The answer to the question "What constitutes a successful water supply system?" depends on who is asked. For the users, it must be a dependable and conveniently located supply. Economists, however, measure success in terms of cost-effectiveness and increases in productivity. Engineers want to see water flowing out of the end of a pipe. Community development workers judge success by health benefits, "self-help" committees, and local control. Voluntary aid people are looking for a "catalytic" effect to facilitate future development projects. Politicians promote the installation

[1] These case studies are quoted with permission from Richard Feachem et al. *Water, Health and Development: An Interdisciplinary Evaluation.* Tri-Med Books Ltd., 5 Tudor Cottage, Lovers Walk, Finchley, London, England, N3 1JH, 1978.

of a water supply if it guarantees more supporters. Each "interest group" wishes to construct a water supply system which first answers its own needs.

Politics, in particular, have had a profound influence on the management of village water supplies. Political events in Lesotho during the 1960s helped to create bitter divisions at the national and village levels. These events are summarized below:

1960 — election won by Basutoland Congress Party (BCP)
1965 — BCP defeated by Basotho National Party (BNP)
1966 — independence
1968 — local government abolished as BNP feared it was becoming a stronghold of BCP
1970 — BNP lost election, declared the results invalid, suspended the constitution, and declared a "state of emergency." Subsequent attempts in the 1970s to promote "reconciliation" failed.

In 1968 the government began to promote village committees to manage local projects through the Department of Community and Rural Development (Comrudev). During this time the village chief's traditional authority was eroded.

In some villages, two or more committees, some an organ of the ruling party, others more independent of politics, were set up to manage specific tasks. The question of who had authority in a particular situation was often confused and contradictory. "We are suffering," said a woman carrying a water bucket. "Our trouble is too much politics in this business."

Ha Moferefere

Ha Moferefere is a small village, about 45 households in all, situated on a high plateau in the mountains. Before the installation of a piped water supply, villagers drew water in the summer from a number of springs which issue in the wet season, at most 150 metres from any household, but in the winter from a single perennial spring to which one must walk between 100 and 150 metres. Ha Moferefere is situated so high up that even the strong perennial spring may be frozen over on winter mornings.

A gravity-fed piped water supply was completed there in 1972. The district Comrudev technician carried out the survey, and selected a spring on a south-facing slope from which to pipe the water down to the village. Unfortunately, the supply has only worked intermittently since its installation; every year the outlet pipe from the storage tank has frozen up for two to four months during the winter. Villagers complain that they had initially suggested a spring on a north-facing slope slightly further from the village, which would enable the tank outlet to thaw out in the winter sun, after each night's frost.

The long-term problem for the village, however, lies in the management of the supply. Prior to 1970 there was no alternative source of authority to the chieftaincy. A BNP committee had briefly formed for the 1965 election but had become dormant soon after. It was resurrected for the 1970 elections, and thereafter the political tension prevented it from again slipping into inertia. In the latter part of that year the chairman of the BNP committee attended a meeting convened by the constituency Party "activist" (Mohlophisi) who suggested to him that the committee might organize the development of the village.

The first step was for the BNP committee to become the Village Development Committee base. It then began to organize cash subscriptions for a water supply.

The supply was installed in 1972 under the management of this committee. However, the chief appears to have been concerned about the legitimacy of a party committee managing the water supply. Consequently, a year later when villagers were setting up a Communal Garden Committee, the chief took it upon himself to arrange that the elected Communal Garden Committee also took responsibility for the water supply.

This was perceived as a threat to the standing of the Village Development Committee, but they were restored to pre-eminence at the end of the following year when the superior to the chief of Ha Moferefere, an ardent government supporter, appointed the chairman of the Village Development Committee as the new chief in the village on the grounds that the superseded chief "obstructed the work of development in the village."

The deposed chief, with the backing of the majority of the villagers and the elected committee, has recently decided to sue for his reinstatement. In the meantime the condition of the water supply has deteriorated. While the issue of management of the water supply has become a vehicle for village political dispute, lack of regular maintenance has resulted in more frequent breakdowns. The village now faces the prospect of less and less piped water and a drawn-out series of court cases which are not likely to resolve the deep divisions in the village.

Tsoelopeleng

Tsoelopeleng is a small village with a population of 35 households. It is unusual in that the supply is well maintained and the water committee well organized.

The idea of having a water supply came initially from the Community Development Officer. The village chief, an exceptionally well-educated and capable man, played a large part in encouraging the villagers. Cash was collected through the office of the chief in 1973, and in 1974 the supply was installed. At that time, against the opposition of a BNP committee based in a neighbouring sub-village, a water committee was freely elected by villagers to manage the running of the supply. The chairman of the committee is the chief's charismatic wife.

The committee, then, not only has the active voice of the chief's wife and the support of the chief, but is also openly elected and recognized as legitimate in the village. The responsibility for maintenance of the "self-help" scheme is also clearly understood by the committee and they have initiated and organized a system of routine maintenance whereby the village is divided into areas, each of which maintains the section of supply closest to it. Maintenance involves the regular covering of pipes with earth and preventing children or animals from breaking the standpipes.

A further reason which probably helps to account for the impressive organization in Tsoelopeleng is that the village is small and politically united. However, being small it also lacks sufficiently skilled people to attend to the supply if something major were to go wrong. So far, their preventive work has been of a sufficiently high standard to prevent any major breakdowns, but the committee actually suggested to us that they needed to have a villager trained in the basics of water supply maintenance.

Ha Kotsi

Ha Kotsi is a poor sub-village of a large and wealthier neighbouring village. It is known as an opposition enclave within a supposedly BNP village.

Ha Kotsi is a small village by any standards. The whole village comprises 18 households. The total population at home on two separate surveys in 1976 were 68 and 64, most of whom were children. The total healthy work force between the ages of 16 and 65 years in and around the village in June 1976 consisted of 17 women and six men. All but two of the households in the village have at least one member who has gone to work in the mines in South Africa.

Prior to 1972 the village women drew water from either of two springs, each of which is about 200 metres from the average household. Both springs are near to streams and thoroughfares, making them particularly liable to faecal pollution. They are protected only by a few stones.

The idea that a piped water supply could be obtained had long been in the air. Ha Kotsi's neighbouring village had already received two water supplies. The decisive impetus for the implementation of a water supply in Ha Kotsi came early in 1972 when a local missionary told a group of women in his congregation that if they were to form a committee to manage the self-help component he would be able to assist the villagers with materials.

At this stage there were no formal committees in the village. Theoretically the village came under the authority of the neighbouring village's BNP affiliated Village Development Committee, but there were only two BNP households in Ha Kotsi and the rest of the village was hostile towards the establishment of a BNP committee. Neither a Village Development Committee nor a BNP committee could be started in the village.

Following the missionary's initial suggestion, a public meeting was held at which the Community Development Officer outlined how an elected committee should be established and what "self-help" entailed. The missionary stipulated that he could only provide funds if, following the installation of the water supply, a communal garden was started, and if Comrudev supervised the installation of the supply.

The first plan for the gravity-fed supply was to lead the water from an excellent spring just beyond the crest of a nearby hill back over the hill down to the village. The villagers had dug the half a kilometre or so of trench before it was discovered that the crest of the hill was too high for the spring water to flow over it by gravity.

Nothing further occurred until the arrival of a more vociferous Community Development Officer, who decided to obtain further funding so that over a kilometre of steel pipe could be purchased to take the water on a steady downhill slope around the hill rather than over it. Accordingly, in early 1973 with the help of a number of additional households in another sub-village who benefitted from the change of plan, the pipe was laid under the direction of the District Comrudev technician.

Three events marred the implementation. First, the tank outlet was not properly flanged. Second, the ground was so rocky around the hill that well over a quarter of the total length of the pipe remained exposed after the first rains had washed the loose soil away. Third, and most crucial for future village organization, the technician had an illicit affair in the village from which an illegitimate child was born. Despite this, by February 1973 the supply started working in time for a scheduled visit by the Prime Minister to the area.

The supply worked for just over two years during which time only minor problems were encountered, some of which were attended to by the committee. No major breakdowns occurred and no serious maintenance was carried out. By

June 1975 the minor problems had built up until the supply stopped working completely: several taps were missing or broken; great lengths of piping were exposed and many were cracked; the exposed piping had also been damaged by animals and herd boys; the unflanged tank outlet had broken; and the eye of the spring had begun to move below the box. By July 1976 no further repairs had been attempted and water was again drawn from the traditional springs.

The elected committee which was to organize maintenance was established just after the supply was installed, all the members being women. The committee's chief concern was with their communal garden and little attention was paid to the water supply. When the supply broke down, the committee met regularly to organize village labour and cash contributions but neither was forthcoming from the village. In a year they only managed to raise a little money, and no repair work was carried out despite frequent visits by the Community Development Officer who came out on foot to encourage and advise them.

After monitoring the situation for eight months or so it still remained unclear why the committee did not succeed in organizing the villagers to fix their supply. The majority of villagers understood the responsibility for maintenance was theirs. A freely-elected committee represented the villagers, all of whom claimed that they needed and wanted a piped water supply. Some of the reasons for the failure of the project were obviously beyond the villagers' control. The poor installation meant that much more was required of the villagers. No technician was on hand to advise the villagers or to repair the supply, and the Community Development Officer had to suggest to the villagers that they hire a private welder to repair their tank as Comrudev could not help them. The need for outside help was all the more acute given the very small size of the village and its lack of skill and manpower. And yet it remained a mystery why the committee was unable to elicit the villagers' support in attempting to repair the supply.

Further clues were forthcoming only after intensive interviews were conducted in every household in the village. A constant theme in reply to our questions was the hostile opposition of men to women. The women blamed the men for the lack of repairs in that they refused to join work parties, while the men either said that the maintenance of the supply was a job for the women as they benefited most from more accessible water, or suggested that the women on the committee were incompetent. Two particularly outspoken men went further and spoke of political differences between the men and women of the village.

Further questions unearthed the bone of contention. At the time when the water supply was being installed, the eldest son of one of the most important families in the village was killed in an accident at the diamond mines where he was employed. His death was attributed to the BNP and political feeling ran high in the village. It was around this time that it was discovered that the technician, a prominent Government supporter, was the father of an illegitimate child in the village. The combination of these two events caused a great deal of argument and bitterness, the result of which was a split between the men and women of the village. A stalemate was reached in which the men, who were expected and better equipped to carry out the repairs to the supply, would not cooperate with the women who controlled the committee.

The problems resulting from these scandals were no doubt exacerbated by the size of the village. If such small villages are to receive supplies it would seem that good contact with a district office would be necessary to come to grips with the scandals, feuds, and political infighting characteristic of small powerless societies everywhere.

Women Finding Suitable Assistance: Soapmaking in Mali

Susan Caughman, Mariam N'diaye Thiam[1]

Women often lose their traditional sources of income as society adopts improved techniques of production.

> **Within most industries and occupations, in rich countries or poor, the more highly mechanized a job is and the more sophisticated the machinery it involves, the more likely it is to be done by a man. Even jobs traditionally classified as "women's work" are often taken over by men when they are mechanized: palm-oil pressing in Nigeria and rice-milling in Indonesia are two examples. Modernization brings with it a redistribution of institutional and economic power between the sexes — one which frequently makes women run faster to stay in the same place.[2]**

Strong local women's organizations can prevent this loss of income but their strength depends in part on access to better techniques of production. Some women's organizations have been able to acquire such assistance.

Soapmaking, a traditional source of revenue for women in West Africa, has been transformed into a small business by the 50 members of the Women's Cooperative in Markala, a town of 5,000 people in the Segou region of Mali. Using soap boiling tanks developed by the Technology Consultancy Centre (TCC) of Kumasi, Ghana, the cooperative members experimented with local oils and fillers until they developed a laundry soap equal in quality to the more expensive soap sold in Mali. The Soapworks now produces 2,000 bars of soap a week and is entirely managed and staffed by the women.

The Markala Cooperative was founded in 1975. Its members discussed various income-producing possibilities, making all decisions about projects and internal management. Its initial activities utilized existing skills, such as the collective

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[2] Kathleen Newland, *The Sisterhood of Man*. New York: Norton, 1979.

gathering and sale of firewood, cloth dyeing, and the sale of fish oil. The income from the cooperative paid for school fees, and most of the members' family food other than the staple grains provided by male relatives.

Cloth dyeing matched women's schedules and interests and in the first year became the principal revenue base for the cooperative. Local dyers taught members improved techniques of dyeing and soapmaking, and two representatives attended a cloth dyeing training program in The Gambia in 1977. However, profit margins were low due to the high cost of chemical dyeing and the labour required by traditional indigo and mud techniques. Cooperative members wanted to expand their range of income-producing activities and began experimenting with different techniques of soapmaking.

Mali's one soap factory turns out a product which does not meet the demand for laundry soap. (As is typical of many large-scale industries in Africa, the soap factory uses mostly imported ingredients, even though local farmers — usually women — could produce some of these if the large-scale technique was modified.) Imported soaps, the other alternative, are too expensive for most of the rural population. Malian women have had to rely heavily on locally-made soap of potash and oils which dissolves quickly and is often too caustic. There is, therefore, considerable demand for a reasonably-priced, good quality laundry soap.

As the first step toward improving soap production, the cooperative members found a soapmaker from the Bozo ethnic group who showed them how to make soap using caustic soda. In this cold process soapmaking, oil is melted and then allowed to cool to body temperature. At the same time a caustic soda solution is prepared and cooled. The caustic soda solution then is added slowly to the oil and the mixture stirred constantly until it becomes shiny and translucent, or "saponifies." The soap is then poured into molds, allowed to harden, and cut into bars for sale.

Cooperative members experimented with both fish oil and shea butter, the two oils most readily available. Fish oil produced a delicate soap which lathered extremely well; however, long hours of stirring were required before saponification occurred, and the soap remained very soft. Shea butter, on the other hand, produced a hard soap after only a half hour of stirring, but it did not lather well. Moreover, both soaps had an unpleasant odor which could not be masked with perfumes or local lemon grass. A final disadvantage was the high cost of imported caustic soda.

Only during periods of acute soap shortage or plentiful oil supply could the cooperative members make a profit with these soaps. Nevertheless, the experiments with cold process soap gave the women considerable expertise in caustic soda use and the process of oil saponification.

The cooperative approached outside organizations for assistance only to be given formulas for soap using ingredients that were not available or told that small-scale production would be unprofitable.

In February, 1979, Peter Donkor, Research Associate and soapmaking expert from TTC, visited Mali under the auspices of the Women and Development Project, a joint project founded by the American Friends Service Committee and the Malian Ministry of Rural Development. At the request of the cooperative members, he spent three days in Markala studying the possibilities of improving the quality of locally-made soap.

Donkor examined the problems of quality and cost and suggested that a combination of shea butter and other oils be used to produce a soap which both lathers and is hard. He also proposed that the cooperative try boiling or hot process soapmaking. This process offers several advantages: production costs are lower as the proportion of caustic soda to oil is considerably less than in cold process soapmaking, more soap is produced for a given quantity of oil as water and fillers increase the bulk of the soap, and the boiling process removes the strong odors of fish oil and shea butter.[3]

During this visit Donkor and the members of the soapmaking committee used the boiling process technique with different combinations of shea butter, fish and peanut oil (figs. 1, 2). Satisfied that a high quality soap could be made from these

Fig. 1. Experimenting with different soap formulas before the larger soap tanks were installed.

[3] For a technical description of soapmaking, see Peter Donkor's paper, "The Development and Transfer of an Intermediate Technology for the Small-Scale Soap Industry of Ghana," Technology Consultancy Centre, University of Science and Technology, Kumasi, Ghana, November 1978.

Fig. 2. The first experimental bars of soap being cut by hand.

oils, he then helped the soapmakers assess the profitability of such a soap. Basing the production costs of soap on the highest seasonal oil price (Table 1), the committee concluded that soapmaking could indeed be a profitable venture and requested that Donkor return to help them install a soapworks based on the Ghanian design.

During the months before the planned installation in May 1979, the cooperative members assembled the necessary equipment, all of which was available in Markala. Local welders made two boiling tanks from galvanized iron and two tank stands of reinforced iron rod according to TCC diagrams. Wire-suspension cutting tables and 10 molds were ordered from a carpenter. A scale for weighing raw materials and plastic sheeting to line the molds were purchased.

On Donkor's return, the soap boiling tanks were installed. For several days a local mason did skilled work, while the women carried the bricks, rocks and cement needed for the installation. The tanks on iron stands were put in place and mud bricks packed around three sides of the stands, thus creating a reinforced

Table 1:

Typical Costs and Income from Soap Production (Malian francs)

Shea butter	70,000	
Peanut oil	12,600	
Fish oil	21,000	
Palm oil	1,600	
Caustic soda	7,800	
Wood	1,500	
Clay	3,000	
Perfume	1,250	
Salaries for 20 workers/500 francs per person	10,000	
Total Cost (excluding capital costs)	128,750	($320 US)
Number of pieces of soap made	1,150	
Sale price of one piece	150	
Cost price of one piece	112	
Net Income	43,700	($110 US)

400 Malian francs = $1 US

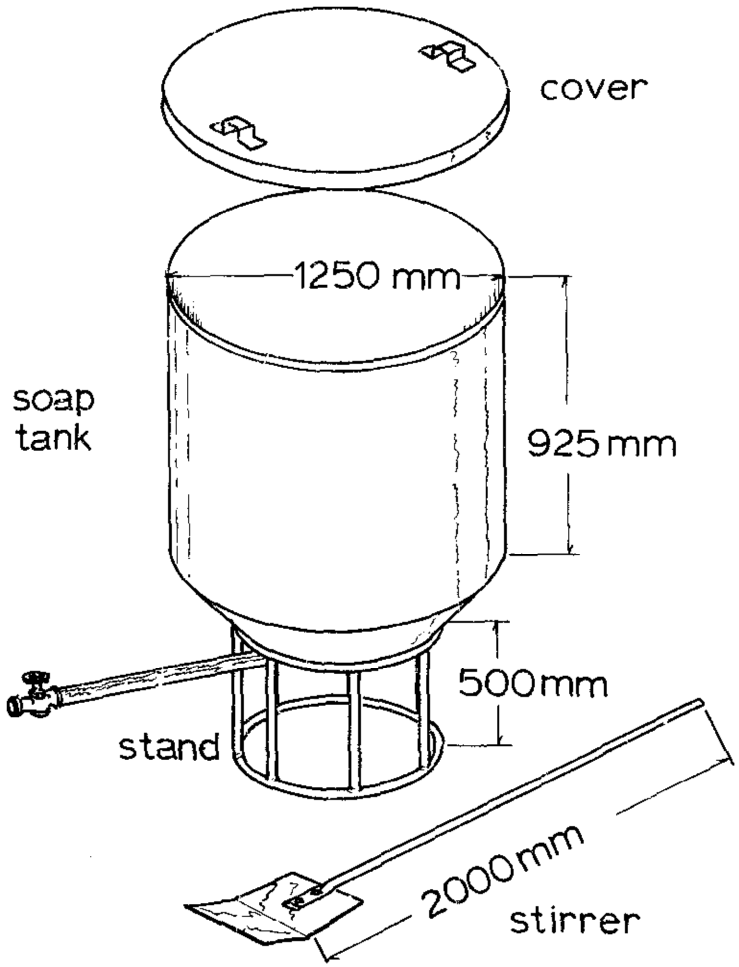
mud oven under the boiling tanks (fig. 3). A cement wall was then built around the tanks and filled in with rocks. A thin layer of cement created a platform on which the soapmakers stand during the boiling process (fig. 4). The total cost of the installation was 505,380 Malian francs (about $1250 US).

Under Donkor's supervision, the cooperative members produced four batches of boiling process soap of 150 litres each. The mixture of oils and caustic soda solution was brought to a boil and water added slowly to accelerate saponification. The Markala soapmakers' previous experience enabled them to identify when and how much water to add as a saponification medium, when saponification had taken place, and how much water to boil off before removing the heat.

With the fire removed, perfume and the kaolin filler solution were added to the liquid soap, which was then poured into molds to harden. Finally, the large blocks of soap were cut into 250 gram pieces by pushing the blocks against a wire suspended vertically between a cross bar and the table top. This simple system, introduced on TCC advice, was a marked improvement over cutting with a knife. The cutting table produces identical pieces of evenly-cut soap and reduces waste to a minimum.

After a week of soapmaking trials, the cooperative members were satisfied that they had acquired the basic techniques and Donkor's training was complete. Over the following months, the Markala soapmakers continued to experiment with combinations of oils, fire intensity, timing of water additions, and different fillers. They found a nearby source of kaolin filler and tried different methods of producing a kaolin powder fine enough to assure increased soap hardness, smoothness, binding, and transparency. The end result is a laundry soap which compares extremely well in quality and appearance with any industrially-produced soap sold in Mali and is a product of which the members are justifiably proud.

