PN-AAV-153
45196

PPC/CDIE/DI
ACQUISITIONS
Room 209, SA-18
Agency for International
Development
Washington, DC 20523

TECHNOLOGY TRANSFER:

IMPLICATIONS FOR WOMEN

This paper was prepared by Mary Boughman Anderson of the Harvard Institute for International Development Case Study and Training Project funded by the U.S. Agency for International Development.

INTRODUCTION

Much of the literature on technology transfer now acknowledges that technologies are not value free or value neutral. Two important volumes (Stewart, 1977 and Goulet, 1977) which cam out in 1977 represent a turning point in this recognition.[1] Technologies are seen to be embedded in and to carry social values, institutional forms, and culture - even as they also reflect resource endowments and the organization of production.

It is also true, though less often acknowledged, that technologies are not gender neutral. Because in every society, there is a gender based division or labor (or, as it is called in the industrialized countries, occupational segregation), technologies have different and differential impacts on men and women. Technologies as techniques affect the ways in which people do things; technologies as systems of knowledge affect the ways in which people do things and in which people think about what they do. If men and women do different things, then any particular technology will affect the roles of men and women differently. When technologies are transferred across boundaries where the roles of men and women differ from those in the originating country, the impact on men and women will be different in the receiving country from that in the sending country. Technologies affect the ways in which people think about what they do, and the transfer of a technique from an area with one set of norms affecting work roles to another with different expectations, beliefs, and norms will often bring about surprising (and sometimes unfortunate) outcomes. A.K.N. Reddy in his effort to devise an appropriate science and technology policy for India, cautions any recipient country regarding the impact of an imported technology. He writes, "Technology can be considered to resemble genetic material which carries the code of the society which conceived and nurtured it and which, given a favorable millieu, tries to replicate that society." In technology transfer it is not enough either to determine the terms of trade by which one country may purchase another's technology or to ensure that a given imported technology utilizes the recipient country's resource base appropriately. The cultural, social and political "codes" carried by technologies must be considered if unexpected, and often negative, impacts in the receiving countries are to be avoided.

How can we understand the socio-political biases and gender implications of technologies? What are the most useful ways of thinking about transfers of technology from one area to another to ensure the best possible outcomes? How can we ensure desired economic results while maximizing beneficial social/political impacts and minimizing negative effects on people and the environment? This paper will examine the issues of technology transfer and will provide a framework for understanding the relationships between technology transfer and women's involvement in development. We shall address specifically those issues which are most important in designing projects that are effective in both engaging women in the development process to the greatest possible degree and assuring women's participation in project benefits.

Transfers of technologies involve both a sender and a receiver. Several assumptions about technology and economic development influence both parties involved in a transfer, and affect outcomes of the transfer. It is useful to make these assumptions explicit before proceeding.

The historical experience of Europe and North America during the Industrial Revolution as well as the unprecedented material abundance produced by coupling scientific discovery, technological innovation, and industrial production, have shaped the very definitions of modernity which influence today's attempts at development. Progress has been equated with the emergence of a technological capacity for transforming resources into material abundance and, even more important, with a mind set that holds that nature can and should be controlled through science and techniques to serve human ends.

The success of this period in producing wealth brought with it an optimism that all problems were amenable to scientific/technological solutions. In 1934, Richie Calder proposed that the British House of Lords be replaced by a Senate of Scientists because, he claimed, such a body would have the knowledge and technique to solve all the problems then confronting England. Science could solve not only scientific and material problems, he and others claimed, but also any social, political or human problem as well. There was no better examplar of this belief than Buckminster Fuller who expressed it this way: "...for every human problem there is a technical solution...You may...ask me how we are going to resolve the ever-accelerating dangerous impasse of world-opposed politicians and ideological dogmas. I answer, it will be resolved by the computer...all politicians can and will yield enthusiastically to the computer's safe flight-controlling capabilities in bringing all of humanity in for a happy landing." (Hughes, p.41)

Even as the experience of the Third World has not substantiated this optimism, the basic assumption persists that technical solutions can be found for any problem. Efforts to develop Science Policy Institutes in many developing countries, to negotiate systems for the equitable transfer of technical knowledge, to develop international journals for the publication and dissemination of discoveries--even the appropriate technology movement--all rest on the assumption that a technological "fix" may be found. If we can only get the technology "right," then the assumption is that progress and development in the Third World will be inevitable. Many writers, policy makers and advocates for women's involvement in development are now searching for the "right" technologies for women to assure their involvement in and benefit from development.