Fig. 3: Wood-Fired Soap Tank



The original group of three soapmakers has expanded to 10 women who have mastered all production techniques. Ten more women provide assistance on soap production days twice a week. Participants in the soapmaking are paid for their labour. All income from soapmaking is held in a separate account which was initially used for purchase of raw materials. Recently, however, with new profits from soapmaking, the cooperative has raised the monthly stipend received by each member by 25 percent.

A number of obstacles must be removed before the Markala Soapworks can attain the members' goal of both producing and selling 2000 bars of soap per week. They must have retail agents in other towns since Markala cannot absorb this quantity. This in turn has strained the cooperative's bookkeeping system. The two literate members of the cooperative record the transactions of their millet grinding mill and cloth dyeing, as well as soapmaking. Recently an improved

Fig. 4. Soap tanks in use.

bookkeeping and stock control system for the Soapworks was established; however, further training in bookkeeping is needed. In August 1979 the cooperative began purchasing raw material in bulk in order to increase profits by reducing production costs. This in turn has required a reevaluation of the working capital necessary for the soapworks, an accurate stock control system, effective transport, and storage facilities. These problems are currently being studied by the members, who may seek credit for expansion as well as technical assistance in cooperative accounting.

Traditional soapmaking has long been recognized as a woman's task in Africa, but has often become a male preserve when improved technologies permit the production of large quantities of high quality soap. Rural women seldom reap the profits from improved soap technologies. In the Markala case, however, a low-cost soapmaking technology led by a cohesive, self-managed women's cooperative has enabled low-income, rural women to retain control over and improve upon a traditional source of family revenue.

The Markala cooperative has begun to teach soapmaking technologies to other women in Mali. In January 1980 the Markala cooperative trained 15 representatives from nine rural women's groups in cold process soapmaking. These groups have begun production and, depending on local oil supplies and group cohesion, it is likely that some will install soap boiling tanks in the future. It is hoped that the transfer of soapmaking technologies will then strengthen other womens' institutions in the country.

In conclusion, a number of factors about the transfer of soapmaking technology to the Markala cooperative are noteworthy. The women chose to develop soapmaking on the basis of their own skills and knowledge of local demand and resources; they were involved in adapting an imported technology to their conditions. They controlled the introduction of new techniques. Finally, the cooperative achieved a significant group strength through its soapmaking efforts which enabled it to benefit as an institution.

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Condensing a Solution: Community Solar Engineering, Haiti

Ron Alward and Tom Lawand[1]

The *Handbook on Appropriate Technology contains* a detailed description of a solar distillation plant built at Source Philippe, La Gonave, Haiti in 1969. Eleven years after its inception, Tom Lawand and Ron Alward of Brace Research Institute looked back on this project and tried to answer the question of why this project succeeded when others, equally sound, have failed. They looked closely at the decision-making process, the selection of options, and the longer-term technical reliability of the system.

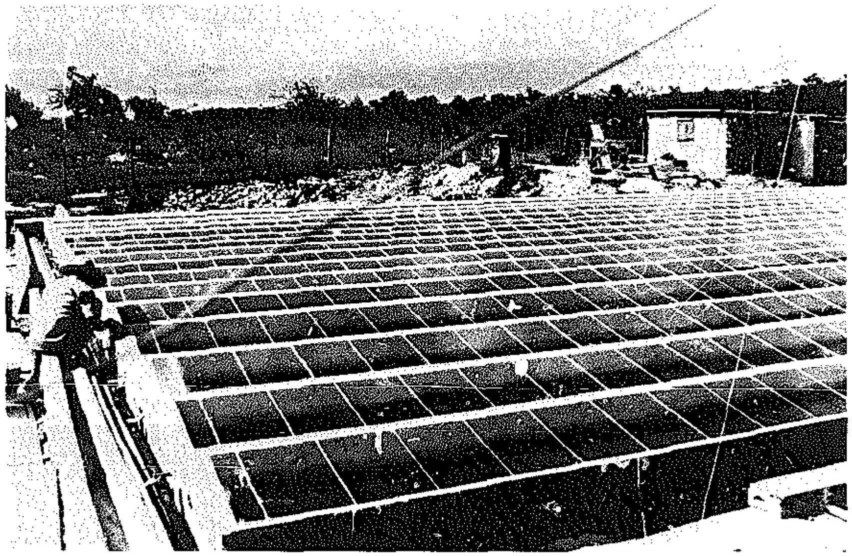
Source Philippe, an isolated island community of 250, had no natural supply of fresh water other than rain. A large rainwater catchment system had been built, but there was still an urgent need for fresh water. Efforts to drill for fresh water had proved fruitless. Recurring droughts meant that people had to depend on distant water sources (a nine hour round trip by foot or donkey) or water brought by boat from the mainland. In conjunction with the local community, the Brace Research Institute designed a solar distillation system which produced 1100 litres per day of fresh water from either brackish well or sea water, and collected rainwater. The cost of the system is high (approximately $60 US per capita in 1969) relative to groundwater systems but still low compared to the alternatives. During periods of drought, over 1000 persons per day obtained water from the still. The local community was involved in all phases of the project from the choice of solar energy to distill water through the labour-intensive construction. Without question, the technology employed was adequate: the still continues to work, it is integrated into the life of the village, and the village is responsible for its maintenance.

Solar stills are usually only feasible in arid sea coast regions where the ground water is salinated and not potable. The best locations are small, isolated communities with a low demand for drinking water.

In 1968, after considerable research, the leaders of Source Philippe and a Haitian agronomist, with the help of l'Eglise Méthodiste d'Haiti, identified solar distillation as one of the options for providing fresh water. Brace Research Institute was initally asked to help determine the feasibility of this option. After

[1] Brace Research Institute, Ste. Anne de Bellevue, Quebec, Canada

Solar Still, La Gonave, Haiti.



discussions of desalination techniques between the village cooperative and the agronomist, solar distillation was chosen as the most likely to succeed.

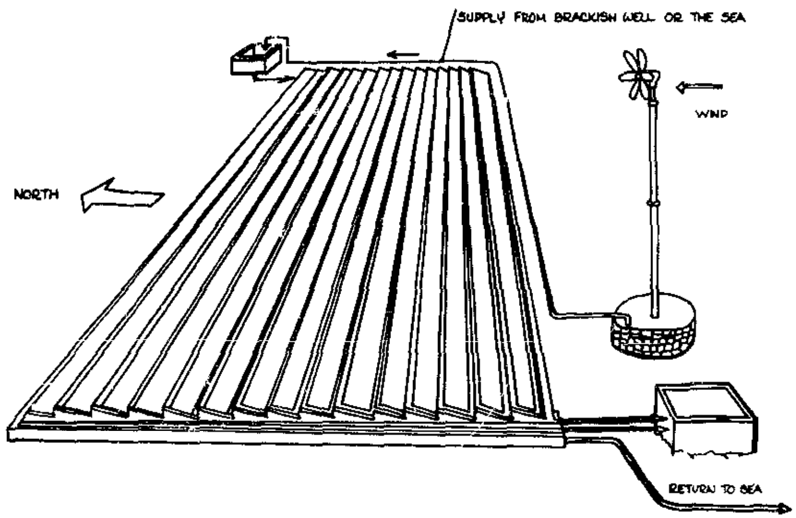
The technology used for this project was sound and had a reliable record for providing fresh water in a variety of communities throughout the world. Local resources, such as sun and wind energies, construction materials and human skills, determined the adaptations of this technology.

Village members specified their water needs to the Brace engineer and expressed concern over the appearance of this novel device and how it would be integrated with their existing water reservoir. The engineer also asked for advice on insulation material, and the villagers suggested the use of coffee husks for this purpose. With this on-site information and further correspondence with l'Eglise, Brace designed a suitable solar distillation plant.

When the Brace project engineer arrived in Source Philippe four months later, working drawings in hand, he found that the people had changed their minds about the site originally selected since a large shade tree, which formed a communal meeting place, would have to be cut down. Finding a new site which did not disrupt village activities required alterations in the original design. The new design constraints were not a problem as local construction skills were used to obtain the necessary south-facing slope, dig the well, and build elevated and sunken water reservoirs. The community's skill in stone-wall terracing methods was particularly impressive. In many instances such skills were instrumental for decreasing the quantity of construction materials used. The Brace engineer later said that the village workers taught him a considerable amount about the use of lateritic soils mixed with cement and efficient techniques of hand-mixing large quantities of concrete.

The interaction and learning which took place on all aspects of the project between a local non-governmental organization, engineers, village leaders, an animator, and the villagers themselves partly account for the still's success. Over

Basic features of La Gonave solar still



five long, hot, dry months the construction involved every man, woman and child in the village.

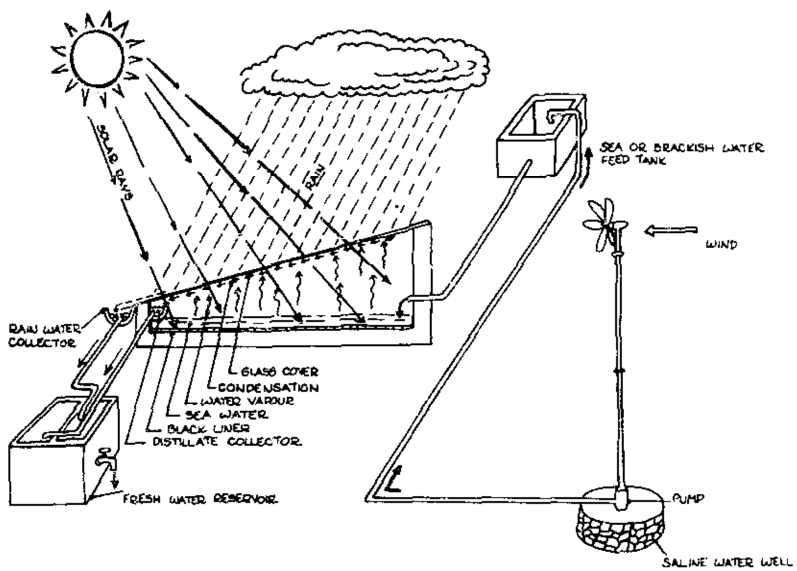
It was realized at the outset that the most vulnerable part of the system would be the pump used to elevate water from the well to the solar distillation site. Thus the primary wind pump had a hand pump and even buckets as back-up.

The original windmill was a Savonius Rotor built in a Port-au-Prince workshop of oil drums and other locally-available parts. After installation it became apparent that this system was incapable of reliably delivering adequate quantities of water up the 5m head from sea level to the saline water reservoir. The Savonius Rotor waterpump was eventually replaced by a small German-made Lubing wind pumper (original cost $200). Its bronze pump rod lasted about two years before being replaced. The windmill itself lasted five years. Since that time, saline water has been pumped to the upper reservoir by a hand pump. Every few years new pump parts have had to be purchased (totalling about $30 each time) because of the highly corrosive saline water in the well.

A general overhaul and maintenance check of the entire distillation plant was done in 1978 to correct a few technical faults that had developed over its nine years of operation. The coffee-husk insulation material was originally buried under a two-inch layer of sand but, due to settling and sand shifting caused by flowing water in the ponds, some husks came into contact with the butyl rubber basin liner and gradually wore holes in it. During the overhaul, this insulation was removed and replaced by sand. Some glass which had broken over the years was replaced. The overhaul was initiated by l'Eglise Méthodiste d'Haiti and the village leaders. Correspondence with Brace Research Institute technical staff and on-site assistance from church volunteers enabled the villagers to complete the overhaul in six working days.

Prior to the repairs, nine of the original 15 distillation basins were operating at or near capacity with the remaining six basins only partially operational. Since

Schematic concept of solar still operation



that time, fresh water production from the solar still has averaged some 20 percent over design predictions.

Non-technical factors also accounted for the outcome of the project. Everyone in the village needed fresh water; the desired goal was entirely unambiguous. This is worth emphasizing since frequently those who advocate a focus on basic needs in development projects overlook the fact that priorities are often unclear or, at a minimum, there is no general concensus on the order of priorities. When the need is clearly agreed upon, an AT approach to providing solutions is much simpler.

The introduction of the solar still was facilitated to some extent through its incorporation into an overall development scheme for the community which included agriculture, fishing, and health components. Recent successful innovations had paved the way for the solar still. But the use of locally-available resources and skills working through the existing leadership structure, and the participation of the whole community in the project all increased the chances of acceptability by the community. By participating in most aspects of this project the village was able to broaden its range of experiences while utilizing existing skills and familiar working materials.

The introduction of new technologies involves a complex interaction between the people in the community, their social, political and economic structures, the local resource base, and the new technology. The degree of success or failure in technology introduction generally relates directly to the level of consideration given to the various elements in this interaction. If the focus is primarily on technology, to the near exclusion of the other elements, an immediate technical success may be achieved. Often, however, the technology is not used as people revert to traditional practices for a number of non-technical reasons.

L'Eglise Méthodiste d'Haiti provided the structural umbrella under which the project was carried out. They promoted the establishment of a village cooperative council which formulated decisions on project developments, and the church used its base in Port-au-Prince to support village activities.

Local technical and social animators employed by l'Eglise Méthodiste d'Haiti provided logistical, technical, and moral support to the villagers. At critical phases in the technology introduction, before the project was initiated and during the follow-up period, Haitian sociologists, agronomists and other community animators provided the social motivation necessary to ensure the success of the project. They helped the villagers understand the basis of the work and provided the continuing support necessary to ensure the operation and management of the still.

Training villagers in construction, operation, and maintenance procedures was fundamental and essential to integration of the technology into the social fabric of the community. Those trained developed and improved on skills which they have subsequently used to advantage in related activities and other development programs affecting their own and neighbouring communities. Their resolve, willingness, and ability to solve their critical water supply problem contributed most to the success of the operation.

This was an uncommon development project. Everyone in the village was involved: the traditional leadership, the cooperative movement, the church hierarchy, the richest, the poorest, the most powerful, the least influential, and even the externally-imposed police officials. Perhaps more important, all of these structural elements were represented in the decision-making process.

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Putting the Components of AT Together, Papua New Guinea

The South Pacific Appropriate Technology Foundation (SPATF) has organized a network of activities and services to promote small-scale appropriate technology projects mainly in the rural areas of Papua New Guinea (PNG) and other islands in the South Pacific.[1] Over three years SPATF has developed a unique set of interconnected components to serve some of the needs of isolated communities. SPATF has focused as much on developing the support services required to get improved tools and techniques into use as on the techniques themselves. SPATF provides information, implements, technical and financial assistance, and promotes access to these services to help develop the village-level organizations which are the base for further development.

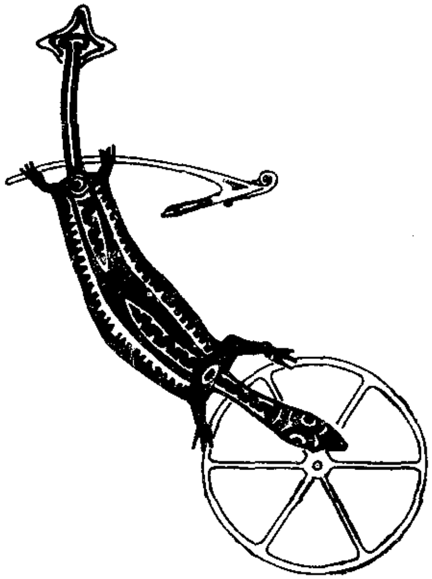
SPATF is adapted to the present development policies, resources, and traditions of PNG. The same organizational structure and combination of components are not necessarily suitable or feasible in other countries at different stages of development, and having policies which may not support appropriate technology.

AT endeavours which focus only on hardware demonstration or information centres will be marginally effective. Information on paper is silent and demonstrations are interesting to look at but a supporting network is required to get ideas into action.

PNG is a diverse country split by mountains and coastal waters. Its 3 million people are also divided by a mixture of languages and cultures. Travel and transportation within the country are expensive. PNG is still largely dependent on foreign aid and primary product exports (copper, coffee, copra, and cocoa) and does not yet have a sizeable number of small-scale carpenters, blacksmiths, or tradesmen in the rural areas who can readily service small-scale technologies. Prior to independence in 1975, development was limited to a few coastal centres. Providing the 80 percent of the population in rural communities with access to improved technologies has been a primary concern of the post-independence government.

[1] Information for this case study provided by Nigel Florida, SPATF.

Fig. 1. SPATF's Logo



In 1976 PNG was one of the few countries in the world with appropriate technology concepts specifically incorporated into its national development plan:

> Government extension and education efforts will be increasingly related to the needs of specific communities through better coordination of field services and by development of a more integrated national and provincial planning system. In this sense the whole aim of the rural development effort could be summarised as that of introducing technologies that are 'appropriate' to the needs of particular communities. In some circumstances, this could mean the introduction of sophisticated, capital intensive techniques. However, in most cases rural development in Papua New Guinea needs simple technology and wherever possible labour intensive rather than capital intensive technology.[2]

Though not a government organization, SPATF is in some respects a policy instrument for the gradual transformation of traditional production. To achieve this, the government will be encouraging introduction of technologies that are appropriate in the sense of "being adaptable to local skills, fitting in with local customs, using primarily local materials, and relying on local control and local initiative."

Economic planners realized that industrialization or urban employment policies can absorb only a small proportion of the workforce:

> Government policy will be to encourage the growth of urban self-employment but again this sector can absorb only a small part of the total workforce. Even if the . . . urban workforce increased dramatically . . . over 70 percent of the total workforce would still require opportunities for self-employment in rural areas.

Moreover this is not a quick solution.

> This strategy for rural development is not put forward as an easy solution; it will only succeed if promoted through a consistent set of policies over the

[2] This and the following quotes are from *The Post-Independence National Development Strategy*. Central Planning Office, Waigani, PNG, October 1976.

lifetime of the next generation. However it is the *only* strategy that will make it possible for the *majority* of the people to become involved in improving their material standard of living through their own efforts.

SPATF built on the initatives of other groups in PNG, in particular the Melanesian Council of Churches which in 1977 published the *Liklik Buk* (Little Book), probably the most impressive AT "handbook" written for and by a particular country. It is an encyclopedia of resources, agriculture, and ideas for rural development workers. About 20,000 copies have been sold worldwide in English and it is now available in pidgin. The book includes a cautionary note entitled "The Appropriate Technology Game."

> Every time an international flight lands in Port Moresby, we get at least one more appropriate technology expert. PNG has more appropriate technology experts per capita than any other country in the developing world, most of them foreigners.
>
> The trouble with appropriate technology experts is that most are experts at little except convincing themselves that they have something to teach. Perhaps *Liklik Buk* is no exception!
>
> It is very pleasant to sit around the yard of a high convenant house sipping beer and drawing plans for dehydrated kaukau factories. It is even satisfying living in a bush house and building an evaporative cooler from poles and mosquito nets. The trouble is that much of the "appropriate" technology is what somebody thinks is appropriate for someone else . . . . Until more of what is called appropriate technology is invented, made, and adopted by Papua New Guineans, the appropriate technology "expert" should examine his motives very critically.

SPATF recognized that there were lots of ideas and potentially appropriate techniques in existence. The problem, the crucial part of a good AT program, was to help local communities identify their needs, and make options available to them, and put them in contact with suppliers of materials, hardware, or suitable technical and financial assistance.

Realizing the need for a network of interconnected supportive services if AT is to be applied, SPATF has the following as components of its AT program. Each part in isolation would only be marginally effective; in an overall program, each one is more successful.

1. Technical Information Exchange Library

SPATF has catalogued over 1,000 publications. The retrieval system is designed to provide a number of alternatives for a particular problem. The final choice of the technology to be used remains with the user.

2. Publications

— A free, three-language, bi-monthly development newsletter, "Yumi-Kirapim," which promotes, informs, and provides feedback on AT development activities.

— "Kaunsila Traim" ("Counselor Try It" in pidgin), a comic strip which appears in a local newspaper. (fig. 2)

— Basic construction and repair manuals for hydraulic ram pumps, sewing machines, drum ovens, ferro-cement houses and water tanks, blacksmith bellows, forges, and charcoal making.

Fig. 2. Kaunsila Traim

3. AT Demonstration Workshops

SPATF organized 15 "hands-on" workshops in 1979 which demonstrated both traditional and improved techniques, and project-related skills that participants can begin to use immediately at the village level, or in organizing their own workshops.

The workshops also introduced participants to representatives of government services and development assistance agencies.

4. Small Project Fund

This fund provides grants of up to 300 kina ($420 US) to group- or community-initiated and controlled projects to supplement local resources and put improved techniques into practice.

A second objective of this fund is to help develop technical and managerial skills, and create an awareness of the need for project planning. For most of the requesters, it will be the first time that they have approached an aid agency; it will be the first time they have written a project proposal; it may be the first time they have managed this amount of money; it will be the first time many have tackled a technical project. There will be mistakes — nails will be budgeted for, hammers not so. Technical expertise will be assured, only to find it does not exist and must be learned. The fund is based on trust — trust that people will spend the funds allotted wisely and to the best of the current ability and will gain from the experience. If a physical piece of hardware such as a drum oven or water tank exists at the end of this experience, that is seen as an added bonus. Drum ovens, water supply/sanitation projects, and pig and poultry projects have been the most popular.

5. Village Equipment Suppliers (VES)

VES evaluates and sells basic tools and agricultural processing equipment that villages can afford (fig. 3). By conducting business by mail, it attempts to overcome the limited access remote villages in particular have to this market.

6. Bomana Rural Workshop

This is a demonstration and training workshop to show that existing and upgraded metal and woodworking and blacksmithing can be developed into small-scale industries which service agriculture. In demonstrating alternate technologies it avoids the pitfalls of becoming a "museum for the preservation of AT" (a pitfall other AT demonstration centres, without a supporting network of activities, have fallen into). It also tests and adapts imported hardware (in particular the equipment sold at VES) and ideas to PNG conditions.

7. AT Development Unit of the University of Technology, Lae (ATDU)

Some AT projects require sophisticated research and design services. Through the ATDU professional engineers and their students, SPATF and their village-level clients have some access to such services. ATDU promotes the involvement of faculty and students in village-level projects. (See the following case study for a description of an ATDU hydro-electric project.)

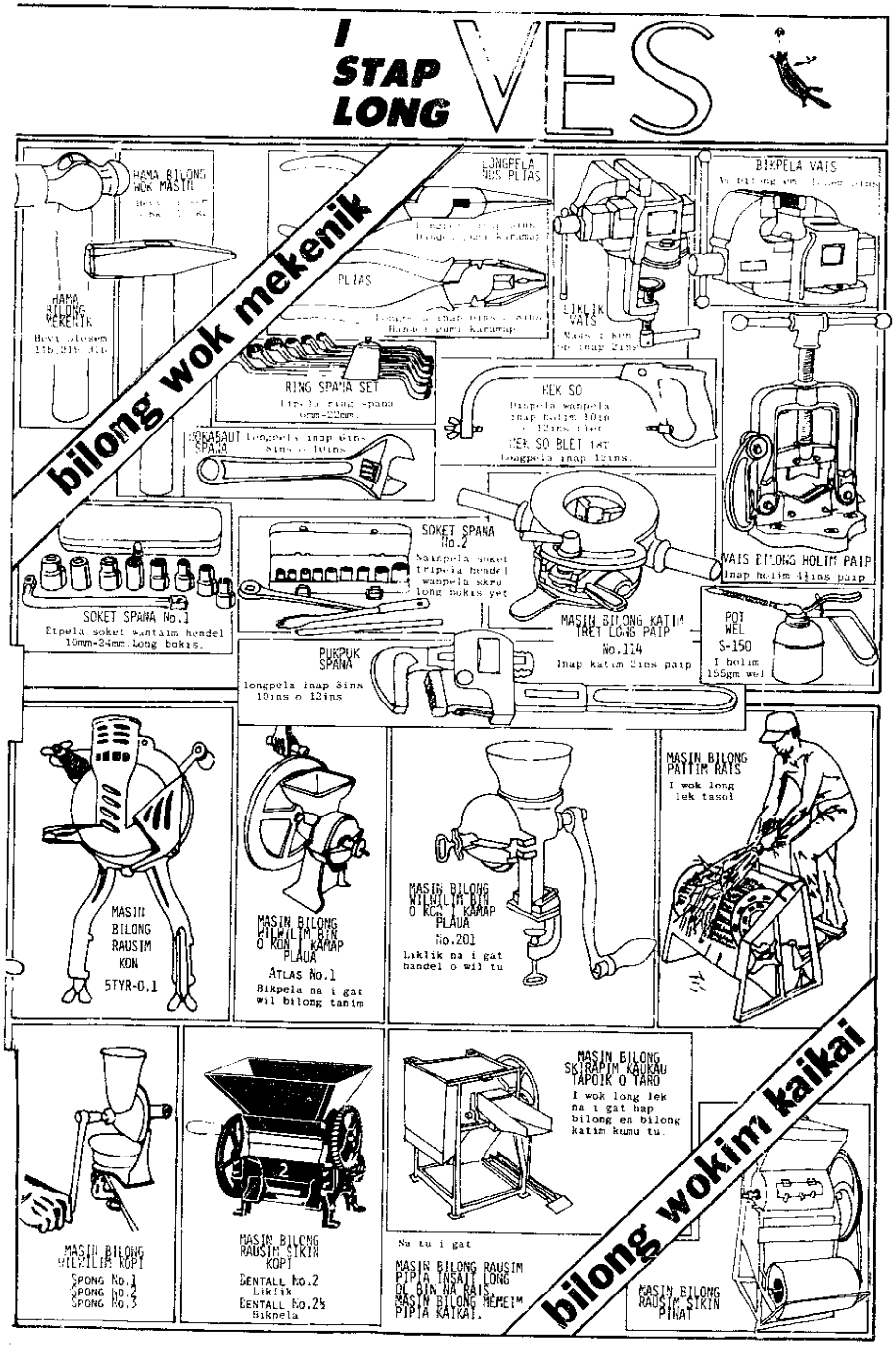
8. Regional Representatives

After a two-year search for volunteers, SPATF is initiating a network of four paid representatives as a link between the head office and the field. These representatives will work from small regional offices and are provided with a mobile demonstration workshop on a 4-wheel drive vehicle.

9. Hanuatek Small Industries

This industrial promotion service offers initial financing for urban workshops, and a variety of training and marketing services. Current services offer help with sewing machine repair, copper beating, ice making, and carpentry.

Fig. 3. Part of Village Equipment Suppliers Catalogue.



Outboard motor repair, low-cost furniture and hospital equipment manufacture, and casting of cooking pots are planned for the future.

10. Administration

This is probably the most important component of any AT organization, once the most feasible approach to serving clients has been identified. SPATF appears to have worked out a practical approach and can coordinate its various components smoothly. The 23 paid staff include 19 Papua New Guineans.

It should be re-emphasized that the above components of SPATF are interdependent and linked to other development organizations in PNG. For example, some demonstration workshops have been designed so women can discuss, construct, and evaluate both traditional and improved techniques from agriculture to sewing machine maintenance. If, in such a workshop, the women find a wood stove proposal potentially useful and manageable, and want to implement the technology upon returning to their villages, they might still need further information, tools, technical assistance, a small amount of money, or feedback from similar initiatives elsewhere to help promote and legitimize their efforts within their own communities. These support services make demonstration workshops much more effective. Moreover, out of these workshops come suggestions for improvements to existing services and technologies.

Further Reading:

Liklik Buk

Available from Liklik Buk Information Centre, P.O. Box 1920, Lae, Papua New Guinea.

A. Fuglesang, *Doing Things Together: Report on an Experience in Communicating Appropriate Technology*. Available from Dag Hammarskjöld Foundation, Uppsala, Sweden, 1977. A detailed report on one of the original AT workshops in PNG.

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Generating the Links Between Engineers and Rural Villages, Papua New Guinea

P. Greenwood and C. W. Perrett[1]

In Papua New Guinea more than 80 percent of the population live in remote villages of only 100 to 300 people. Much of the country is covered by rugged, mountainous terrain which, because of a high annual rainfall, has a large potential for hydro-electric power generation. This is done on a large scale by the public utility for electricity but it is not technically or economically feasible for many of the more distant villages to be connected to the main electricity supply grid. At present the majority of villages rely on kerosene for lighting and firewood for cooking and heating. Those few villages associated with mission and government stations, plantations, and business groups usually have small diesel power plants for lighting and small appliances. Some stations have hydro-electric plants. All these small-scale schemes have been initiated and managed by expatriate personnel and have caused little change in outlying villages since electrification is almost always confined to the immediate station.

In 1975 the University of Technology, Lae, in conjunction with the Appropriate Technology Development Unit (ATDU), based at the University, installed a small hydro-electric system near Baindoang, a remote rural village. Wind power and solar power had been considered but were not seen to have any great potential, although the latter may be feasible in the future. Since liquid fuel must be flown to Baindoang, diesel generation is not economical over time despite its lower initial costs. Hydro-electricity was chosen as the power source because of the heavy continuous rainfall and high head available. Local initiative, essential for success, led to the choice of Baindoang: the headmaster of the local school heard a radio broadcast about a University seminar on rural electrification and invited the University to investigate possible sites in his area.

Baindoang is at an altitude of about 1500 metres and has a generally mild climate with fairly cold nights. It is a subsistence farming area with a small amount of coffee grown as a cash crop. Access is by either small aircraft or an extremely difficult two-day trek through very rugged mountainous terrain from Lae, the

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nearest town. The hydro-electric system is near the primary school and airstrip area, the focal point of the surrounding community of seven villages. The main village of Baindoang is 2 km away at an altitude of 1800 metres and in the near future it will be linked to the system by a high-voltage transmission line.

Since most rural villages have no hope of a government-operated electricity supply, arrangements must be created which permit self-sufficiency. Initial costs must be kept to a minimum, management and operation must be provided by the people themselves, and maintenance arrangements handled on a cooperative basis.

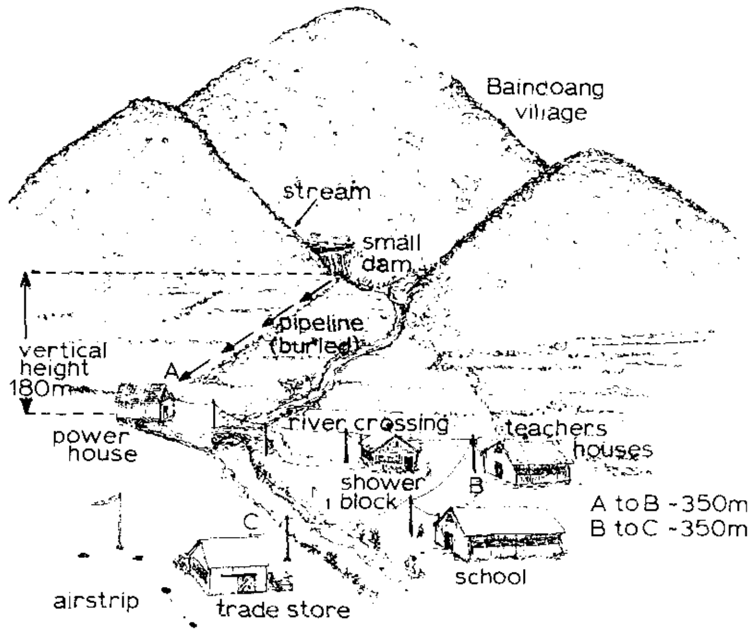
The objective of the project was to install a scheme which was not associated with a mission, government or business interest, thereby allowing villages to achieve more self-sufficiency. It was essential, therefore, that the local community be involved in planning and installing the system in order to be prepared for independence from expatriate involvement, apart from occasional technical assistance. Thus outside involvement was restricted to technical advice and aid. The community, through the leadership of the village council of elders, decided and managed the non-technical details of the project. The council also established priorities for the use of electrical power: a two-way radio, a health aid post, the school, the teachers' houses, the trade store, coffee processing equipment, and a freezer. The elders also encouraged the participation of local carpenters and an electrician.

The installation was managed by two communities. The first, consisting of University and ATDU staff, assessed various technical possibilities. A staff member then visited Baindoang and presented various alternatives to the council of village elders which, with some of the school teachers, formed the second committee. In this way, for example, it was decided that a hot water supply, shower block, and washing facilities should be built. The system was installed in 1978. The community provided and managed the unskilled labour, which often consisted of women and children digging trenches and carrying materials. The University and ATDU provided skilled and semi-skilled labour; University students were encouraged to participate (which they did with great enthusiasm) by assisting with manual labour, house wiring, and design work. (Course credits were the reward for their efforts.)

The hydro-electric scheme (fig. 1) is a high head (180 metres), small flow (8 litres/second), system driving a pelton wheel giving a measured 6.8 kW of electrical power. A single phase, 240 volt, 30 amp, AC alternator is directly coupled to the turbine. The customary, expensive, and complicated mechanical speed governor was omitted in favour of an electronic load controller having no moving parts and requiring little maintenance. This device ensures that the electrical load on the generator is held constant, keeping the generator at constant speed. It was developed by the University and costs about $200 US. The load controller enables electricity to be diverted from a "continuous load" (a water heater) to a "temporary load" (a radio broadcast or coffee processing).

The total steady electrical load is approximately 4.5 kW, consisting of a 3 kW heater and a 1.5 kW lighting load which run continuously 24 hours a day. A large hot water tank is used for showers and general domestic use at the communal facilities. No thermal insulation is used on the tank so the water never exceeds 60°C and the heat loss is available for drying clothes. Variation in the lighting load does not significantly alter the machine running speed but the load controller is required when an intermittent load such as a freezer or power tool is used.

Fig. 1: Small-scale Hydroelectric System



In the event of a loss of a system load, a simple current sensing device will switch on a large water heater in the tail race of the turbine to prevent overspeed and damage to the generator. This method is simple, reliable, and inexpensive.

Answering the modest power needs of Baindoang required some bureaucratic intervention. After ensuring that initial electrical requirements were met, a few bush houses were wired up. Several safety problems, in particular the danger of fire in grass roofs and electric shock should a roof leak, led to the establishment of a standard for wiring bush houses by the Papua New Guinea Electricity Commission Authority.

Since stimulating self-sufficiency was a considerable influence on the engineers of this hydro-electric project, simplicity and reliability were essential to its design. The turbine and generator set was purchased from an overseas manufacturer known for reliability. All other equipment was purchased in Papua New Guinea to minimize later problems of replacement. For future projects, pelton wheels will be manufactured locally. This will reduce the costs for high head schemes by up to several thousand dollars. A maintenance facility is being set up to service this and a number of other systems in the area.

The actual cost of the project is difficult to establish. Overhead costs such as staff time, airfares, and experimental facilities were included in the initial research project and the student field trip budget. The large amount of "free" labour involved could not be assessed.

Travel and subsistence expenses were reduced by using the local labour force. Use of local materials avoided expensive airfreight charges.

The hardware cost of the scheme was 10,000 kina ($14,000 US), including the community washing block and all electric wiring. Funding came from various aid organizations and University sources, plus a 10 percent contribution from the village itself. Contributions from the future users are considered essential for any project of this sort; a sense of ownership is implanted as is active invovement in the project.

The transmission line to Baindoang, the next stage of development, will be expensive but the potential reward is high. The proposed 2 km line, which will carry up to 3 kW, and the wiring of up to 40 houses will cost about $10,000 US. The scheme is supported by the government to discover low-cost methods for future systems and the socio-economic impact of rural electrification.

A full evaluation of the impact of the electrification on the communit . will be of necessity a long term project. However, the immediate benefit to the community has been an improvement in the quality of life. The villagers are hopeful that this will help them attract and retain good school teachers. They also hope that the improved facilities will prompt young people to stay or return to the village.

Only a few minor technical hitches have occurred in the last year and the project has been deemed a success by all participants. Experience has shown that difficulties may arise through aging of plastic piping, land erosion on the river banks near the cable crossings, and earth tremors.

The novelty of the project lies in the application of this largely proven technology to a rural, unsophisticated situation and the handing over of total management to the local community. The major lesson to be learned from it is that for such a project to be a success the local community must be actively involved in all stages of the planning and construction. The project has also illustrated the value of a multi-disciplinary involvement of mechanical, electrical, and civil engineers, and economists and sociologists.

As a result of the Baindoang success, several provincial governments in Papua New Guinea are funding more projects with the same aims and management

Fig. 2: Local Construction Crew

structure. Eight projects are being investigated currently by the University. Its provincial government is establishing a five-year program planned and advised by University staff. Local manufacturing and maintenance facilities will be established as part of the program.

Further Reading:

The Power Guide: A Catalogue of Small Scale Power Equipment
Compiled by Peter Fraenkel. Intermediate Technology Publications, 9 King Street, London WC2E 8HN, UK: 1979. A buyer's guide to suppliers of smaller-scale power sources and an introduction to choosing them.

Energy for Rural Development: Renewable Resources and Alternative Technologies for Developing Countries
Report of an Ad Hoc Panel of the Advisory Committee on Technology Innovation; Board on Science and Technology for International Development; Commission on International Relations, National Academy of Sciences, Washington, D.C.; 1976. An introduction to power supply options using renewable energy and their feasibility. A French-language edition of this report was published in 1977 and single copies are available on request from the Agency for International Development, Technical Assistance Bureau, Office of Science and Technology, Washington, D.C. USA 20523.

Purari: Overpowering PNG?
International Development Action for Purari Action Group. Available from International Development Action, 73 Little George Street, Fitzroy Victoria 3065, Australia. A study questioning the choice and development impact of a large hydro-electric project in Papua New Guinea, also describing how and why such choices are made, and the development impact (or lack of it) in six similar projects elsewhere.

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Appropriate Technology vs. Economic Reality, Ghana

A barrier exists between formal research and development activities and the majority of people. Large research institutions and universities do not have a particularly good record of providing suitable technical options that low-income entrepreneurs or communities can afford to adopt. Moreover, they are hesitant to involve themselves directly in the community or shop-level process of adapting research to local conditions.

This is increasingly recognized and many independent AT centres have been established to link their research to the needs expressed by small farmers, artisans, entrepreneurs or cooperatives. Most of these centres are relatively new. There is little detailed information on their field experience in diffusing technologies or descriptions of the particular constraints which mold their approach to AT. The effectiveness of these organizations is determined not only by their technical abilities and sensitivity to local development issues, but also by national and international level policies which can promote or thwart the initiatives of such groups.

The following report is based on an assessment of the experience of one such group, operating in a different economic context.[1]

The Technology Consultancy Centre (TCC) in Kumasi has had eight years of experience in developing alternate choices of technology in Ghana and, occasionally, in transferring them to nearby countries (see the chapter "Women Finding Assistance, Mali"). It has had a variety of successes and disappointments in diffusing new techniques and products. Despite a focus on close interaction with local entrepreneurs and a willingness to involve themselves in non-technical problems such as assistance with loan applications, certificates of approval from the National Standards Board, import licences, and raw material supplies, they and their clients operate in a very uncertain economic environment. Extremely high inflation rates and price controls increase the risks of adopting different techniques, hence limit the Centre's effectiveness. In a country whose economic policies over the past 20 years have created a bias towards selling or repairing imported items, the promotion of local or small-scale manufacturing is very difficult.

[1] Adapted and quoted with permission from Sally Holtermann, *Intermediate Technology in Ghana*, Intermediate Technology Publications, London: 1979.

Situated on the campus of the University of Science and Technology in Kumasi, TCC was initially established to link the technical expertise within the university with local entrepreneurs or craftsmen to help develop small-scale industry. Since then it has become more independent of the university, setting up its own research, development and production facilities. Now TCC is in the process of establishing "intermediate technology transfer units" for its main clients within the "informal" industrial sector where the majority of the industrial labour force is employed.

TCC provides technical advice to small-scale manufacturers, and helps them develop new or improved products and adapt existing techniques to local requirements. They prefer that local people approach them for technical assistance. The requests they have received vary considerably: chemical testing of products, suggestions to improve product quality or process efficiency, help in meeting various government standards, finding sources of raw materials or developing alternative sources, advice on the selection of new or used machinery, or assistance with feasibility studies for loan applications. On occasion, the Centre has built pilot plant production facilities on its premises to demonstrate technical and economic efficiency. TCC has a professional staff of about six people, and up to 60 people in its production units.

Although TCC would welcome more involvement with cooperatives, most of their clients have been individual entrepreneurs who want to invest in intermediate-scale technologies. Both effective cooperatives and entrepreneurs willing to go into manufacturing are in short supply. With a few exceptions, cooperatives in the region have had a poor history: cooperative officials have often been imposed on the cooperatives rather than being chosen from within the membership. As a result members are reluctant to trust their funds to these officials. Local economic realities present risks for a small-scale manufacturer:

> Imagine trying to run a soap factory when you are uncertain whether the state farm will allow you any palm oil this week even if you are prepared to offer a bribe, when the lorry for transporting the oil has a broken clutch and no-one can find a replacement and when the controlled price you are allowed to charge for the soap is less than you have to pay for the palm oil from which it is made.

The government largely ignored the small-scale sector in the 1950s and 60s. There are few links between big and small firms. Overvalued currency and internal inflation (over 100 percent in 1978) have resulted in artificially cheap imports. Price controls have been ineffective in reducing inflation; since local foods are exempt, the poor do not benefit from them as much as high-income people who are more likely to buy the goods covered by controls. Nor are the controls systematically enforced, therefore buyers spend a great deal of time searching for the best price. There is no shortage of entrepreneurs but a shortage of those who will invest in manufacturing as opposed to trading.