What is behind this? Again, due to the history of the development of science and technology in Europe and North America, there is another strongly held and influencing belief about science. This belief is that science and technology, because they are based in nature, are separate from all normative and political influence. They are seen to free from cultural

or class bias. In fact, there is a great deal of evidence to the contrary, and among scientists there is an increasing acknowledgement of the interactions of their discoveries and knowledge with their social experience. In attempts to transfer technological know-how among the cultures of the North and the South, experience has shown the strong influence of the histories of colonialism, of existing power and wealth disparities, and of ideological differences.

It is important to acknowledge and to challenge these two assumptions: that all things are possible through science and technology, and that the affairs of these fields are free from political bias. Once both the senders and receivers of technologies understand the force of these assumptions and distinguish the elements of truth within them from the false, they are able to analyze the interactions of technology transfers in context and to assess the linkages between the access to and control of knowledge to the effective application of technologies in development.

A FRAMEWORK FOR UNDERSTANDING TECHNOLOGY TRANSFER AND WOMEN

Our technology framework will bring together three strands in order to clarify the relationships of technologies and technology transfer with gender. First, we shall look at the effects of technologies on productive activities. These effects occur in five specific areas: 1) on who does a productive activity; 2) on the location of the activity; 3) on the timing of production; 4) on the skills required for the productive activity; and 5) on the related attributes and activites of any productive task. When we have discussed these areas of effect, we shall then look at the characteristics of technologies which reflect the context of their origin as these influence and work through the technological impacts and, then, at the existing systems for technology transfer and their shaping of these impacts.

These three elements of this framework for understanding technology transfer and women relate directly to the analysis of productive activities and of access to and control over resources presented in the initial paper of this volume, "Women in Development: A Framework for Project Analysis." The relation arises naturally from the fact that technologies affect the ways in which people work and the ways in which they think about their work. The Analytical Framework shows that every society has a recognized set of roles which men and women play in relation to work. The rigidity or flexibility of these roles for controlling and using resources is historically, pragmatically, culturally or religiously based. The effects of the technical innovation on these gender-based roles is of great importance in project design.

A. The Effects of Technologies on Production

There are five basic categories of impacts through which technologies may have an effect on production. In each of these the potential for different and differential impacts on women and men is important.

1. Who Does the Productive Activity? The first and most obvious impact of any technology is to change the doer of an activity, the producer. The introduction of any device, technique or organizational arrangement which alters the role assignments of men and women in production may have a number of ramifications in status, access to and control over resources and income, and in the opportunity for leisure.

Usually in technology transfers from industrialized to Third World countries, the changes in the gender of a producer induced by the introduction of a technology arises in one of two interrelated ways. First is through an implicit expectation that the operator or manager of a technology in the originating country will be replicated in the receiving country. Second, as new technologies are introduced into an area, the ability to handle them is usually associated with relatively high status. Thus, those who either already enjoy higher status or who are in a position to corner it may move into tasks when a technology is introduced that were previously low status when done without the benefit of the new technology.

An ILO study conducted for the United Nations Commission on the Status of Women in 1967 provides an illustration. The study analyzed the impact of scientific and technological progress on the employment and work conditions in the metal trades, textiles, clothing, leather and footwear trades, food and drink industry, and printing and allied trades. In every case where machinery was introduced in activities traditionally done by women, men either completely replaced women in the activities or the activity became sub-divided and men acquired the tasks that employed the technology and required greated skill while women were relegated to the less skilled, menial tasks. These shifts were accompanied by the women's loss of income earning opportunities or by marginalization and lower income.