> The economic circumstances that make it difficult to make money in manufacturing are precisely the ones that make it easy to earn money in trading. Inflation and price controls enable some people to make small fortunes. Between the person who initially imports or produces for sale at around the controlled price and the person who sells to the final customer at a much higher price on the open market, there is a chain of intermediaries, who all take their cut. An investment in a productive enterprise has to promise a

very high rate of return on capital, and a very high absolute profit, before it will entice an entrepreneur away from the lucrative opportunities in trading. This is one of the main reasons why the TCC has found it difficult to find capable and enthusiastic entrepreneurs.

TCC has been involved in producing a wide variety of items such as soap, animal feeds, glass beads, agricultural implements, and nuts and bolts. It was very successful in helping a local entrepreneur develop a paper glue, made from local materials, that could compete with imported glues. Ghana is now self-sufficient in this product.

Problems have been encountered in the diffusion of improved techniques, as their involvement in small-scale soap manufacturing shows. Ghana is heavily dependent on imported soap. Its largest soap factory, partly government- and foreign-owned, uses imported inputs, although Ghana produces one of the major soap ingredients — palm oil. In recent years the large-scale plant has been operating at a loss and 20 percent of capacity, despite government subsidies.

Traditional soap-makers supply most of the soap in Ghana. In 1972 some of them approached TCC for help in improving the quality of local soaps. After considerable research with local oils, fillers and perfumes, and the assistance of a consultant from India, TCC developed a number of satisfactory formulas and built prototype soap plants to demonstrate their economic feasibility. An inexpensive and efficient wood-burning design emerged. Because both the scale and the technique were familiar and credit was not difficult to obtain, many enthusiastic entrepreneurs have bought soap boiling tanks manufactured by TCC. The Centre also designed small plants to make caustic soda, a major soap ingredient, at one-third of the price of imported caustic soda. The Centre also provides training facilities for soap makers who want to adopt these techniques.

In the following years the majority of these entrepreneurs faced a local "oil crisis". There were continual shortages of palm oil; the official cost of oil in 1978 was ten times the cost in 1973. Blackmarket prices increased even more. The controlled price of soap was far less than the increased costs of ingredients. The small plants were using a fraction of their capacity, profits were low, and many soap makers went out of business. Imported soap, when available, is still a more "attractive" product. By 1978 the Centre was advising caution to people investing in soap production. The profitability of these plants is very difficult to determine on paper because the smaller producers can evade price controls (they must) and the price of ingredients fluctuates markedly. The Centre is now studying alternatives to palm oil, particularly the non-edible oils which do not compete with this product, and locally-made perfumes as substitutes for imported ones.

Small-scale soap production is a very risky venture in Ghana not because of inadequate technology but mainly because of the contradictions in the national economy. Recent currency devaluations which increase the price of imports may lead to a clearer advantage for soaps made from local oils.

The small professional staff at TCC has shown considerable imagination in attempting to overcome the economic constraints on their clients. From soap making and other activities they have found that the diffusion of appropriate technologies and the selection of profitable locally-made products are extremely difficult. The Centre has found the use of prototype production units a valuable training tool. They are now endeavouring to establish more prototype production units outside of the university campus in the midst of the existing informal manufacturing sector.

References:

Ben Ntim. "Experiences in the Application of Appropriate Technology in the Technology Consultancy Centre." Paper presented at BERD, Virginia State University, USA, May, 1979.

Contact:

Technology Consultancy Centre
University of Science and Technology
University Post Office
Kumasi, Ghana

Small-scale Technical Assistance, West Africa

Most AT activity goes unrecorded. The busiest innovators are often the small-scale repairmen and manufacturers around urban marketplaces in the Third World. These self-employed machinists, carpenters, designers, tailors, welders, blacksmiths, electricians, bicycle, truck and sewing-machine repairmen are part of the "informal" sector of the economy. The income they generate is seldom recorded in national statistics, their skills and jobs are seldom catalogued in national manpower plans.

These workers are seldom graduates of formal technical schools, nor do they have access to the huge government subsidies or services provided for large-scale manufacturers. They learn through apprenticeship and are skilled in adapting technologies to their particular needs. Their markets are often unregulated and very competitive. They do not earn much, but governments still tax them and provide very little support in return: interest rates are very high, tools and materials are often difficult to obtain, workshops are temporary structures, water and electricity are expensive or unavailable.

Some effort has been made to improve their incomes through access to improved tools, technical assistance, credit, and working facilities. However, these initiatives are difficult to plan and carry out given the general economic and social conditions in many countries.

One conclusion from a study of 21 small-scale enterprises in developing countries is particularly relevant to AT practitioners.[1] The study noted that in less than one-quarter of the businesses was technology the key problem. Like small businesses everywhere, government economic policies, credit policies, and a host of other problems were of greater importance.

The following case study is an interview conducted by the Canadian Hunger Foundation with a mechanic who has been working in the informal sector for many years in West Africa. It describes some of his experiences as a representative of an international development agency working with other "fitters" (repairmen).

[1] Malcolm Harper and Tan Thiam Soon. *Small Enterprises in Developing Countries*. London: Intermediate Technology Publications, 1979.

Canadian Hunger Foundation:
What is your role with the fitters?
Mechanic:
I'm really a mechanical extension officer, sort of like agricultural extension, but working with small-scale mechanics, tradesmen, to offer any assistance I can. My technical skills are mostly in large and small vehicle maintenance. At the moment, I cover a large area — it's about a mile long and half a mile wide, on both sides of a main road going out of town, with a lot of truck and car repair shops in it.
CHF:
What sort of equipment and tools do you use?
Mechanic:
I use a pick-up truck. It has 4' by 8' sheets of plywood made into a box in the back. If you stand outside the truck, you can draw on it. This wasn't used that often but when it was used it was damned handy. Inside the back there was a tool box, nothing sophisticated, except a basic set of wrenches, screw drivers, pliers, and sockets. The most sophisticated item was a meter for testing generators and regulators. Most of my teaching was in electrical components.
CHF:
Could the fitters borrow your tools?
Mechanic:
Generally, no. They were used for demonstration. I kept an eye on the shops to know what tools were available, and if a guy said there just weren't any, and I knew there weren't, then fine. I spent a lot of time looking through little stores — just finding out what was available. Availability is more important to them than the price.
CHF:
How did you get started on this project?
Mechanic:
When I went in, there was a mechanical association, something like a union, but very weak. I introduced myself to the director and told him what I hoped to do. He didn't understand, but he introduced me to about 12 fitters. They didn't understand either. They were really sceptical. They'd never had access to technical assistance right in their workshops. It took a year before I really established a good working relationship with them.
CHF:
How did you do this?
Mechanic:
As well as understanding the mechanical problems, you have to be pretty sensitive and patient. It's understanding when to talk and when to teach, how to explain technical problems, when not to step on toes, when to see something is wrong and not say anything at all. For example, you couldn't start early in the day. If you did, the apprentices would be there but the master wouldn't. You didn't work with them, you only worked with the master. That was one of the basic rules of the project. The other thing is you don't talk to customers. You are on the master's side. You're trying to improve this guy's business or improve his work. Say a customer comes up and says "Have a look at my car." If I look and say this and this, the customer says "But the master just did that." Sometimes you have to be very careful that the fitter doesn't lose face when he asks you a question in front of a customer.

I started with this group of 12. I persisted. I visted them regularly on Tuesdays and Thursdays. At first they said no, we don't have any problems. I'd show up again. After a while they realized that I wasn't there to make money off them, also that I understood and respected their skills. Now they have confidence in me.

CHF:

How did you learn these skills?

Mechanic:

In another city in a smaller fitting area. There they mainly fixed small trucks and taxis. They had all kinds of cars: American ones with British engines put in them, Russian with French, and so on. I learned to do the job there. I made a lot of mistakes, learned a lot about their methods and their resources. A lot of things they fixed the way they do because you just couldn't do it the way a mechanic's manual said you were supposed to. It is not usually because they didn't know the best way, they just didn't have the tools, like a hoist or a gear puller.

I learned that before you get anywhere, they tested you. A fitter would ask you a question because he wanted to know if you knew the answer. He already knew the answer. If you didn't know, he couldn't learn anything from you. For this reason I've avoided one of the fitters in the area I'm now working in. He fixes diesel injection pumps — I'm just not familiar enough with them. You can't fake it with them.

CHF:

Is this one of the reasons that the technical schools are not interested in your work? Yesterday you were talking about the government's policy of hiring only mechanics who had diplomas, the over-emphasis on "paper" qualifications, in spite of the fact that many government vehicles are unofficially repaired in fitter's workshops and not the government workshop. In effect, the technical school graduates are no more effective in repairing vehicles than the fitters, often less.

Mechanic:

Sure, my job isn't very appealing to the technical schools because you have to be a mechanic, know what you're doing, and accept unorthodox techniques. You are tested every day by a fitter who is having a problem and is economically motivated. So for a technical school teacher or graduate there is a lot of reluctance. With the salary they are paid it's easier to be in a classroom or a "modern" garage.

CHF:

Do the fitters have access to credit?

Mechanic:

Sure, but it's expensive. Some shops will give you "3 for 2." For the price of 2 you have to pay back 3, a 50 percent mark-up over a few months. The money lenders are worse. Over 100 percent interest in a short period, and they use force to collect. Some people who have had loans from government or commercial banks have had them written off by a friend. Many of the owners of large transport trucks have paid cash for them, they don't borrow money.

CHF:

What about the problem of materials and spare parts?

Mechanic:

The best source is wrecking yards. In one I used to work near, the size of the pile over the years remained the same but anything of value was taken out. You knew *after a while that all the parts lying there were useless, just heaved back. Sheet* metal for vehicle bodies is harder and harder to get, it's all imported. Wooden vehicle bodies are illegal for safety reasons — they claim more people get injured in accidents if wood is used. Yet wood is available. Electrical conduit was used to make a lot of things, passenger seats for vehicles were bent out of it, but now you can't get it. Steel rods are hard to get. The building industry gets most of the local production so that small manufacturers of nuts and bolts, bar chairs or burglar bars are priced out of the market.

Materials are a real problem. Paint, for example. First, they get old tins, put three-quarters of a gallon in each, then top it up with gasoline so it goes farther. Some paints are spoiled because gasoline isn't the solvent, but they try to sell it anyway. So you run into a lot of problems just getting materials and when you do get them you might run into unexpected technical problems.

CHF:

How are the fitters trained?

Mechanic:

Masters take on apprentices. Of course, it's all outside the formal education system. The masters usually get apprentices from their home town. How it usually works is a father will negotiate an arrangement with a master and pay him a fee. There's usually no set time period, but an agreement to review the situation after a few years. The masters are realistic, maybe the apprentice won't learn anything in two years. When you become a master you give a big party, slaughter a sheep, buy beer. Later you might get money from your family to start your own shop.

A lot of your qualifications depend on who trained you. If you had a good master you let people know. Some masters are really good, willing to teach, not make you cook or wash clothes. They are supposed to give you money for food, but there's no legislation and no one could enforce it if there were. Some apprentices run away, and if you do, you can't come back.

CHF:

Are the fitters organized in any way so they can buy materials cooperatively, pressure the government to provide better services, or even technical services like the ones you're providing?

Mechanic:

It won't happen. The union is very weak, it doesn't even put pressure on the city anymore to repair the road into the fitters' area. But they're still taxed, a flat rate income tax, property taxes. Even peddlers need a vendor's licence. But the taxes don't bring any benefits, it is money that only goes out. The water supply is poor, and the electrical supply voltage drops very low sometimes. For an industrial area the services are very poor.

CHF:

You are also working for an international development organization. What are their expectations?

Mechanic:

They really don't understand my working environment and have unrealistic expectations. They wanted me to push the program a lot faster, but I kept pointing out that establishing a working relationship with these fitters couldn't be pushed. To my employer it was very straightforward: increase their incomes, collect figures, and write a report that looked good.

My employer wanted me to keep records and evaluate. "Are the fitters you're working with benefitting? What are their incomes now, what are their incomes after you've been working with them for a while?" I said, "Wait a minute, this information is confidential." If I go poking my nose into their accounts it will destroy the relationship I've built up with them. Legally the fitter is supposed to be keeping accounts. If I started recording his work in detail, someone from the taxation office might get hold of this information and come in and say "Where are your books showing you repaired this engine on April 1st?"

CHF:
Do any of them keep accounts?

Mechanic:
Sure, in their pocket or in their heads.

CHF:
How did you resolve the problem of evaluating your work for your employer?

Mechanic:
We worked out a compromise. We coded the fitters, say "P6" for petrol fitter number 6, on a map. I keep the map. In this way I can protect my clients. On other sheets I recorded the code, date and work completed.

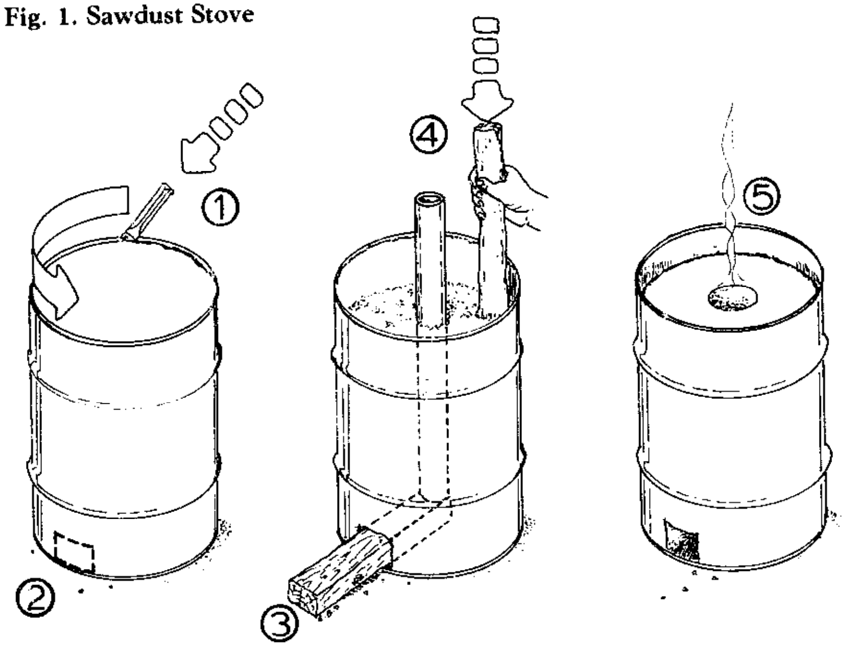
CHF:
Do you think the government or technical schools will continue your work after you leave?

Mechanic:
Frankly, I'm disappointed. I doubt it. After a long wait, I had one fellow in training with me for a while. He was a workshop assistant without paper qualifications. He really began to understand the way you had to work with the fitters as a consultant, when to listen, when to say something. Just before I left, the government brought in a fellow with formal training and papers, but no experience, to be the project leader. The future of the project is uncertain.

CHF:
What if someone from outside wants to introduce a new technology that the fitters could manufacture? How receptive are they to new techniques?

Mechanic:
It's just not predictable. For example I tried to introduce a sawdust stove (fig. 1). I thought it was terrific: almost free energy for anyone who was interested and who had access to sawdust waste. You can use it in the house, it's easier to light than a charcoal stove, you can turn it off by suffocating the fire, and the metal doesn't get so hot, so it doesn't oxidize. You have to have dry sawdust. You get a drum with a hole in the bottom, you put a 2 x 4 in there and set a length of PVC pipe on top of the 2 x 4. You throw some sawdust in, pack it down, gradually packing it to the top. Make a big metal washer. Then put the washer on the top, pull up the PVC pipe, pull out the 2 x 4 and there is your draft. Drop a twisted piece of newspaper down to light it — no need to fan. In five minutes it's burning up to temperature, yellow to blue flame, and no smoke. You are burning the wood gases first, and the charcoal you make along the sides of the chimney continues to heat. You end up with an ash — like charcoal ash — of salts and minerals. It is highly efficient and very hot. The size of the hole determines the temperature, the larger the hole the hotter the flame. A woman used one I made out of a grease pail to cook palm oil and complained that it was too hot. Nobody adopted this. I promoted it for about six months but there are only a few around. Some of the problems were getting a supply of sawdust, drying, and transporting it.

Fig. 1. Sawdust Stove



1. Chisel out the barrel top to form the washer.
2. Chisel out a hole at the bottom.
3. Insert a piece of wood.
4. Insert a piece of pipe and pack sawdust around it.
5. Drop in a piece of twisted newspaper to light it.

But you never know for sure when a new idea will become popular. I once worked with a fellow who was rebuilding car batteries. At first he wasn't interested in my suggestions. Six months later I saw him again he was using some of my suggestions. Part of a new project I'm now working on is introducing improved technology to manufacture hoe blades. There is a large demand for the blades but will the manufacturer accept our technology? As a technologist I'd feel fine if you asked me to build a machine to make hoe blades, but I'm trying to help people to make hoe blades. The technology is simple, people are not. In answer to your question, I just don't know.

Local AT Experts, Indonesia

Who is designing appropriate technology? It is not the exclusive domain of professional engineers. They are usually not familiar enough with existing production abilities in low-income areas. The most active designers are those who are already producing products for this market. Their techniques are not necessarily "traditional" but often highly-developed crafts which have already undergone many improvements. In most cases the innovators already know what their clients need and can afford, and the available local skills and materials. Any professional designer would agree that such information is the basis for good design. However, many improved technologies, even those based on professional design and labelled "appropriate," have been implemented without considering local needs, costs, or resources. People in local workshops cannot as easily afford to make false assumptions and are not protected by patents, copyrights, or subsidies. Their very survival confirms the suitability of their technologies.

In Indonesia, about 25 percent of the workforce is in the informal sector. Many of these people are highly skilled, producing watch parts, generators, components for televisions, film-editing machines, all often adapted from imported models. Some sell their products directly to larger firms. Some are at the mercy of middlemen who control access to credit, raw materials or markets. In other cases they have to pay fees to someone in the formal sector charged with regulating small industry. Many civil servants supplement their incomes through equity in these small industries.

Many development assistance programs focus on what is called "target populations." Some AT practitioners working in Indonesia in the informal sector have concluded that "it is probably more apt to call this group the 'active population' rather than the 'target population' since we ourselves are the ones with much to learn."

Following are descriptions of some informal technicians in Bandung, Java.[1]

Food Processing

Gasoline-powered coconut graters are rapidly replacing hand-operated ones, grating a coconut in less than a minute; about one-quarter the time required by

[1] Based on material submitted by J. Moeliono, St. Boromeus Hospital, Bandung, Indonesia, and Russ Dilts and Craig Thorburn, PLNPM, Jayagiri, Lembang, West Java. Graphics by Craig Thorburn.

Fig. 1. A Coconut Grater

the old method. The tool used previously by these coconut salesmen was a small tin and wood hand-held grater; the teeth were made by punching nail holes in the tin from the back. At least two businesses in Bandung manufacture the new machines which sell for $300 to $400 US, including engine. The gasoline engines are manufactured in Jakarta by a jointly-owned Japanese-Indonesian company. The original models, copied from imported machines, used electric motors, but as electricity is so undependable, the users decided to switch to gasoline. One model uses an old 49cc two-stroke moped engine.

The grating cylinder is made from ungalvanized 3-inch iron pipe. The teeth last for about six months of heavy use, and are then re-punched. The better models use solid steel cylinders.

Acetylene Generators

Most of the welders in Indonesia using oxy-acetylene torches have their own acetylene generators. Some make their own but most prefer to buy them from small manufacturers. Usually they are made from oil drums, cost $40 to $150, and

Fig. 2. Acetylene Generators

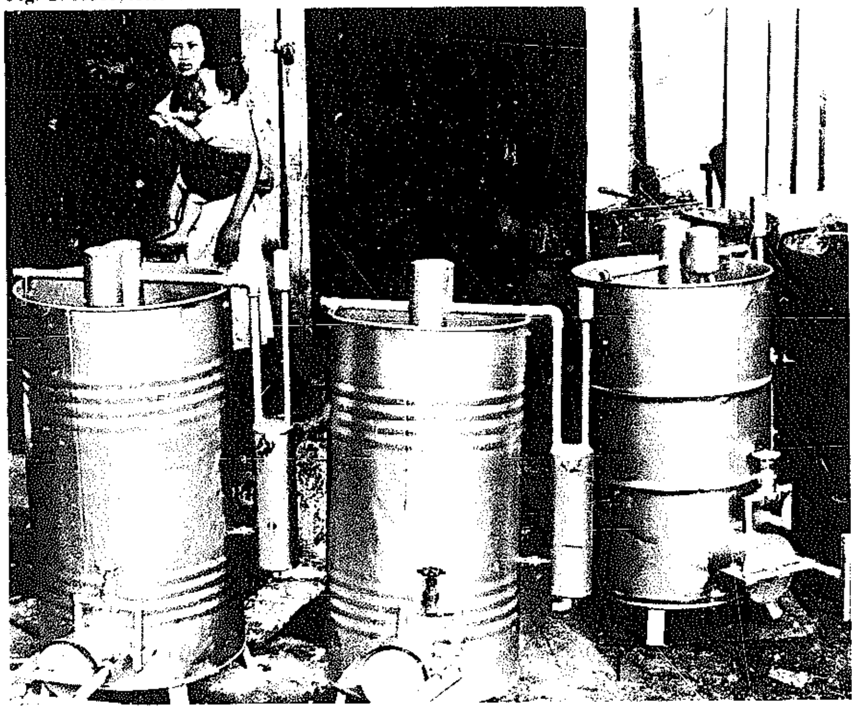


Fig. 3. Schematic Diagram of Generator

1. Carbide in Drawer
2. Water Mixes with Carbide
3. Gas into Tank
4. Water Rises, Creating Pressure
5. Excess Gas is Bled off
6. Gas Forced through Water in Flame Trap
7. Gas Drawn Off for Use

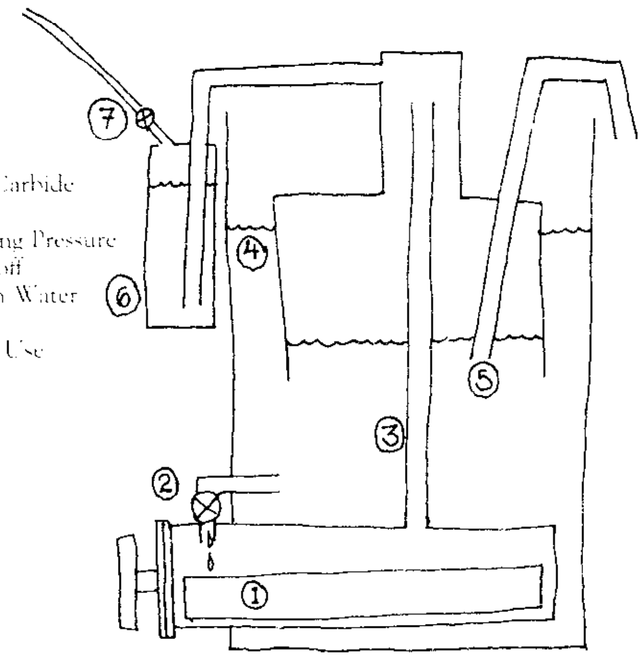
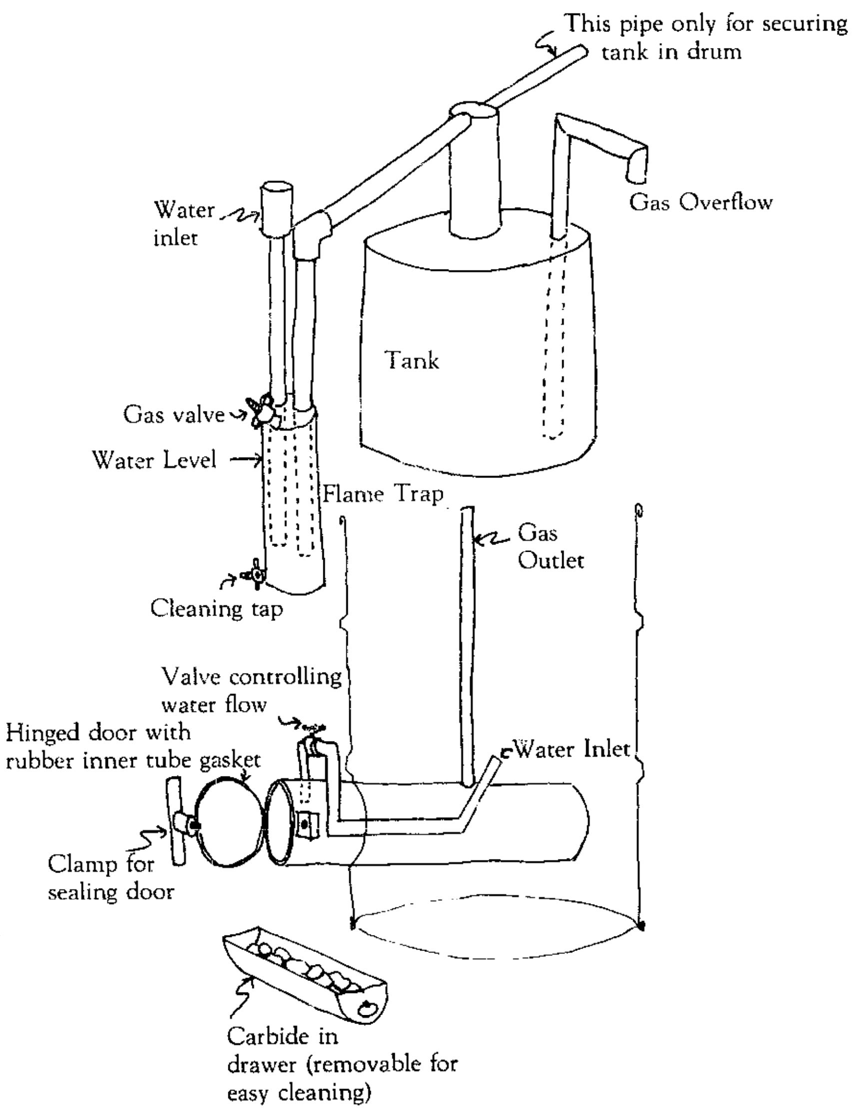


Fig. 4. Gas Tank and Generator



last about three years. The operation is simple: calcium carbide (CaC_2) reacts with water in a chamber at the bottom of the drum to produce acetylene (C_2H_2) gas. Accumulating gas displaces the water, thereby creating pressure. Gas generation is controlled by adjusting the flow of water into the chamber holding the carbide. Excess gas escapes from an overflow vent.

Coffin Makers

This travelling tinsmith makes stainless steel coffin linings. His charcoal stove has a hand-cranked blower. His entire workshop fits in two small wooden boxes hanging from a bamboo shoulder pole.

Fig. 5: Coffin Maker

Local Machine Tool Manufacturers

This workshop shows the diversity of resources and techniques which are developed by small-scale manufacturers. Metal shears have been copied from an

Fig. 6. Metal Bender

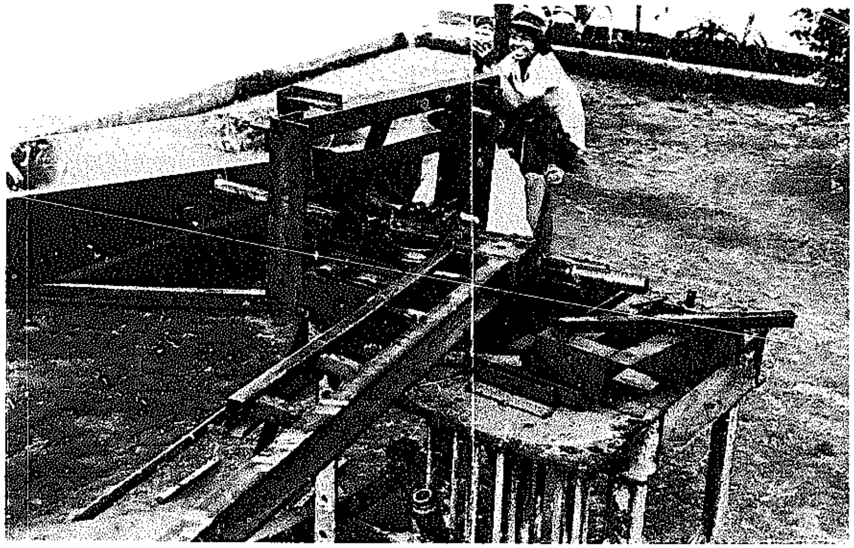
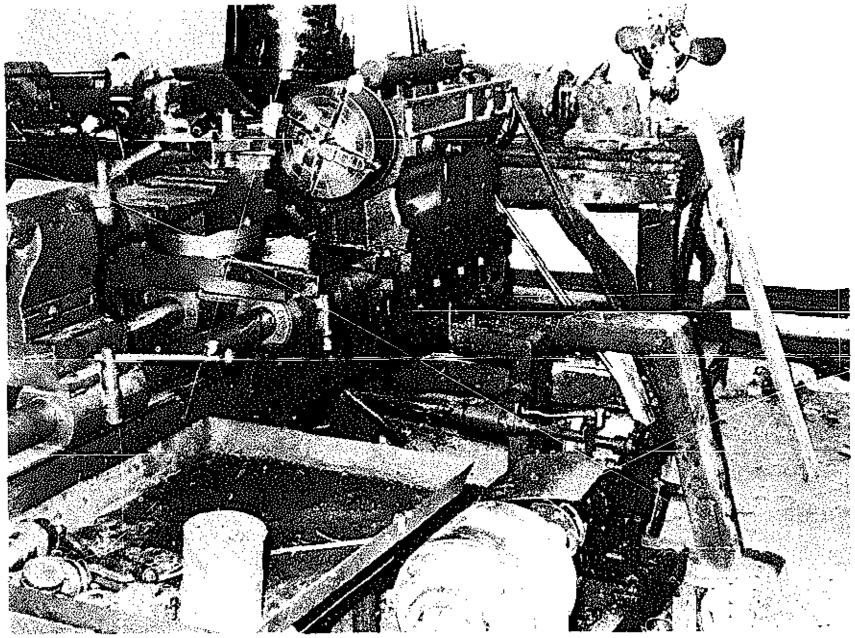


Fig. 7. Metal Lathe



imported model. The metal bender, designed by the owner, has interchangeable wheels to make bends of different radii on various sizes of pipe, rod, or strap. The metal lathe, also his own design, incorporates an imported chuck, a Willys jeep engine block and bearings, and a Mercedez Benz transmission.

Battery Manufacturer

An automobile battery manufacturer and repairman buys many of his components from large factories, sells or trades the lead he reclaims from old batteries to them, and sells many of his batteries through formal dealers.

Fig. 8. Battery Manufacturer

Hydraulic Ram Pumps

Recently the owner of this machine shop became involved in designing, manufacturing, and selling hydraulic ram pumps. He employs eight skilled welders and machinists who received informal training as his employees. They are very versatile workers, changing their products from month to month. Car and truck parts predominate, supplemented by products such as pellet guns, folding theatre seats, and cast aluminum CB radio antennae. One employee gets information on available materials by searching regularly through the local scrap metal market.

These shops look cramped and disorganized for a purpose. Few of them have a business licence and therefore cannot get low-interest business loans; if they were licenced they would have to pay taxes, from which they anticipate no benefits. When the tax-collector comes by, the owner can say, "Look how difficult business is — I don't have enough money to paint my shop."

Hydraulic ram pumps, powered only by water flowing into the inlet or drive pipe, push a smaller quantity of this water to a height above that of the supply.[2] For example, a vertical fall of water of about 4m will deliver about 5 percent of this flow to an elevation of 40m, or 22 percent of the flow to a height of 8m. The pump can be manufactured from standard metal or plastic pipe fittings. A similar kind of pump was used to supply water to the fountains and lakes of the Taj Mahal in India. The pump requires adequate water and sufficient head to power it. The mountainous region around Bandung satisfies these conditions.

For two years an agricultural engineer had designed and built these pumps at a technical college and installed them in local villages. However, he became progressively disillusioned with the effectiveness of the welfare method of essentially giving the pumps to the villages. After two years no pumps had yet been built in local machine shops.

In 1979 the machine shop owner and the engineer collaborated on the production of ram pumps. They experimented with different air chamber dimensions, check valve configurations, and impulse valves to improve the pump's efficiency. One impulse valve uses motorcycle shock absorbers, automobile valve springs, and teflon bearings. Teflon is hard to find; when the current supply runs out the valve will have to be redesigned.

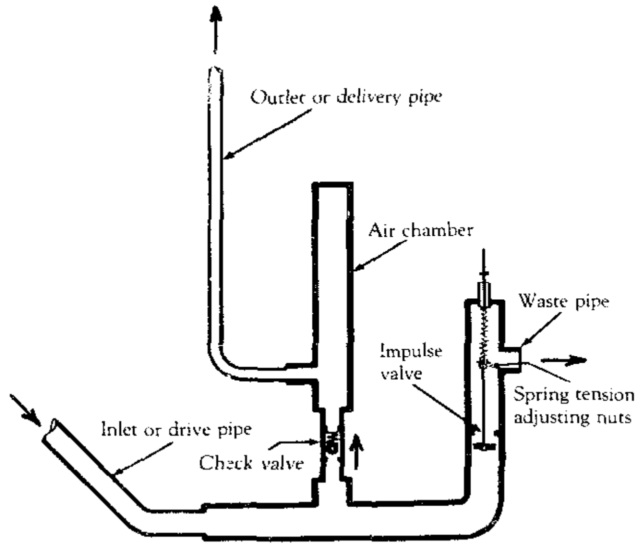
A used-motorcycle repairman familiar with the rural markets was hired as a salesman. He usually approached community leaders about the possibility of sharing the costs of the pumps. To promote sales the engineer and the shop owner have built a small demonstration model which they can install at a site in a few hours. The three men can also provide engineering services to assure the correct choice of model for a particular site.

At first, many orders came in from individuals, villages, and development organizations. But the process has had its problems: one village leader had to be persuaded not to demand a commission before allowing his village to purchase a pump. Elsewhere an irrigation official complained that a new pump was wasting irrigation water. Villagers were helped to alter the irrigation canal so that they could continue using the pump.

Promotional work has tapered off recently. The machine shop owner now finds it profitable only when he can fill orders directly from his workshop.

[2] Most books on low-cost water supply systems describe this pump in detail. See for example, S. Watt. *A Manual on the Automatic Hydraulic Ram Pump.* Intermediate Technology Publications, 9 King Street, London, U.K. WC2E 8HN.

Fig. 9: Schematic Diagram of Hydraulic Ram Pump



Assisting Small-Scale Industry

Many small-scale industries in developing countries are highly innovative — they have to be. (It is interesting that in so-called developed countries, the most innovative firms are often the smaller ones.) Although the success of these workshops is dependent on the skill and initiative of individual entrepreneurs, they generally work against a variety of formidable obstacles beyond their control. On one side they face biases favouring larger-scale industry, government regulations, shortages of raw materials, lack of suitable technical advice, marketing restrictions, and so on; on the other side, the low-income market they serve does not have the social or economic power to make stronger demands. (Poor people do not make demands for better technologies simply because they are unaware of them). Many of these restrictions are rooted in national and international economic and political policies.

Development assistance programs focusing on small-scale enterprises have not been very effective:

> . . . government sponsored assistance programmes are often ineffective and can even damage the interests of the businesses they are intended to serve; although the government may see itself as a source of help, many small business people look upon it as the agency responsible for incomprehensible or irrelevant regulations whose enforcement provides an ideal opportunity for local corruption. Some small business people may reasonably be excused if they feel that the government is like a man who runs over you with his car and then ensures that you receive the best hospital treatment. You are grateful for the treatment, but you would prefer never to have been injured in the first place.[3]

[3] Malcolm Harper and Tan Thiam Soon. *Small Enterprises in Developing Countries: Case Studies and Conclusions*, p. 90.

Echoing the decentralist beliefs of appropriate technology:

> It is rarely economic to set up a special agency to carry out all these services for small enterprises, since the skills and facilities already exist in one government department or another; the problem is to ensure that they are all available to small-scale enterprises, and that they are effectively co-ordinated. This depends more on awareness of the importance of small enterprises and common sense and co-operation at all levels, particularly in the field, than a formal commission or other institution at the centre.[4]

Further Reading:

Kenneth King. *The African Artisan: Education and the Informal Sector in Kenya.* London: Heinemann, 1977. A detailed account, with case studies, of small-scale production in relation to the formal and informal education system in Kenya.

Malcolm Harper and Tan Thiam Soon. *Small Enterprises in Developing Countries: Case Studies and Conclusions.* London: Intermediate Technology Publications, 1979. Over 20 case studies of the experience of small businesses in various developing countries.

[4] Ibid. Pp. 90-91.

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Strengthening Houses and Local Organization, Guatemala

Kathryn Rhyner-Pozak[1]

Houses in impoverished communities are the most vulnerable to the devastation of earthquakes or hurricanes. After such disasters some people have access to new building materials provided by international aid agencies; others, usually the poorest, have to rely on traditional designs and materials. The poorest communities are seldom involved in the process of designing stronger houses using techniques or materials they can afford or that local industries can provide. Generally, their new houses remain as liable to destruction as before.

The devastation caused by the Guatemalan earthquake of 1976, which left 250,000 people homeless or without adequate housing, underscored the need to develop inexpensive housing which is also earthquake resistant.

Architect Kurt Rhyner, in conjunction with a local community, started a successful project of 150 improved adobe houses in Baja Verapaz, a remote region which had been largely ignored by the major aid programs.

Baja Verapaz is extremely dry and mountainous and is best known for its manufactured clay goods — roof tiles, bricks, and pots. Houses in the area are made of adobe brick or bajareque, a grid of wooden poles which is plastered with mud. The 1976 earthquake almost totally destroyed both semi-urban and rural homes in the area.

The architect first discussed ideas on new housing with the people of Baja Verapaz. Without exception, they wanted cement block construction, although all were well aware of the basic problems of transporting cement, its price and scarcity, and the lack of good sand. The attraction of cement was largely the result of advertising by the construction materials industry to enhance the material's quake-proof image and exploit the widespread fear of adobe houses that existed after the earthquake. Cement block houses, however, are not necessarily quake-proof, especially if poorly constructed, although the use of more cement and reinforcing steel does make them more resistant.

Most experts dismissed the traditional methods of adobe and bajareque. The possibilities of improving adobe construction were generally not considered by

[1] A member of the Grupo Sofonias, Costa Rica.

either the consultants or the unnerved villagers, some of whom refused to sleep indoors until after the first anniversay of the earthquake.

Kurt Rhyner felt, contrary to public opinion, that adobe combined with some concrete was the most appropriate building material for the region. While searching for people to participate in a construction experiment, he found a new community organization in the village of Salama which was looking for alternative building techniques.

During meetings consisting of 20 to 30 people, Rhyner discussed building systems and which houses fell, their faults in construction, and why some houses remained standing. He explained improved construction techniques through the use of wooden models.

In designing earthquake-resistant houses, Rhyner drew on a United Nations construction manual, produced after an earthquake in Peru, which outlined techniques for building earthquake-resistant houses of mudbrick. The manual is based on studies of models of adobe houses which were strengthened with the addition of a relatively small amount of reinforced concrete and tested on earthquake simulation tables. The manual stresses the following five factors:

1. A solid foundation (fig. 1).
2. Good quality adobes and masonry work.
3. Crossed interlocking corners (fig. 2).
4. Horizontal band of reinforced concrete situated above the doors and windows (fig. 3).
5. Solid roof construction.

Fig. 1. Foundation with humidity ring to preserve adobes

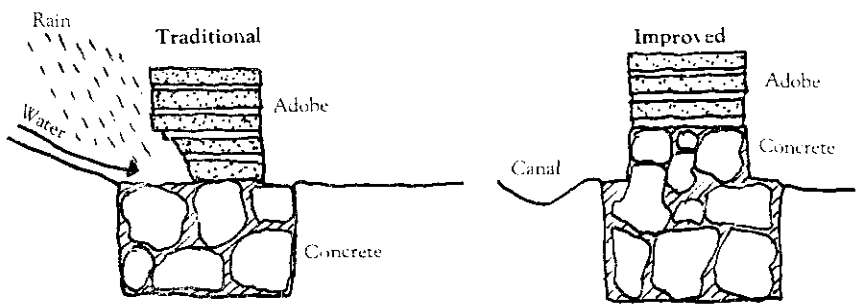


Fig. 2. Corners and dividing walls with interlocking corners

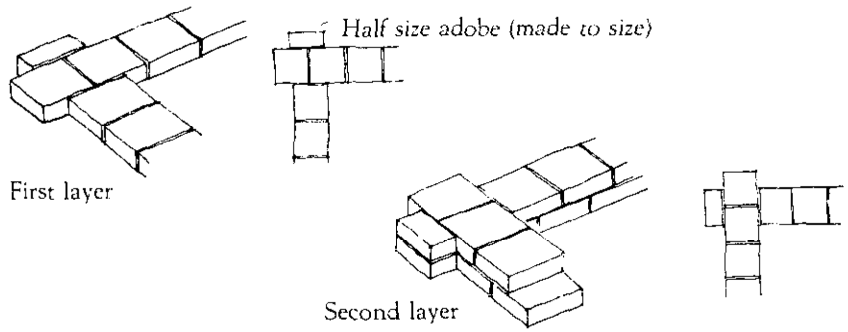
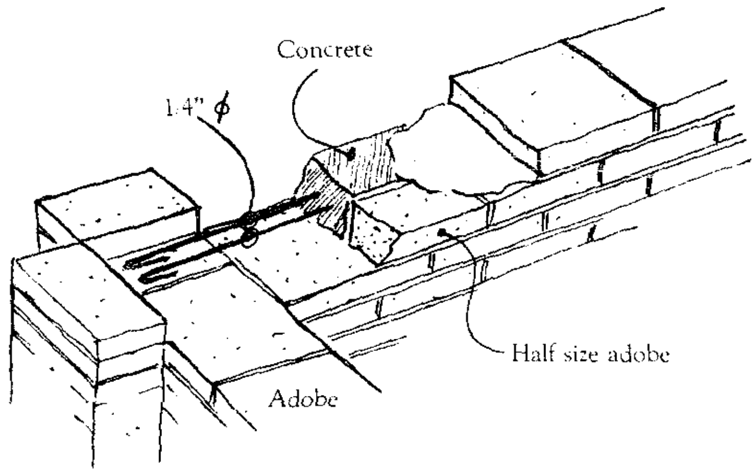


Fig. 3. Concrete ring to reinforce the walls and corners



These design features can resist the predominantly horizontal earthquake forces; without them the walls and the roof collapse on the occupants. Most of the traditional adobe houses in Guatemala lack the requisite foundations, corners, and horizontal concrete reinforcement. The difference between a good adobe house and a poor one can be expressed as about 20 bags of cement and about 25 kg of steel for the horizontal reinforcement, at an approximate cost of $100.