In Java, when rice mills were introduced, women who had traditionally earned their only monetary income from hand milling were displaced as men assumed the positions in the factories. (Timmer, Some Cautionary Tales) A similiar result occurred in Korea when the government installed rice mills there. (Hoskins, II, p.51)

In the Ivory Coast, traditionally women had been responsible for growing and spinning cotton which men then wove into cloth. Women controlled the cloth, and used it as a source of wealth and some status and power. With a thrust toward turning cotton into a cash crop resulting from the colonizer's need for increased supplies, technological innovations were introduced to increase the cotton output. Through extension agents and

technologists who worked with men, (as well as because male head of households were required to pay a head tax for family members in cash), the growing of cotton became a domain of men. In a secondary phase of production, however, because women were displaced from their primary role in cotton production, they were subsequently hired into newly built textile mills, now as weavers with machinery. Technological changes induced a series of changes in gender assignments of the tasks associated with cloth production (Etienne, 1987).

These examples show that a technology can change the doer of any productive activity. But, in addition, a technology may alter the components of a productive task, breaking it into separate functions or changing the activity that results in a given production, and, in doing so, also alter the gender roles in these separate or changed parts of the country.

A technology may also focus on a single component of a job, rather than the entire task and, by doing so, alter productive relations between men and women. In Upper Volta, an AID/NASA project installed a solar pump to save women the work of lifting water. As it turned out, the lifting of the water was the least time consuming or difficult part of the water collection task of women; they spent most time and energy in carrying buckets of water from the well location to their homes. The pump, in fact, aided the male cattle herders far more than the women in that the women only used a few buckets a day in home consumption while herders used many buckets for watering their cattle. For the technology to address easing the work of women, there should have been more concentration on the piping of water rather than only on pumping. (Hoskins, p.43 II)

Technologies also affect doers of activities in that they may be either labor-saving or employment-generating. In certain circumstances, a decision to employ a labor intensive technology may draw women into the labor force and to tasks not previously and traditionally theirs. Sometimes, status is increased in this process. The period of the Chinese Revolution from the 1950s through the mid 60s provides a good example. Decisions to employ low-capital techniques to construct water irrigation and storage technologies demanded that women, as well as men, be mobilized in large numbers for this construction. Because the status of the worker was so high in that revolution, women gained as they adopted this role explicitly alongside men. In Java, the interaction of the massive involvement of labor in building irrigation systems and the mobilization of large amounts of female labor showed some of the same characteristics (Hart, 1983).

While technologies of production influence who does what, technologies of marketing and importation can also have this effect. In colonial India, the importation of cotton from England displaced many Indian workers, primarily women, from the jobs of spinning and weaving on which they had previously depended. The production and transportation technologies were both sufficiently inexpensive to make this a viable

economic alternative for cloth production. Even if the cost of transportation were subsidized, the existence of an adequate technology for transferring the cloth was a factor in the displacement of Indian women from traditional work.

In cultures where women and men both engage in trade, but there are distinctions as to quantities and types of products traded by each, the introduction of carts, roads, or trucks can alter these distinctions. These transportation technologies may either favor the trader of larger goods of they may open opportunities for traders who were previously limited by their ability to carry their produce. The effects on women traders relative to men can only be analyzed in context when the divisions of labor and the socio/cultural meaning of it is known.

Finally, technologies may introduce processes which, because of social or cultural restraints, make them inaccessible for use by a certain group. For example, when bicycle pumps have been introduced in some societies, women have been prohibited from using them because of taboos about women sitting astride a device.

Thus, technologies can change the doer of a productive activity Expectations about who can and does handle technology change the need for labor either positively or negatively, change access to goods previously produced by women so that they come from another source, and introduce a technique not seen as suitable for women in social or cultural terms.

2. The Location of the Productive Activity. Technologies may affect production by relocating activities. In many societies, women have different patterns of mobility from those of men. In some they are confined to certain private or "female" places, such as the household compound, by social or religious traditions. In others they may be restricted in the ways they move about, being required to travel in pairs or groups, or always with a spouse or a father, or only in certain kinds of conveyances. Women may also be restricted in their movements by their other productive and household obligations such as child care, food preparation, or livestock care.

When technologies change the location of any task, they may then result either in the exclusion of women from the work or in a change in their traditional work patterns. Some women limited by purdah may not accept employment in a situation where both men and women work; nor may they work outside their compounds. A rice mill which is located in a central area for ease of access may not provide opportunities for Bangladeshi women who formerly were responsible for all rice processing because they are not free to accept work in such a location. When a technology centralizes productive activities, and women may not go to the new place of the activity, men move into productive activities where women previously held sway. This occurence tends to reinforce the belief that men work with technologies and women do not or that men do "modern" work while women only work in subsistence sectors though the real issue is only where the technology is located.