Logical technical explanations and simple monetary calculations soon convinced the Salama committee that adobe remained the most practical construction material. Most people agreed that cement block construction was financially out of their reach. The few who still wanted cement block construction were usually "better off" and saw the cement block home as a status symbol.

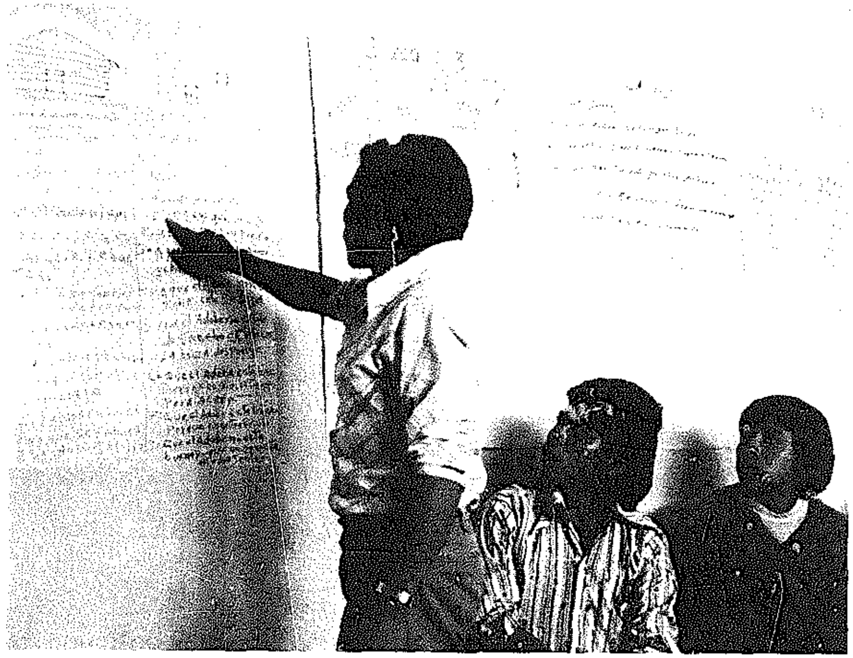
In other meetings, small-group discussions analyzed house design and the advantages and disadvantages of adobe and wood construction (fig. 4).

Appropriate technology can stimulate analytical capacities with a community in addition to giving a specific technical education. The focus on the technical aspects of the Salama project was viewed by the project organizers as part of a much broader development process through social animation. Other community priorities, such as water supply problems, were discussed at these meetings and led to other projects.

Through these meetings, a small group of masons *cum* animators emerged. They helped plan a house with each participant according to family needs, preferences, and financial resources. They then helped local groups of families use the improved methods to build their own houses.

About 100 Salama families were divided into 20 construction groups. A building group was made up of three to nine families (fig. 5). Women actively participated in the meetings, and some in the construction itself. One member per family worked on all the houses for the group. Thus, each person built his neighbor's house as well as his own, and gained greater experience in house construction. One bureaucrat from the capital commented that these houses were much too beautiful for campesinos and must surely cost more than they could afford (fig. 6).

Fig. 4. Group Discussion of Housing Design



A comparison of the costs of adobe and cement shows why people were willing to rebuild with adobe. A concrete block house, with a metal (lamina) roof would cost $1500 to 2000 (including transportation and supervision); an adobe house with a tile roof would cost $600 to 700. In an area where the average income is about $500 per annum per family, this is a significant difference. Moreover, the majority of families had yearly incomes of less than $200. The money for materials was provided through interest-free, 10-year loans from the development agency Caritas Switzerland, with the intention that the capital would become a revolving fund for use on other projects. The average family needed a loan of about $400. The loans were administered by the Salama committee; however, local control of these funds met some resistance from church officials who wished to maintain their traditional authority.

Although adobe construction is time-consuming compared to cement block houses with corrugated steel roofs, the owner is not left with a large debt, the repayment of which in Baja Verapaz would force him to find temporary work at the large coastal estates. The technique is quite labour-intensive as the following table shows:

Making adobes for one house	70 days
Gathering sand, stones	40
Laying foundations	15
Construction of walls	120
Putting on roof	10
Finishing (plastering, windows, doors, floor)	30
Total (average)	285 days

Some groups made their houses in as little as 150 days; other groups took more than a year and a half.

This technique is feasible where people are underemployed and have little income or possibility of income. Many people did make their own adobes, since they had more time than money; others used commercially-made adobes available from small-scale producers.

There is little difference in cost between a metal roof and a tile roof because a tile roof requires more support. The major economic difference between the two is

Fig. 5. A Construction Team Making the Wooden Form for the Concrete Reinforcing Ring

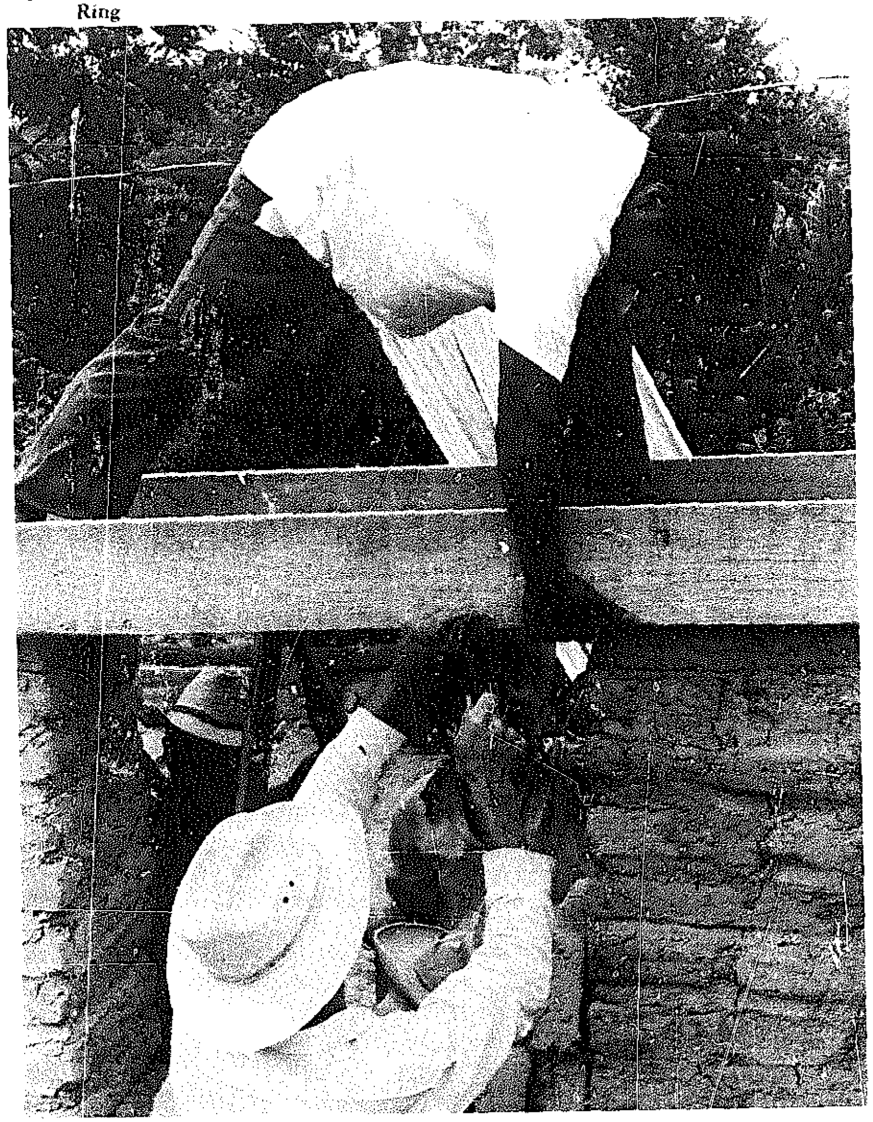


Fig. 6. First House Constructed by a Group of Three Families

that the money for a tile roof goes into local family tile businesses, while metal roofing is made from imported materials in the capital city. Approximately two-thirds of the project funds were invested in the local economy. Small local businesses of three and four persons have been kept actively employed since, producing roof and floor tiles or making doors and windows and thereby revitalizing part of the local economy.

Another point is that compared to the cement block house with a metal roof, the adobe house with tile roof has insulation properties which are crucial in the parching heat of Baja Verapaz. As well, the adobe and tile houses can be repaired and maintained locally without dependence upon imported products.

Fourteen masons, trained through construction of two model houses, have become experts after working with the housebuilding groups for a year and a half. They are now able to earn a living in their communities and, at the same time, promote sound building methods. Several people have found jobs as masons with salaries substantially higher than what they had previously earned. One of the masons later constructed 25 houses in another region without any supervision by the foreign expert. Project funding was terminated in August, 1978, but construction continues as the knowledge is now dispersed among the population.

The project was not without its problems: cement shortages, delays in funding, bridges left unrepaired after the earthquake, and a complex combination of bureaucratic constraints are a few. Some local officials disapproved of both the location and methodology of the project.

The Saláma project was a success, however, and demonstrates the evolution of integrating improved building and materials with local techniques. The new techniques, though coming from rather sophisticated research on earthquake-proof construction, are affordable to the poorest members of the community and compatible with local skills. Ideas were introduced through a local committee, which, in the process, developed organizational skills. Through participation the people now possess both earthquake-proof adobe homes, and the ability to make them.

Earthquake-proof adobe houses were not the only result of the project. Many other ventures developed through the Salama committee such as vegetable gardens, market stall construction, cooperative chicken farming, and better water supplies. People learned to work together to produce results as a community that they could not produce alone.

The Grupo Sofonias also evolved from this project. It acts as a liaison between base groups and donor agencies to help define projects and technically assist in their realization. It believes that technical projects cannot occur in a vacuum, but must be part of an integrated community development scheme, however small.

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Users Assess Appropriate Technology, Indonesia

Developing and implementing improved technology in many rural areas is an experimental, technical, and social process. The best approach is not always clearcut. In the spirit of open inquiry, technologists who have attempted to implement low-cost options are assessing their experience. Many organizations are looking for less arbitrary methods of choosing technologies. As the following case study indicates, the challenge of actually having the technology adopted by potential users remains.

This report[1] shows that "small" can be very difficult. It shows the challenge of working for rural target groups and the need for a wide technical, social, and economic sensitivity and open-mindedness.

It is not the intention of this report to show failure. The fact that the Development Technology Centre of the Institut Technologi Bandung (DTC-ITB) had the courage to move out of a scientific institution into the everyday reality of rural people is worthy of congratulations.

During June and July, 1978, DTC-ITB set up several field stations to demonstrate well-known, internationally-promoted simple technologies in the Sukabumi district of southwest Java. Three projects, dealing with energy sources (solar, biogas, and wood stoves), ferro-cement boats, and water supply, were to be used for experimental and dissemination purposes.

This followed a general needs assessment, done in 1976 by DTC-ITB, which had identified general education and skills, health and sanitation, the level of economic life, marketing of products, improved production equipment, and sources of energy. The assessment, however, did not identify potential users of new techniques or the requirements of local people. It is hoped that this study sheds more light on the subject of needs assessment and problem-solving priorities.

Seven to nine months after the demonstration projects were set up, the DTC-ITB team collected data on the effectiveness of the field demonstration program and gaps in its execution. Interviews done at each field demonstration of a random sample of the population represented at least 10 percent of the potential respondents. Using standardized interview forms, the impact study attempted to

[1]Based on a report by the Development Technology Centre of the Institut Technologi Bandung, (DTC-ITB), Bandung, Indonesia. Summarized with the permission of DTC and TOOL (Netherlands).

measure the quality of extension services, their general appropriateness to consumer or producer, technical and economic feasibility, field station performance, and the relationship of the technology to the people's priorities.

The technical performance of the projects is summarized in the following table:

Technology	Number of projects	Repairs by DTC-ITB	Repairs by population	Out of order January 1979
Solar Heater	2	0	0	0
Biogas	3	0	4	0
Pindang stove	1	0	0	1
Ferro-cement boat	4	1	0	2
Bamboo pump	16	10	9	14
Pralon pump	9	4	2	4
Hydraulic ram pump	6	5	12	2

The solar and biogas projects were the most technically successful, although there was no local involvement at all in the case of the solar water heaters.

The pindang stove was an attempt to improve upon the energy efficiency of a traditional Javanese food preservation technique, *pindang ikan*. Tuna are cooked in buckets with salt and water over wood fires until all the water has evaporated; the fish can then be kept without refrigeration for up to two months. The DTC-ITB demonstration used a five-bucket "pindang stove," which was supposed to have lower energy costs, making fish processing more economically feasible. The stove was in use for only one week and was in an advanced stage of deterioration by the time of the impact study.

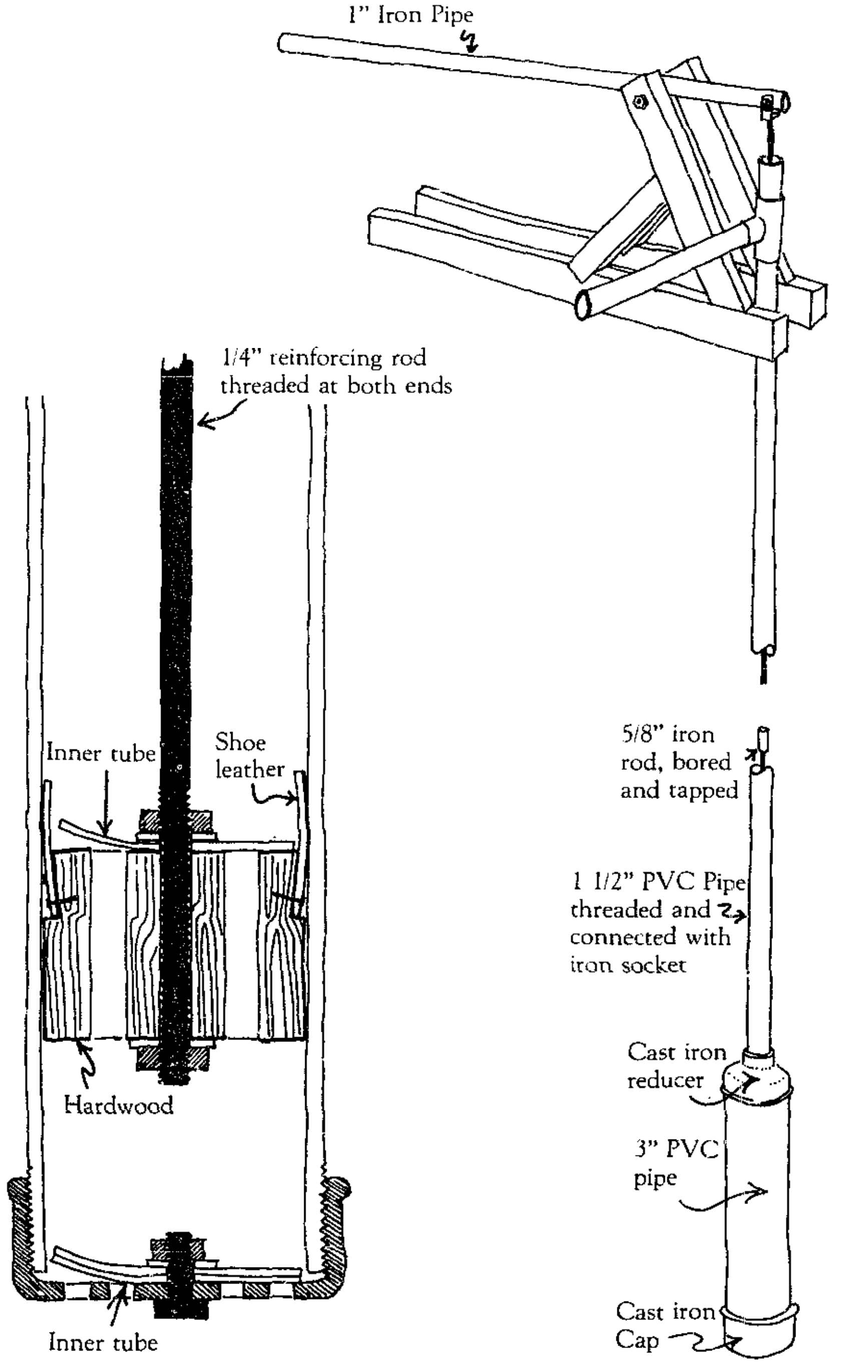
Boat owners, builders, and crew members were very interested in ferro-cement boats but those built had serious technical problems. One was wrecked, one was never launched because its quality was so poor, and the remaining two had not been launched at the time the study was done.

A month or two after installation the bamboo hand pumps began to "smell bad" (rot), so the villagers took them apart. Although the pumps would seem to be a total technical failure, villagers subsequently attempted to build this type of pump at five locations. Some of the pralon hand pumps had leaking foot valves, which local people were not able to repair. They made three attempts to construct their own pralon pumps; two worked (fig. 1). The hydraulic rams were carefully maintained by the villagers, and two cases were reported of water rams being built after seeing the demonstration rams.

DTC-ITB treated the local population as consumers of technology rather than as participants in a process. Despite this approach DTC-ITB tried to discover to what extent villagers perceived these technologies to be suitable for their needs and living conditions. They asked a variety of detailed questions about the people's desires to learn to construct the technology at their own expense and their general impressions of "appropriateness."

The bamboo and pralon pumps were seen as appropriate and there was a high interest in learning to make them; this meshes with the fact that some people did actually build them. But there was relatively little interest in the other technologies. When questioned about their willingness to buy them at anywhere from full price to less than a quarter of the full price, the vast majority of respondents either said no or did not give any answer. They appeared to be willing to learn about

Fig. 1. Pralon Pump



them but reserved judgement on adopting them. In summarizing the opinions of the local people the survey indicated that most of the technologies were economically unfeasible.

The impact survey also asked if local people had used the three field stations. A high number of respondents had never heard of the stations despite intensive use of mass media, pamphlets, and information manuals. When the effectiveness of the extension work around the demonstration sites was investigated, it appeared that direct contact between DTC-ITB workers and local people was much more effective than media campaigns in promoting access to technical assistance.

The most striking pattern that emerged from an examination of the respondents' needs is the lack of correspondence between the perceived needs and the implemented projects. Villagers were most concerned with unemployment, irrigation, and pest control. Water supply projects, which provided clean water for washing and drinking, were installed though no groups saw this as a primary need. People who received pralon pumps had wanted improved irrigation and cleaner water; this may account for the interest this technology generated. People who were concerned about fuel problems did not receive energy projects. Water-buffalo owners, for whom obtaining fuel is no problem, received biogas digesters, much to their surprise. Of the segments of the fishing population who might directly benefit from building ferro-cement boats, only boat builders expressed the need for improved production equipment, employment, and a higher quality product.

DTC-ITB came to some difficult but honest conclusions in their assessment of this project:

> Small is very difficult . . . we will only be able to cope with these difficulties if we keep an open mind toward ourselves and our performance, while realizing that dealing with appropriate technology means dealing with people . . . We have to start by analysing . . . the target group and their socio-economic needs. Once this data is obtained, the engineer should do his job and do it technically well; neglecting technical quality is one of the great threats to the reputation of appropriate technology.
>
> Eliciting the human factors . . . by communication and controlling the technical quality . . . is one of the most difficult jobs on earth; it is also the greatest challenge.