Changes in the location of production where women are not restricted by religion or deeply embedded tradition but only by their other home-based productive obligations may cause women to move out of traditional patterns and undertake new activities. When the wool mills of western New England wanted to attract cheap female labor in the 19th century, the owners built dormitories (and installed chaperones!) to house the young girls who took employment. In China as women moved into factory labor, nurseries and child care centers were built in the factories to allow women to meet their nursing obligations of the very young children and to subsititute for the child care work of women for older children. Electronics factories in southeast Asia and others in Mexico have recruited mainly young, unmarried women in order to avoid having to provide these services. In West Africa, urban women who have undertaken economic activities outside their homes have worked out a variety of alternative systems for providing food to their families, including rotating the responsibility for food preparation among members of a group. Small street vendors of food clearly help meet this need as well.

3. The Timing of Production. A technology may eliminate or lessen the time it takes to accomplish a job, may change the time of day or year when a job must or may be done, or may lessen the time spent on some aspect of a job while increasing the requirements for other aspects.

A recent publication on women and technology shows a photograph of two sweating and miserable women in southern Africa using a solar stove designed by an expatriot technician who "understood" energy abundance (in this case, solar) relative to human labor (ISIS, 1983).

The purpose of the technology was to eliminate the need for women to walk for as much as six hours a day to gather decreasingly available firewood. The technician, however, did not know that these women traditionally cook in the early morning hours or the late afternoon precisely in order to avoid the heat of the day. The invention untilizing solar energy involved a significant rescheduling of the daily activities of the users. The technician understood resource endowment; he did not consider the time requirements of his invention relative to other uses of time in the recipient society.

A technology designed to increase output/acre through applications of fertilizers or insecticides may force increased labor applications over that acre, changing the time allocations of workers. If those laborers who are responsible for the fertilizer or insecticide applications are already overburdened, as is the case with many African women agriculturalists, the technology will have had a differential impact on different workers. In much of the world, women are carriers of water--necessary in backpack insecticide sprayers. Women often weed, the requirements for which increase with fertilizers. If tractors plow more land, the cultivators, weeders, harvesters and food processors--often women--have more work.

The impact of a technology on one part of a productive process will be felt both on that component, and also on a related processes. When various parts of a productive chain are assigned by gender, it is important to know this in order to understand labor constraints, opportunities, and characteristics. When a technology saves labor on one aspect of production but increases in on another, economists have assumed that the labor freed from the former will be available to the latter. When gender determines functions, this is not the case.

Even within the jobs that are those of women, a technology may save labor in one while increasing it in another. A new cooking stove may, for example, reduce the amount of wood a woman needs to collect and save time. It may also require wood of a shorter length or smaller diameter thus necessitating more time spent on chopping wood. Enclosing the flame of a fire inside a fuel-efficient stove may force women to cook and/or serve meals during daylight hours because of the loss of firelight. A stove and its chimney or flue requires maintenance for efficient performance and this takes time.

Linkages, attendant activities, and gender roles complicated the introduction of technologies. To assess accurately a gain in time savings, one must consider shifts in time of day when a task must be done, shifts in amounts of time spent on an activity and all its attendant activities, and shifts among workers (and genders) of time allocations in the processes affected by the technology.

4. Skills Needed for Productive Activity. A technology can alter the skills needed for doing a particular job. Skills are required both in production with a technology and tis maintenance and repair. Access to and control over the knowledge required to acquire a technology and to use it may determine who does a particular job and who gains from that production. Gender biases are built into the systems of training, education, and skills acquisition which often comprise a part of technology transfers. Educational systems shape access to and knowledge of technologies in several ways. First, in most societies more male children go to school than female, and fewer males drop out of school than females. The ability to read, exposure to a broader world and the options it contains, and training in science and mathematics all support a subsequent ability to understand, respond to, use, and control technologies which have originated elsewhere. Advanced training follows basic training so the chain is reinforcing; those who lose out early are virtually prohibited from later involvement.

In most rural areas of the world, schooling provides the only way for children to learn to speak a more widely used language beyond that of their village, tribe, or cultural group. The ability to communicate with outsiders is an essential part of gaining access to knowledge and technique which can come from outside.

Schooling also transmits and reinforces expectations about who does what in "modern" society. Gender roles, as they have emerged in the technology-creating societies, are taught even as information about these societies and their modernization process is taught.

5. Related Attributes of Activities of a Productive Task. Many productive activities have associated with them some ceremonial, social or familial activity which, if the production is changed, are also changed and sometimes, lost. This factor may affect the productive activities which occur around the home more than those which occur elsewhere and, therefore, may be a more important consideration to women than to others. The Loreno stove, by enclosing the fire, utilizes wood efficiently, but at the same time deprives the household of firelight around which, in many parts of the world, the family traditionally gathers in the evening for conversation and decision-making. At a more practical level even, the same stoves that have reduced smoke and improved health in terms of respiratory disease have also been associated with increases in malaria and other insect borne disease because the smoke had been effective in killing insects. Smoke also is thought by some women to be helpful in making thatch roofs more resistant to the rain.

Women have traditionally used the time of long walks to fetch water and firewood for social organization, conversation and interchange. Technologies which alter these functions eliminate these opportunities as well, so that other forms have to be found. Technologies which gather women in certain areas, such as grain mills, can have the opposite effect--that is, they can facilitate social activity and opportunities for education. For example, women in Asia have received literacy training while they wait for their rice to be ground at mills as women in Africa have received nutrition training while waiting in line at clinics.

The cotton weaving in the Ivory Coast, discussed above, traditionally involved an important element of aesthetics. Prestige was derived from the beauty and patterns of the weaving more than from the income derived from it. With the changes in production that resulted from cash cropping much of this value has been lost and other means for satisfying it have had to be found.

By their nature, technologies are disruptive of old patterns precisely because these old patterns have not been sufficiently productive. People look for and adopt technologies in order to increase their economic security. However, for a technology to be effectively adopted, the gains to recipients must outweigh losses, and some of these are non-economic. Marilyn Hoskins, summarizing a range of case studies on the transferrence of household technologies to women in many countries notes, "...costs appear to be a relatively less important consideration than may implementers had expected and that of aesthetics relatively more important."

Projects which are designed on the assumption that the suitability of technology transfers can be assessed by economic criteria alone are, therefore, likely to result in unexpected failure. Experience has shown that economic rationality is not the only, or even the primary, motivator of all decisions in many parts of the world. This is particularly true in the spheres of activity which are not entirely with the market. Because many of women's productive activities fall outside the market sphere, such a caution might be even more relevant to understanding potential technological impacts on women or to developing any predictive capability regarding these impacts.

B. The Effects of Technologies on Consumption

Related to the division of labor in production, but requiring additional empirical research and analysis is the division of labor in consumption. Some aspects of consumption seem to have gender implications. Partly, this is directly related to production in a cyclical way--who produces hat determines who consumes what--and partly it is the result of traditional roles.

Some consumption technologies would seem to be entirely gender neutral but turn out, in practice, not to be. For example, a radio can provide access to information on a broad and unlimited scale. A radio may be listened to, a television may be watched, a telephone may be used equally by male and female ears, eyes and voices. However, when a radio is placed in a traditional gathering place for men, such as a beer hall or the village council, and if women are restricted socially from full access to this place, then men will gain access to additional information not available on an equal basis to women. The technology, itself, becomes a reinforcer of patterns of access and control which already exist in the society.

A technology may alter consumption patterns in relation to a good it is designed to produce. The example of the solar pump for water, referred to above, provides a case in point. While designed to facilitate women's access to water, it benefitted cattle herders more. Whereas the herders had traditionally moved away from the watering place where the pump was installed when the rainy season came, the pump made water access so much easier for them that they remained closer at hand all year round. This caused the women to have to stand in line to use the water each time they came. It also meant that the cattle fed on small and new plant growth in the area of the village which women had previously used for food, handicrafts, and medicines. Utilization of the water supply increased markedly straining it beyond its capacity. Women had to wait in line longer, walk farther for the plant growth, and risked periodic loss of this resource as a result of the innovation. The impact of the technology with a productive intent was to change for the worse women's consumption patterns.