Big AT vs. Little AT: Organizing a Large AT Program, USA

Ron Alward[1]

One of the largest AT organizations in the world, the National Center for Appropriate Technology (NCAT) in the United States, has had considerable success in reaching some of its clients, but it has also had problems that have reduced its effectiveness. The experience of NCAT is relevant to any group which is promoting access to technical and financial services for lower-income groups. Ample funds, a competent staff, and suitable technologies are not enough. The whole concept of AT arose because governments, corporations, large institutions, and bureaucracies were not in general providing access to these services, or willing to help with the social formation of organizations of low-income people that can demand and absorb these services. Hence, AT groups have advocated more direct contact with their clientele and a different style of internal organization which is independent of bureaucratic procedures, small in size, and held together by a commitment to a cause rather than rigid procedures.

It is inevitable in such a situation that conflicts arise. However, these conflicts are exacerbated if there is not a sound working relationship, based on an understanding of the concepts of AT, between staff and management, between the group and its funding sources, and other AT groups. Some of these problems are also inevitable because the concept of AT is multidimensional, attempting to address problems in an integrated technical, social, economic, and political framework; problems whose solutions do not fit neatly into standard frameworks for making investment decisions on development activities.

NCAT was established in Butte, Montana, as a private non-profit organization in 1976. It is principally funded by the United States Government's Community Services Administration with the primary goal of developing and applying technologies appropriate to the needs of low-income communities in the United States.

In order to achieve its goals, the Centre operates in four major areas. These are:

[1] Ron Alward is an engineer who has worked with NCAT and other AT organizations.

1. A technical research staff working on various aspects of energy conservation, renewable energy utilization, community and economic development, building technology, agriculture and waste recycling.
2. An information collection and dissemination program with a growing list of publications in the above technical areas.
3. A program of grants to stimulate appropriate technology research and demonstrations by community groups and other AT organizations.
4. An extension program consisting of 10 regionally-based field representatives who help develop contacts between community groups and appropriate technologists around the country.

Including the extension staff, about 65 people are currently employed by the Center. The operating budget is about $3 million per year of which approximately one-third goes to the grants program.

The beneficiaries of NCAT's activities are generally intended to be low-income groups including urban and rural low-income people, native American groups, and communities in the Trust Territories and dependencies. A wider audience is reached through the information, research, and grants programs due to a significant public awareness of the activities of the Center.

Technical Resources

The Technical Research Staff has a wide range of capabilities. It undertakes basic research, product development and testing, report and publication writing, and technical assistance, depending on the specific needs of its constituency.

Some examples of the most popular and successful work undertaken at NCAT are:

- assessment of residential heat losses and domestic energy use inefficiencies as a prelude to reducing energy costs;
- training packages for low-income home improvement crews;
- testing and certification of do-it-yourself solar collectors;
- design, construction, and horticultural management manuals and technical assistance for solar greenhouses;
- production of manuals, resource bibliographies and slide shows on a variety of appropriate technology topics; for example, micro-scale hydroelectricity, cellulose insulation, low-cost solar collectors, organic farming;
- assistance to citizen advocacy groups in the areas of energy, food, shelter, and community economic development.

Since NCAT generally responds to the needs of people it serves and since its technical staff is generally well qualified, it has promoted very few unsuccessful or unpopular technologies. One technology that has been the subject of considerable popular interest is composting toilets. However, it has been the experience of NCAT staff who deal with the subject that most purchasers of these commercially available systems find them somewhat unreliable and difficult to maintain.

Small Grants Program

In order to encourage dissemination of small-scale technologies and promote locally-developed solutions to technical problems, NCAT operates a small grants program. Typical grants are:

- An organic no-tillage small farm demonstration project in California. Under this grant a non-profit group is running observation trials of till and no-till farming methods. The plots are compared for yields, moisture retention qualities, and cultivation requirements. The project has been used to demonstrate the advantages of no-till methods to local farmers through tours and to others through seminars and publications.

— A solar greenhouse for starting vegetable seedlings in Louisiana. In this project an association of 30 low-income vegetable farmers built a solar greenhouse designed by NCAT technical staff and funded by the grants program. The 1000 sq. ft. greenhouse enabled the farmers to grow vegetable seedlings so that vegetables could be produced earlier to take advantage of the early season higher market prices. Before the greenhouse was built, none of the farmers could afford to buy seedlings and thus had to plant seeds directly in the fields, with the result that their produce was ready at the height of the harvest season when prices were lowest. Since installation of the greenhouse, gross farm incomes, directly attributable to the use of early seedlings, have increased markedly.

Effectiveness in Reaching Constituency

NCAT's primary mechanisms for contacting its constituency are its newsletters, publications, and extension staff. The technical research staff also operates a technical assistance program to respond to enquiries and resolve problems either by mail, telephone, or site visits. All these techniques tend to be very effective for reaching those people and communities that are well organized, usually under the federal Community Action Agencies and Community Action Programs, native American groups, or appropriate technology groups. On the other hand, the unorganized poor have made very little use of NCAT's services except in areas where the NCAT regional representative has made specific attempts to contact these people.

During the formative stages of NCAT it was expected that it would model itself around the issues and concepts of the name it chose. Activities at the technical level generally fit the criteria of appropriate technology, however the Center has encountered major organizational problems. As well, the Center has suffered criticism from other AT groups in the United States for its range and sphere of activities. The following sections may yield useful information for others contemplating the establishment of similar national or regional organizations.

Funding the Operation

Given the inherent political nature of some aspects of appropriate technology, particularly when working with low-income groups, it is important that an organization engaged in such work be staffed by persons committed to its ideals and objectives. Moreover, financial support must be obtained from sources that are least sensitive to external manipulation and who understand the concepts of AT.

The initiators of NCAT found a single government agency to provide the necessary funds. This may not have been wise for at least two reasons. First, the sponsoring government agency itself was, and is, often subject to strong pressures from other individuals and groups of differing and often conflicting political and economic persuasions. Second, the single funding agency held virtual control over the Center's activities, a difficult situation to be in when working on activities different from those of most government agencies and using procedures different from those normally accepted by bureaucracies working with low-income groups. The result for NCAT was that it soon found itself at odds with the sponsoring agency. The ensuing series of crises lasted more than a year, detracted from productive output, and eventually resulted in a change in both leadership and internal organization.

Multiple source funding, though harder to achieve, may have been a more appropriate basis from which to operate such a center since the amount of direct influence over operations by any one of the sources would have been significantly reduced. Whether the funding source is single or multiple, it is vital that those attempting to establish such an organization fix terms of reference which are satisfactory to themselves, to the funding agencies, and to those they employ.

Size of Organization

NCAT grew from one to fifty employees in about eight months. This high growth rate was undoubtedly the cause of a lot of early organizational problems which could have been resolved with less difficulty, or even avoided, had the organization started small and grown slowly. A very young organization in a new and somewhat controversial field and trying non-traditional organizational approaches, for example democratic management of the workplace, is more visible at the political level if it is larger rather than smaller. Such visibility became a liability for NCAT during the period when its internal operations were not all smooth.

Style of Organization

NCAT was established with a nationally-based board of directors of varied backgrounds. The board was not a cohesive unit and very quickly succumbed to pressures exerted by the funding agency. These pressures, coupled with a lack of management-level diplomacy led to the series of crises mentioned earlier. The result was a major reorientation of the internal organizational structure from one favouring democratic management to one that today is excessively hierarchical. A management was eventually imposed on the Center which had virtually no knowledge and little understanding of appropriate technology practice and theory. It has become overly concerned with management efficiency, and has attempted to resolve internal organizational issues by edict rather than by consultation. Quite naturally, appropriate technologists attracted to work at the Center because of its sphere of activities often find they cannot reconcile the work environment with their concerns for meaningful change. One result has been a high turn-over rate of technical staff.

Sphere of Activities

Those who were originally involved in establishing NCAT saw it more as a national coordinator of appropriate technology activities. In addition, they saw it as a vehicle for disseminating information and providing technical and program support and resources to the various groups across the country already involved in appropriate technology development.

The roles eventually assumed by the Center quickly alienated many established AT groups because they perceived, right or wrong, that:

1. NCAT was intruding into their sphere of activities, offering services in competition with their own. For example, a community in southwestern Texas was in the midst of a severe energy crisis, having had its natural gas supply cut off by the distributing company. NCAT's early encounters with the community were undertaken to the near exclusion of an established AT centre nearby. This led to an unnecessary and often bitter struggle to gain influence in the community. Two years of acrimony passed before a working

relationship was finally arrived at between the community, the AT centre and NCAT.

2. NCAT, being much larger than most AT groups and government-funded organization, was monopolizing the limited resources traditionally available to the smaller AT groups. This has been an often-voiced criticism of the NCAT operation. Before NCAT, most AT groups were small and the competition for funds to run their operations and do research and development was more or less between equals. Once NCAT became established, a significant source of direct funds for these centres was perceived to have been eliminated.
3. Due to its mandate and the source of its funding, NCAT was required to work predominantly with government sponsored low-income agencies and groups often to the exclusion of other legitimate AT groups. However, with appropriate technology concept dominant in its mandate, other AT groups felt there was a significant need for NCAT to widen the scope of its grants program to include their own activities, which often reached a broader spectrum of American society.
4. NCAT was too concerned with developing new or modified technologies on which the NCAT label could be put, when there were ample and often satisfactory systems existing or being developed elsewhere. These groups felt NCAT should ensure that not only were the technologies being developed but also that information concerning these technologies was being adequately disseminated to those most in need, and that the users and potential users were being adequately informed on the appropriate use, operation, and maintenance of the systems they were acquiring. An example often cited in this context concerns solar water heaters: emphasis does not need to be placed on designing a better solar water heater, but to ensure that potential users, be they low-, medium-, or high-income people, do-it-yourselfers, or purchasers, be able to obtain or make efficient and effective systems appropriate to their needs.

Local Legitimization

NCAT was established in an old and economically-declining mining community partly as a stimulus to the economy of the region through local employment at the Center. Although this was achieved, there has been very little attempt by NCAT to integrate its services into the community itself. The stated reason for this is that as a nationally-based organization, the Center cannot favour one community over another. The result of this lack of integration has been considerable ignorance on the part of the local community about the Center's operations, and some distrust and suspicion of those who work there.

Bureaucratic reasons for separation seem paltry in comparison to possible advantages: technologies and methods of introducing them could be tested in the community; the local people would become more aware of the various aspects of AT and they could provide another political and economic base for the Center's activities.

The Limits of Appropriate Fishing Technology: Resource Management, Canada

"The traditional, small-scale fisheries of the world are not simply relics of antiquated technology, but are often repositories of skill, experience, and sensitivity to the local environment. . . . Government fisheries management programs have been notoriously ineffective, not only because of poor science or political manipulations of the managers, but also because they contain very little appreciation of the economic and social realities of the systems being managed and even less appreciation of the potential of existing informal or indigenous forms of resource management."[1]

The following case history is one example of attention being given to the appropriate resolution of local economic need but without sound resource management. In Newfoundland the inshore fishery has suffered marginalization; government and industry efforts in fisheries development have emphasized centralized, vertically-integrated and industrialized units of production to the neglect of — and at the expense of — the small-scale, decentralized, labour-intensive inshore fishery.

Along many coasts of the world large trawlers move in and heavily fish the waters. Inshore, small-scale village fishermen see their catch diminishing, the women who process and market the fish bemoan their declining income, local shipwrights sit idle, and customers complain about the rising price of fish.

This is one small episode in the "tragedy of the commons." According to international law, off-shore fisheries have been common property, open to whoever has the capital and technology to exploit them. Generally, the benefits have gone to the few larger-scale harvesters. As access to resources is uncontrolled, there is no incentive to conserve and fish stocks are depleted. One fisherman may refrain from overfishing, but that does not stop someone else from moving in and reaping the benefits of his restraint. Although many in-shore fishermen have traditionally regulated access to their coastal fishing grounds, competition from off-shore fishermen for a migratory resource is increasingly a threat to their efforts in conservation and to their existence.

[1] This case study is adapted and quoted with permission from Bonnie J. McCay, "Appropriate Technologies, Fisheries, and Resource Management," *Journal of the International Association for the Advancement of Appropriate Technology for Developing Countries*, Vol. 2, No. 4, March 1980. Graphics provided by Fisheries and Oceans Canada.

Inshore Cod Trap Fishing

Conflict over access to ocean resources, particularly off-shore oil and mineral rights, has forced governments to intercede. During the 1970s, many nations declared control over a 200-mile-wide zone along their coasts, the United Nations Conference on the Law of the Sea attempted to rewrite the obsolete open-access laws, and local communities suffered the social cost of fisheries policies biased toward large trawlers integrated with distant processing plants and shipyards.

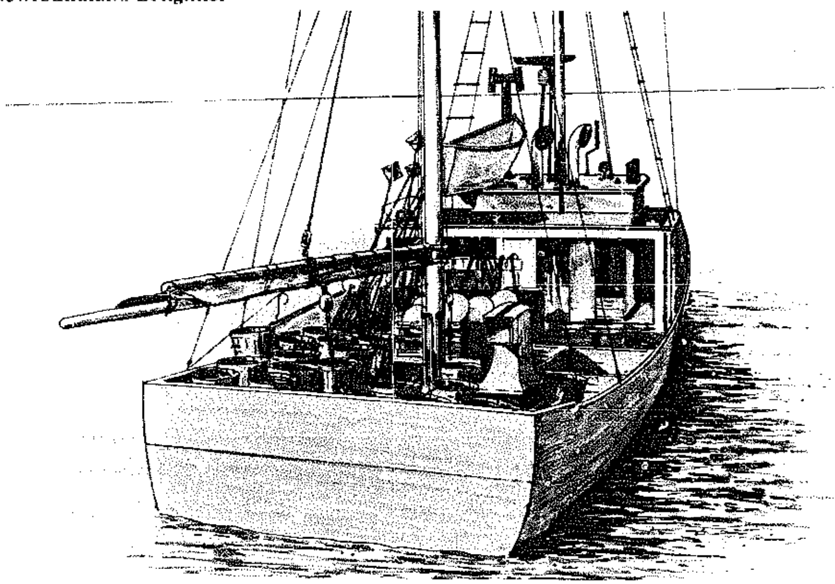
Some governments have recognized that small fishing communities cannot continue to be excluded from develoment projects. In some cases they have been supported with better technology, marketing, and credit. The *Handbook on Appropriate Technology* describes such a case in Newfoundland. However, it is instructive to look at the impact of this AT initiative in one community, Fogo Island, because it was implemented without a well-developed local organization or the necessary policies to control access to fishery resources. Without such organizations or policies, coastal fishermen and communities will reap only limited and temporary benefit from appropriate technology.

Fogo Island lies 10 miles off the northeast coast of Newfoundland. The population of 4000 living in nine communities has had few alternatives to fishing for a living. Traditionally, during a five month season, small crews harvest cod and salmon in open boats. Local customs regulated access to the inshore "cod-trap" fishing grounds. However, since the 1950s, the catch has declined as the off-shore trawlers, mostly foreign, compete more effectively for the same resource. By 1970 fish were scarce around Fogo Island.

Until the mid-1960s the communities did not attempt a united stance to negotiate with outside government and business agencies. The communities relied on merchants based in the provincial capital, St. John's, for credit, supplies and markets and had become increasingly more dependent on government welfare. Their early efforts to develop community-based organizations could not overcome what one observer called the "traditional disputes over women and fish".

The federal and provincial governments initially attempted to resettle the inhabitants of these small "outports" in larger, more industrialized centres. Some

Newfoundland Longliner



went, but the high costs of the scheme, the lack of jobs in larger centres, and pressure from local leaders and extension workers in Fogo Island and elsewhere forced the governments to subsidize a rural development program in the outports themselves. Certain AT concepts were observed in the development of a shipbuilding and producers' cooperative and the construction of improved fishing vessels. As the program proceeded, more emphasis was placed on building new boats while alternate sources of income — the fish-processing and marketing cooperative — were largely ignored. Local concern that existing fisheries resources would not support bigger and better boats was lost in the scramble for financial and technical assistance. The leaders of the cooperative movement of the island lost control over deciding what the problems and solutions were.

The new boats are intermediate in scale between inshore open boats and deep-sea trawlers. These "longliners" are diesel-powered wooden vessels 13 to 21 meters in length with a crew of three to six men. Their cost in 1973 was about $50,000, compared to $4000 for an inshore boat and several million dollars for a trawler. These longliners were equipped with radar, sonar, and other navigation and fish-finding aids. Instead of selectively catching fish near the shore, fishermen could now extend their range and fishing season.

So far so good. The longliners satisfied many of the criteria of AT. Their construction required the use and development of local skills and created more jobs than the construction of deep-sea trawlers. Large subsidies from the government were a strong incentive to fishermen to adopt this technology. In the late 1960s, the incomes of longliner fishermen increased and the government recognized this investment as producing more benefits than equivalent investments in larger-scale fishing technologies.

The initial progress, however, was not to last in the face of limited fishing stocks. By the early 1970s longliner fishermen had to spend more time at sea, buy more equipment, and hire more labour to stay financially afloat. As these costs nizes the value of the traditional inshore cod-trap fisheries. If the cod stocks are replenished, this will probably be the most efficient means of catching them.

The proposed fisheries development plan has not yet been implemented, but the restrictions on the foreign trawler fleets have improved the catch of local fishermen. Although the Fogo Island longliner fleet has not expanded, its financial problems are much less severe. The cooperative has placed more emphasis on fish processing rather than shipbuilding, recognizing that production from the traditional inshore trap fishing rather than longliner fishing is critical to its success.

The process of improving the economy on Fogo Island points out the limitations of emphasizing one scale of production, one economic activity, and only local control of development. Without a variety of investments and support at the national and international level, local initiatives in appropriate technology have tight boundaries.

References:

B.J. McCay. " 'Fish is Scarce': Fisheries Modernization on Fogo Island, Newfoundland." *North Atlantic Maritime Cultures*, Raoul Andersen ed., The Hague, Mouton: 1979.

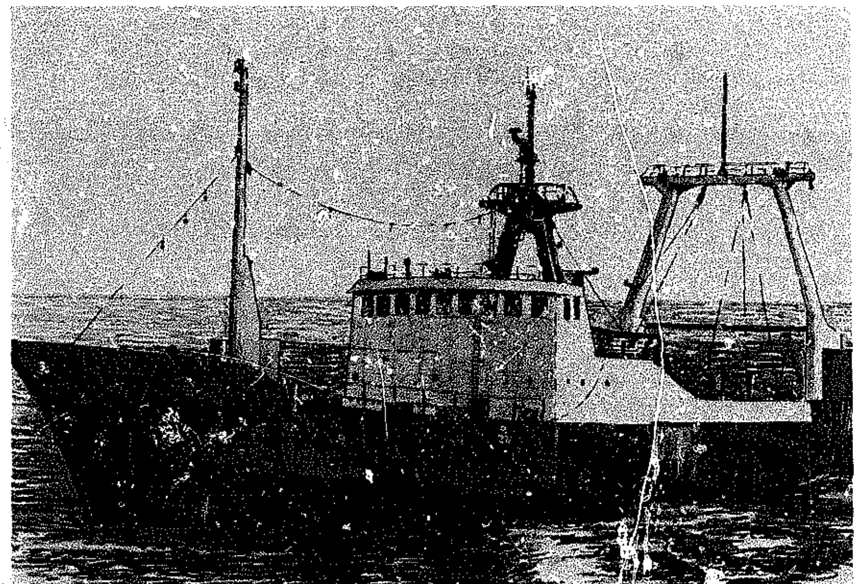
and efforts escalated, fishing became more intensive. The local controls over inshore fishing rights could not be extended to deeper waters. Now both the offshore trawlers and the "nearshore" longliners were depleting the stocks which migrated seasonally to waters used by inshore fishermen. The number of Fogo Islanders engaged in fishing declined. The Fogo Island cooperative was now on the verge of bankruptcy. New orders for longliners ceased; losses from shipbuilding absorbed profits from other operations. Very little of the longliners' catch was processed in the cooperative's processing plant, its most profitable operation.

This is yet another situation where the introduction of a new technology, even though based on some of the concepts of AT, has exacerbated problems by ignoring certain basic realities. Without a resource management policy to control the activities of all fishermen, inshore, nearshore, and offshore, the longliner fishermen had no choice but to continue as participants in resource depletion. Without initiating such a policy, the production of longliners was highly inappropriate.

The plight of the small Newfoundland outports, even when supported by local fisheries and community development workers, is largely in the hands of national governments and international agencies. Recent Canadian initiatives give indications of recognizing the need to combine fisheries resource management with rural development and the choice of technology.