In some areas of Africa, women note that because they now grind their meal at a mill only a few times a week, rather than daily grinding the family ration at home, their children use the meal which is now stored in the home for snacks. This may improve nutrition. It may also put stress on food supplies if the productive process of daily pounding at home had in fact operated as a rationing system for consumption.

In Ghana, a project that had apparently been successful in getting women to use a fuel efficient stove was later found to have failed to sustain this use. The women explained that the new stoves did not accomodate the large cooking pots necessary for the Ghanian type of cooking. In this case, a refusal to change consumption patterns caused the productive technology to be abandoned. (Hoskins, p.47)

Table I shows a scheme for tabulating the effects of technologies on production and on consumption which we have discussed and for noting and assessing the implications of each of these impacts on women in particular. With this part of our three part framework in place, we shall turn now to examine the characteristics of technologies and of transfer processes which form the other cornerstones of this analysis of the relationships of technology transfer and women.

C. Technology Characteristics

Technologies may be small or large, simple or complex, cheap or expensive, labor saving or employment generating, locally based or imported, etc. That is, any technology has a series of definable characteristics which influence its transfer from one context to another and, specifically, through the analysis of effects above, the impact of its transfer on women in the development process.

These characteristics are both material and non-material. Recognition of the misfit of physical characteristics of imported technologies to local environments led to the "appropriate technology" movement, which stressed the importance of fitting a technology's resource requirements to local resource endowments.

E. F. Schumacher's Small is Beautiful subsequently led many people to believe that an appropriate technology is always small, simple, cheap and labor-intensive. Much effort has been put into the invention and development of such "appropriate" technologies to be disseminated around the world. In fact, the characteristics of technologies are more complicated than this. Appropriateness implies a link to some external factor and a judgment about correctness in relation to something such as resources, goals or values. Furthermore, scale, complexity and expense are not always positively correlated. It is possible for a large machine to be both simple and cheap and a small one to be highly complex and expensive. That is, the characteristics of technologies can be combined in a number of different ways and these combinations incorporate physical and non-physical elements.

Table 1

Technology Transfer and Women: A Framework for Analysis

I. Effects of Technology on Productive Activities

A. On Doer

1. Traditional Doer
2. Doer with Technology
3. Implications for Women

Age	Gender

B. On Location

1. Location of Traditional Production
2. Location of Production w/ technology
3. Implications

Home/Nearby	factory in village	factory outside village

C. On Timing

1. How Long Activity Traditionally Took
2. How Long Activity Takes with Technology
3. Implications for Women

4. Time of day/week/month/year Activity Traditionally Done
5. Time of day/week/month/year Activity Done with Technology
6. Implications for Women

7. Segmentation of Time as Activity Traditionally Done
8. Segmentation of Time as Activity Done with Technology
9. Implications for Women

D. On Skills Needed for Activity

1. Skills used to Do Activity Traditionally
   i. Where acquired
   ii. How acquired
2. Skills Used to Do Activity with Technology
   i. Where acquired
   ii. How acquired
3. Implications for Women

E. On Onerousness of Activity/Attendant Benefits or Activities

1. Onerousness When Done Traditionally
2. Onerousness When Done with Technology
3. Implications for Women
4. Linked Benefits/Activities When Done Traditionally
5. Linked Benefits/Activities When Done with Technology
6. Implications for Women

II. Effects of Technology on Consumption Activities

A. Through Technology Itself

B. Through Products of Technology

Thomas P. Hughes writes about these complications as technological "style." He notes that mechanical technologies were primarily developed in the United States where energy was abundant and labor short while Europe, with the opposite resource endowments, relied more heavily on chemical technologies (Hughes, 1980). Biological technologies emerged in 19th century Europe but were elaborated in America through the application of genetic science to large scale agriculture. In a sense, because of climatic conditions, disease vectors and crop types vary widely among geographic areas, it is more obvious that biologically based technologies require adaptation for effective transferrance than it has been for mechanically and chemically based technologies. With all three types, hwoever, adaptations have not been adequate because even when they have occurred, they have usually taken account only of the physical resource base characteristics of technologies and not of the non-physical characteristics.

Technological style, then, requires more exploration. Hughes illustrates the concept by comparing the development of Volkswagen with the oversized American car. While one is energy efficient and the other is not, these styles also embody and reflect generalized cultural style including a set of explicit values (grandeur vs. utilitarianism), class attitudes (conspicuous consumption vs a "people's" car), and intended use (to spend a lot of time in, to travel long distances in, to go to drive-in movies in vs. getting around town and through narrow streets conviently). Hughes writes about the transfer of technology from Britain to colonial America which was striving for its independent technology, "British engineers transferring technology would have used iron and steam because they knew it; Americans used wood and water because they had it." But, the development of the Mississippi river boat in one country and the shipbuilding industry in another reflects not only these resources, but also the fact that the British required a means for moving beyond their small island to explore distant lands while the Americans wanted to navigate the large rivers of their continent and had little desire to cross any oceans. Technological styles are composites of many factors.

What difference might technological style make to gender? What should we understand about it in order to design projects that engage women as effectively as possible in development? Table II provides a system for tabulating the importance of technologies' characteristics, which make up this "style", on projects' impacts on women.

We look first at the physical requirements of technologies in the originating environment. These include the factors of production--land, labor, and capital. When the use of these resources in the original technology are identified, then two questions, related to its transfer should be asked. First, are these resources available in sufficient quantity and quality in the recipient country? Second, who in the recipient country owns, or controls, these resources? Men and women, by virtue of tradition and tasks, frequently have different access to and

TABLE II

CHARACTERISTICS OF TECHNOLOGIES

Physical

	Requirements in Orginating Country	Availability in Recipient Country	Control in Recipient Country
Land			
Labor			
Capital			

Implications for Women

	Purpose of Originating Country	Suitability in Recipient Country
Mechanical		
Chemical		
Biological		

Implications for Women

Non-Physical	Originating Country	Recipient Country
Skills		
Organization		
Discipline		
Cooperation		
Scale		

Implications for Women

control over these resources and the patterns of this gender-based division vary from country to country and from context to context within countries. Often patterns of resource control are changing as well. In Kenya, for example, new land ownership laws are transferring title to land almost exclusively to men. Under traditional systems women enjoyed assurance of access to land, and this access was central to their roles as primary subsistence producers. As land laws change, women's abilities to farm are changing. Technologies which affect farming patterns will clearly have differential impacts on men and women with their different access to and control over land. In every society, it is relevant to any plan for technology transfer to determine who has access to adequate capital to buy and maintain a technology. Men and women also have differential access to and control over labor. Women may command the labor of their children only or form interchangeable labor units among kinship groups of women. Men may hire men, but in some societies women may not. Women may work for wages, but in others they are restricted from wage activity by tradition. Thus, resource inputs to effective technology usage is one of the most important factors for analysis in understanding technology transfer impact.

In considering physical characteristics of technologies and their gender implications, we include in Table II the issue of style which we described above in mechanical, chemical, and biological terms. The point is to make explicit the purposes behind the development of the technology where it originated. What questions or problems was the technology originally designed to answer? Who decided? How did the priorities get set for which problems to solve? In all three areas, mechanical, chemical, and biological, a vast number of technological developments have been in response to productivity needs in the market sphere. Returns to research and development in this area can be calculated to determine expectations for profit investment.

There are a number of areas in the Third World where profits can be realized through technological innovation, so new questions based in Third World experience are being posed to the mechanical, chemical and biological technologies. These tend still to be concentrated in certain activities and certain types of activities. Who is involved in determining which areas should have priority? Are women included in the decision-making places? Not often. There are two reasons for their absence. First are the issues of differential access and control to traditional decision-making and to capital resources. Second, women's work is disproportionately concentrated in nonmonetized sectors or in small scale enterprises. These areas are not seen as those which are most likely to produce profits on a scale to justify certain types of technological innovation. While this calculation may be correct, it is also true that women's productive sectors are increasingly recognized as central to many countries' overall productivity. Subsistence agriculture feeds the majority of people and produces the majority of food in many lands. Understanding the basis on which technologies have been developed in the originating countries is essential to determining what other considerations should be included in the decisions about where to focus them in developing countries.