In 1977, Canada extended its jurisdiction over a 200-mile-wide coastal zone and established policies to gradually exclude foreign trawlers. A year later the Newfoundland government proposed a new fisheries development strategy that is a model of balance: it proposes that if the fish stocks can be restored, then all sectors of the fishing industry, including inshore and longliner fleets, be expanded thereby overcoming the previous bias toward offshore trawler fleets. It also recog-

Small Canadian Stern Trawler



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Notes From Conferences on Appropriate Technology

Robert Mitchell

AT means many things to many people. Its practitioners frequently approach similar situations with completely different philosophies and intent. In order to test the reader's sensitivity to AT, we have included the following comments, gleaned over the years from various conferences and discussions. Read it simply for the examples of influence which determine the fate of AT projects (and their users). If you find some of the remarks a bit disturbing, so much the better.

Engineer A

I've just got involved in a rural water supply program. The people who hired me think the problems to be solved are simply engineering ones. After talking to people who have worked on installation of wells and pumps for many years, I find they are talking more about the non-engineering aspects of water supply than anything else. Sure, in many cases the pumps installed have not been reliable but, equally important, the local organization to maintain and finance the recurring costs of these pumps is never developed.

Community Development Worker

I've been working with local people in an isolated poor community for five years. Most of our work is getting people involved in making decisions through committees in a local cooperative. After a lot of trial and error, we now have a clean water supply, hand pumps a short distance from most houses, agreement on the need to keep the pit-latrines away from wells, and are looking into some alternative waste-disposal systems. It's really hard to find good information or people with experience in low-cost options. Three local people run a medical clinic and dispensary — 20 basic drugs cover most problems. One of these people is a "native" doctor who is great with setting broken bones and really good with psychiatric problems. Another is a midwife who the women feel comfortable with. We have learned a lot by our own mistakes. There have been other initiatives in new seeds and cropping patterns. The local people know a lot about agronomy. Some of them can identify over a thousand local plants.

In the last six months there has been a lot of activity around the village. A lot of government people have appeared with bulldozers and surveying equipment. It turns out that they are thinking of putting in a hydro-electric dam. It's hard to get information, they don't talk to us much, really avoid us. Rumours have started flying — some say a lake is going to cover all or some of our land. It turns out that who owns the land is not certain. I finally asked one man if this was true and if we lose our land how will we grow our food. He said, "Don't worry, we're going to attract a lot of industry. There will be jobs for everyone; there will even be a proper hospital." One old fellow said he saw the same thing happening a long time ago and said not to worry, they always go away. I'm not so sure.

I finally went to see the farmer's organization on the coast. They said it's too political, they don't want to get involved, but gave me the names of some other organizations [illegible] see and write to. Most of them said they couldn't help. One organization s[illegible]e the money to come here today. After listening to all you people I'm not s[illegible]hat you can help me. A few maybe. Seems you have a lot of the same problems here.

Foreign Aid Administrator A

I think we have to put more emphasis on rural development and delivery systems.

Development Economist

I've been involved in helping a small country develop its sugar industry. The sugar can be grown by a lot of small farmers spread out over a number of different regions in the country. Land distribution is already pretty good. We are faced with the choice of selecting the scale, number, and location of the sugar mills to process this sugar. We looked at a range of choices all the way from one large central mill to many smaller local mills to produce the same output. In the last 20 years, there has been a lot of work on smaller-scale sugar mills, most of it in developing countries themselves.

Our analysis looked at a wide range of factors: local skills, materials, distribution of benefits, local vs. foreign fuel sources, the reliability of smaller scale production compared to larger scale, infrastructure to service mills, the world and local sugar market, integration of sugar production with cereal crops, economic links created by the various choices, etc. What we ended up with was a document, which weighed four kilograms, that showed that five or six medium-sized mills would be the best investment in economic, technical, and overall development terms. In effect, it was a plan to help integrate small-scale agriculture and industry.

However, what is really feasible in this situation? A large international corporation has been lobbying the government to set up a single large plant with the government as the majority shareholder. An international development bank is willing to finance this venture. The bank and the corporation have figures to prove that their choice is the most feasible. In fact, when I talk to their economists I find our concepts of development are very different. They view the investment as inherently good, saying that any investment in this country is intrinsically developmental. Moreover, the large international corporation owns the company which supplies it with large-scale sugar-processing equipment, thus the choices of technology is predetermined.

At the moment it appears the choice will be the single mill. The corporation can guarantee construction and start-up times which is very appealing to the ministry of industry. Since this ministry does not cooperate much with the ministries of agriculture or development on such decisions, their opinion has the most weight. Some local government officials, particularly the ones who have studied the report, are concerned about concentrating the investment in one place, but have had difficulty getting discussion going on the more balanced approach of five or six mills. Admittedly, our approach is more difficult to implement and requires more interaction between various government agencies. But these local officials believe that development is a slow process, the existing planning agencies have to take a long-term, coordinated strategy if development within the existing system is ever going to occur. I've suggested that they use our document to bargain with the multinational corporation, but the government is afraid the corporation will go to another country if it makes too many demands.

Foreign Aid Administrator B

We've always been doing AT. We've been transferring a lot of wonderful expertise to the Third World. As my slide show indicated, Canada has some of the best expertise in this technology — first-rate, state-of-the-art. It is the best solution for their situation. Everyone I talked to there is really excited about this opportunity. People here in export development also see it as a good opportunity and Canadian companies need the work. We have helped many countries finance it with an interest-free loan with a 50-year repayment schedule and a 10-year grace period.

Teacher

I've been teaching in an isolated primary school where the curriculum is determined in the capital city, mainly by overseas consultants and book publishers. In the past year, the region has been severely affected by drought, our water supply in the neighbouring village has almost dried up. Long before this the hand pump that the government installed broke after six months and we have not been able to get the ministry concerned to repair it. They say they have no money to fix the vehicles required to transport the heavy equipment to extract the old pump from the ground to repair it. Then by chance I came across a book on alternate water supply technologies. In it were a variety of water pumps, storage and collection techniques. I realized that a lot of my older students, with some help, could understand and help develop these. Also, some carpenters and blacksmiths said they could easily make some of the parts though one cautioned that getting the proper size bolts out here was sometimes a problem. The school inspector, when I asked for a small amount of money, was really enthusiastic about integrating some of the school curriculum with local needs. He pushed our request for six months, but got nowhere. Our plans for a rainwater collection and storage system and a better hand pump that we could repair ourselves are still in my drawer. A year or so later he admitted to me that it was most frustrating; the government engineers felt he was questioning their authority and wisdom. They consider themselves the experts in choosing water supply technology for villages. Also, he found out that the original water pump was the product of a very expensive research and development program to develop a better hand water pump. When he repeatedly pointed out that they still broke down, he was usually dismissed by comments that the villagers didn't appreciate the pump and misused it. Our choice of technology boils down to what the government is willing to give us. We have to find another way.

Engineer B

I've developed a unique design for a windmill water pumping system. It's cheaper and more reliable than any alternatives I've seen. I've heard they really need this kind of equipment in the Third World. I've tried it out on my farm. It really works well. Don't know why I didn't think of it sooner.

Foreign Aid Administrator C

Look, off the record, we have to say we've always been doing AT. To say otherwise implies we haven't been doing it in the past. If I understand correctly what the AT people are saying, and believe me it took a long time for me to get to the real basis of your arguments, the approach to development you are recommending just does not fit into the standard procedures of our organization, and besides it would be hard to control and administer. I sympathize with what you are saying but the general attitudes in our organization just don't allow for real dialogue on choices with other agencies, let alone dialogue with the final users of these technologies. Let's admit it, people don't get promoted by asking questions, it's how much money you can justify on paper and get out the door. Evaluation of past investments is time consuming and perhaps threatening. I suggest as many of you do that you have to work outside bureaucracies.

International Technical Assistance Volunteer

Before I went overseas I thought I knew what was appropriate. After all, I was given a three-month course on solar and wind energy hardware and thought that all I had to do was build some of this stuff, demonstrate its potential and people would automatically adopt it. Boy, did I learn. One thing we tried was a windmill to pump water. There was plenty of wind, particularly at night but the people living near it didn't like the noise. It goes "whup, whup, whup" and the bearings sometimes squeak. It didn't work very well, anyway.

Academic

I've been studying the socio-economic and technical feasibility of AT for over three years. I have developed a 3-dimensional matrix of 108 elements for selecting AT. With this model we can determine beforehand what is appropriate.

Energy Consultant

Aren't we already doing appropriate technology? What you call AT is second-rate. How the hell am I going to extract oil from a kilometre down in the ground, dig a hole with shovels?

Foreign Aid Administrator D

Look, the local people are already doing AT. If AT is the technology that is best suited to local conditions and makes good use of local materials and skills, then local people are already exploiting these to the best of their abilities. I respect the wisdom of these people. Yes, they need access to better technology but hardware alone is not going to solve their problems. Without some changes in the local conditions of agriculture production, these low-income farmers are going to be continually dependent on the whims of what are essentially welfare handouts from the decision-makers on high. AT people do not address this issue often enough.

Social Scientist:

I have been hired by an international development agency to do a study of the social and economic aspects of a proposal to install a solar-powered photo-voltaic system to power a grain mill and a water pump in a village in the Sahel.

This new technology and the process of integrating it with a community of 2000 people is an experiment; the equipment is still very expensive. Other studies have shown such systems to be poor investments compared to hand pumps or diesel motors. The project engineers maintain that the solar components are reliable and virtually maintenance-free (most applications so far have been in laboratory or outerspace conditions). Even if this is true, the non-solar components can break down.

I have been trying to ask a lot of questions the engineers are not too concerned with. They see it as a relatively straightforward application of existing technology. Experience with projects of this sort elsewhere indicates that successful adoption of anything, be it a hand pump or a farm implement, rests on at least three important things: expressed need by the potential users, willingness to adapt the technology through discussion with them, and some local control over the management of the technology. I believe these questions have to be asked now if small-scale solar power is going to be productive in the future in the Sahel.

To begin with, the local community has not expressed a need, the engineers have been reluctant to discuss solar-powered options with the three existing owners of diesel-powered grain mills, and in this case the community is not organized in a way to manage its water supply. In the colonial era, the local chief and his advisors had been stripped of virtually all power to administer public works, let alone consider new options in technology. It is simply not an issue that is commonly discussed between local groups and outside consultants. The usual procedure is to depend on the central government for such initiatives. However, the government agencies have few resources, the best people are overworked, and so the services to rural people are unreliable. In the long run if this initiative is to be extended both within this community and others, the management must be mainly local. But are the project officers willing to allow the time for these skills to develop?

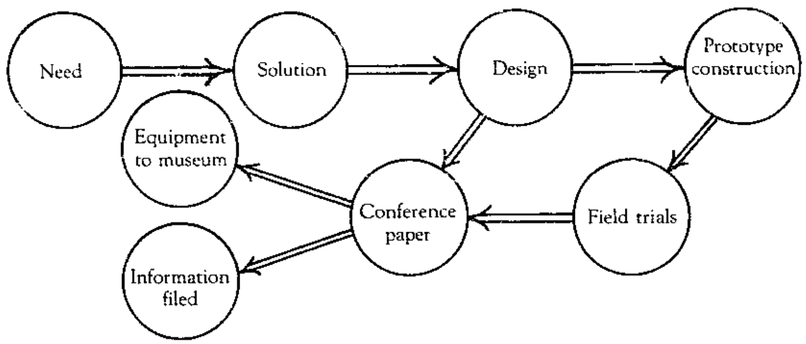
Probably 99 percent of the discussion and work on this project has been completely outside of the village in the capital city or overseas. The engineers for this project have been hired on a short-term contract. They want the system installed now. I suspect they will leave behind a monument to inappropriate technology. As an inventor of an unusual windmill said, "I'll sell plans for it next year if it works. If not, it will make a fine sculpture."

Further Information

Most of the information on AT is in people's heads; rooted in their experience, not on paper. Most working drawings, information, or equipment usage has to be discussed locally and adapted. The problem and risks for potential users are two-fold: to locate suitable technical assistance and to organize themselves to evaluate and implement it. Finding a range of options and not just one "solution" remains a problem.

A gulf exists between the knowledge in low-income communities and that of formal institutions. A small community may find large official organizations intimidating or inaccessible. Too often the research conducted in these organizations follows the flow chart below:

A common research flow chart[1]



Organizations Promoting and Implementing AT

Some of the many smaller independent organizations formed to bridge the gap between information and action focus as much on community development or adult education as on technical equipment. The combination of both is a strength; each alone is often insufficient. Some large organizations are modifying their services to make them more accessible to local people.

The strength of the smaller organizations lies in their connections with user communities. The following directories provide an introduction to these AT groups and non-governmental organizations (NGOs):

[1] Adapted from P.H. Dunn, *Appropriate Technology: Technology with a Human Face*. London: MacMillan, 1978.

Appropriate Technology Directory by Nicolas Jéquier, with the assistance of Gérard Blanc, 361 pages, OECD, Development Centre, 2 rue André-Pascal, 75775 Paris; 1979. (Also published in French under the title **Repertoire des Centres de Technologie Appropriee.)**

Institutions and Individuals Active in Environmentally-Sound and Appropriate Technologies. United Nations Environment Programme, Oxford, Pergamon Press: 1979.

Rural Technology in the Commonwealth, A directory of organisations, compiled by Bruce Mackay; Food Production & Rural Development Division, Commonwealth Secretariat, Marlborough House, Pall Mall, London SW1Y 5HX; Second edition 1980.

Directory of Canadian Non-Governmental Organizations Engaged in International Development. Canadian Council for International Co-operation, 321 Chapel Street, Ottawa, Canada, K1N 7Z2: 1978.

A NGO Development Directory, OECD, Development Centre, Paris.

Inquiry services and technical information designed for the non-specialist are available from the following major distributors:

Groupe de recherches et d'échanges technologiques
GRET
34, rue Dumont d'Urville
75116 Paris
France

Intermediate Technology Development Group
ITDG
9 King Street
London WC2E 8HN
England

National Center for Appropriate Technology
NCAT
Box 3838
Butte, Mt. 59701
USA

TOOL
Mauritskade 61a
1092 AD
Amsterdam
Netherlands

Volunteers in Technical Assistance
VITA
3706 Rhode Island Ave.
Mt. Rainier, Md. 20822
USA

The following international organizations provide information on AT:

Food and Agriculture Organization
FAO
Agricultural Service Division
Via delle Terme di Caracalla
00100 Rome
Italy

United Nations Industrial Development Organization
UNIDO
P.O. Box 707
A-1011 Vienna
Austria

World Health Organization
WHO
Appropriate Technology for Health Programme
1211 Geneva 27
Switzerland

Suggested Readings

For an introduction to the formal analysis of the role of science and technology in development and underdevelopment:

Bhalla, A.S. *Technology and Employment in Industry: A Case Study Approach.* Geneva: International Labour Office (ILO), 1975.

Bhalla, A.S. (ed). *Towards Global Action for Appropriate Technology.* Oxford: Pergamon Press, 1979.

A summary of an international conference of AT analysts in December 1977.

Chambers, R. "Project Selection for Poverty-Focused Rural Development: Simple is Optimal." *World Development*, February, 1978.

Development Alternatives, Inc. *Strategies for Small Farmer Development.* Boulder, Colorado: Westview Press, 1976.

An empirical study of rural development in the Gambia, Kenya, Lesotho, Nigeria, Bolivia, Columbia, Mexico, Paraguay, and Peru.

Diwan, Romesh K. and Livingston, Dennis. *Alternative Development Strategies and Appropriate Technology.* New York: Pergamon Press, 1979.

An examination of technology in a world context, of conventional development strategies (a failure) and alternative, more beneficial, options.

Edquist, C. and Edqvist, O. "Social Carriers of Techniques for Development," SAREC Report R3: 1979 (Swedish Agency for Research Cooperation with Developing Countries) SIDA, S-105, 25 Stockholm, Sweden.

An analysis of who chooses technology, combining "structuralist" and "actor-oriented" approaches.

Lipton, M. *Why Poor People Stay Poor: A Study of Urban Bias in World Development.* London: Temple Smith, 1977.

Morehouse, Ward, ed. *Science, Technology and the Social Order.* Rutgers, New Jersey: Transaction Books, 1979.

Essays examining the effects of modern technologies on social and political structures, especially in the Third World. A call for redirection in development to promote greater autonomy for individuals, communities, and nations.

Ramesh, J. and Weiss, C., eds. *Mobilizing Technology for World Development*. New York: Praeger, 1979.

A wide perspective on the issues in technology and development, with policy recommendations, from a conference of specialists in 1979.

Sigurdson, J. *Rural Industrialization in China*. Cambridge: Harvard University Press, 1977.

Singer, Hans. *Technologies for Basic Needs*. Geneva: International Labour Office (ILO), 1977.

Advocates socially-oriented technology policies, a balance between capital-intensive and labour-intensive techniques, and discusses some of the constraints on adopting such policies.

Steward, Frances. *Technology and Underdevelopment*, 2nd ed. London: MacMillan, 1978.

An analysis of the impact of inappropriate technologies on the Third World: unemployment and technological dependency; the political and economic restrictions on more appropriate strategies. Includes two case studies on choice of technique in Africa.

Timmer, C.P. et al. *The Choice of Technology in Developing Countries: Some Cautionary Tales*. Cambridge: Harvard University Press, 1975.

Three significant case studies of the impact of new techniques and the reasons for their choice.

For a less formal introduction to appropriate technology, development, and *possible futures:*

Boserup, Esther and Liljencrantz, Christina. *Integration of Women in Development: Why, When and How*. New York: UNDP, 1975.

Canadian Hunger Foundation and Brace Research Institute, *A Handbook on Appropriate Technology*, 2nd ed. Ottawa: 1979.

Available in English, French, and Spanish from the Canadian Hunger Foundation, 323 Chapel Street, Ottawa, Ontario, Canada, K1N 7Z2.

George, Susan. *How the Other Half Dies: The Real Reasons for World Hunger*. Penguin Books, 1976.

Jequier, Nicolas (ed.) *Appropriate Technology, Problems and Promises*. Paris: Organization for Economic Cooperation and Development (OECD), 1976.

One of the first general outlines of the concept of AT, its roots, and case studies of AT in practice.

Lappé, Frances Moore and Collins, Joseph. *Food First: Beyond the Myth of Scarcity*. Boston: Houghton Mifflin, 1977.

Lappé, Collins and David Kinley. *Aid as Obstacle: Twenty Questions about our Foreign Aid*. 2588 Mission St., San Francisco, Ca 94110, USA: Institute for Food and Development Policy, 1980.

The Open University. *Control of Technology*. Walton Hall, Milton Keynes, U.K. MK7 6AA: The Open University Press, 1978.

A 16-unit, university-level, self-instruction course which thoroughly covers all the social, economic and political aspects of people controlling choices in technology. Oriented to British context but examples are drawn from world-wide sources. Units 15 and 16 focus on the Third World, China, in particular. For the non-specialist, the best single introduction to the issues.

Robertson, James. *The Sane Alternative: Signposts to a Self-Fulfilling Future*. 7 St. Ann's Villas, London W11 4RU U.K.; 1978.

Rybczynski, W. *Paper Heroes: A Review of Appropriate Technology*. Garden City, New York: Doubleday, Anchor Books, 1980.

Worldwatch Papers

Brown, Lester. "Food or Fuel: New Competition for the World's Cropland." March 1980.

Eckholm, Erik. "Planting for the Future: Forestry and Human Needs." February 1979.

Hayes, Dennis. "Pollution: The Neglected Dimensions." March 1979.

Norman, Colin. "Soft Technologies, Hard Choices." June 1978.

Available from:
Worldwatch Institute
1776 Massachusetts Ave. N.W.
Washington, D.C. 20036
USA

Periodicals Focusing on International and Local Development Issues

"Cauderos del Tercer Mundo" (also in English)
Périodistas del Tercer Mundo
Apdo 20-572
Mexico 20 DF
Mexico

"Ceres" (in English, French, or Spanish)
Food and Agriculture Organization
Distribution and Sales Section
Via delle Terme di Caracalla
00100 Rome
Italy

Available in Canada from:
Canadian Hunger Foundation
323 Chapel Street
Ottawa, Ontario
K1N 7Z2

"Famille et Developpement"
CCP 518, Dakar, Senegal

"Ideas and Action" (in English, French, or Spanish)
FAO Freedom from Hunger Campaign/Action for Development
Via delle Terme di Caracella
00100 Rome
Italy

Available in Canada from: Canadian Hunger Foundation

"New Internationalist"
New Internationalist
Montagu House
High Street, PE18 6EP
Cambridgeshire, U.K.

"Development is not a simple sanitary process of investing capital or introducing new technologies . . . It is a messy, conflict-ridden business of social change."

Erik Eckholm

It is easier for social scientists to get cash and Chairs by mocking HYVs (high yield seed varieties) in Sussex, . . . or Washington, than by devising with technologists, inputs for poor farmers in field situations. That perhaps is why appropriate technology remains largely wind and I do not mean windmills which are at least worth tilting at.

Michael Lipton

Whatever has happened to the economies of poor countries the literature of project appraisal has an impressive record of growth.

Robert Chambers