The non-physical characteristics of technologies which comprise the other elements of technological style are just as important in their potential differential impacts on women and their roles. These include such things as organization, level of skills required, type of discipline required, degree of cooperation and scale of operation. A technology originated in an area where production is organized hierarchically will not be suitable necessarily where production is carried out cooperatively. In situations where women's productive work is organized differently from that of men, as is the case where women's mobility is restricted, a technology which meets the organizational setting of the one will not be so suitable for the other. The connection of the analysis of the non-physical characteristics of technologies with the related attributes or activities of any productive activity is obvious. When a technology provides water to women individually at their homes, they may, as we saw, loose an opportunity for interaction which was important in the ways they had previously organized their water gathering work. The purpose of this analysis is make explicit the variety of characteristics of different technologies which will affect their successful transfer and to relate this to the definable separate roles of men and women so that the differing impacts may be seen at the stage of project design.

D. Characteristics of Technology Transfers

There are three basic mechanisms by which technologies are transferred in assistance programs. (There is an extensive literature on the processes of technology transfer through trade and commerce including implications of technology packages, components, servicing contracts, licensing, patenting, etc. A particularly good analysis of the implications of various technology aid and trade packages may be found in Hans Singer, Technologies for Basic Needs, ILO, 1982, pp.29-50. Because we are concerned with project design and implementation by agencies involved in providing aid to developing countries, we are focusing here only on the aid transfer mechanisms.) These are 1) through direct projects or programs, 2) through personnel and 3) through education and training programs. Usually the three are combined in any given project. A project will introduce a new technology making it available physically to project participants. Personnel will bring it, assemble it, demonstrate its use and maintenance. Training systems for its use will complete the transfer as project beneficiaries learn to use and maintain the technology. Personnel also, of course, do the training.

Much of the previous discussion was concerned with elements which define the technology (the equipment or technique), itself. To complete the analysis, more discussion is in order here regarding transferring personnel.

The person who transmits a technique or knowledge of it can affect or determine who finds out about it and who can have access to using it. There is growing documentation of the problems which have emerged as a

result of the fact that male extension agents or teachers and instructors do not, in many societies have access to women who may be potential or actual users of technologies. (Fortmann, pp.205 ff and Boserup and Liljencrantz.)

The effect of the agent in technology transfers is even more important and more subtle than direct gender access implies. The characteristics of the possessor of knowledge about a technology or of the person who controls a technology communicate a message about who may have technological knowledge or control. This occurs in two ways that usually reinforce each other. The possessor/controller may believe that it is only people like himself who can manage technologies. Thus, he looks for people like himself to be the recipients of his efforts to disseminate, sell, give or demonstrate a technology. Others who see that usually (or always) a man or men handle technologies will make the same assumption that this is inevitable. In agriculture, there is an additional insidious related belief which follows. Because women have, in many parts of the world, been responsible for subsistence agriculture, there is a sense that the modernization of agriculture through the application of technologies requires, at the same time, the masculinization of agriculture. (ILO Office for Women, "Women, Technology and Development Process, in Dauber and Cain, pp. 33-50) This same type of belief is found also in industry. As rice milling became industrialized in Indonesia, men ran the mills.

Technologies originating in Europe and North America often carry this message. In the history of the development of technologies in these societies, for a variety of reasons not necessarily replicated in other cultures and places, technologies have been for the most part invented, developed, controlled and used by men. Ironically many technologies, in fact, have obviated gender differentiations based on size, weight, strength or speed (anyone can push a button for example, or drive a power steering tractor) forcing us to give up our notions that women are too weak or fragile to do certain tasks. Rather than breaking down the gender-based division of labor, however, we replaced the limits imposed by physical characteristics with limits believed to be imposed by mental capacity, talents, acumen, and inclination. We developed the belief that women "don't do" math and that women "don't like" to work with machines. Women tinker with a machine with a hairpin; men repair a machine with tools. As western assistance agencies approach development projects and programs in which they transmit a technology, the staffs of these agencies often carry these attitudes and preconceptions and assume that, the more complex the technology, the more inevitable it is that they will need to locate men to whom to transfer it.

Even those concerned with broader access to technique are often trapped into these gender-based expectations. One US agency which is designed to transfer technologies appropriate to all askers from any area of the world, quite recently still carried photographs in its major publicity pieces which showed only men working with technologies. A line drawing, showing women washing clothing on rocks, was the only pictorial

representation of women. Its technical assistance experts are predominantly male as is true for most such agencies. Thus, in a subtle way even this organization devoted to increasing access to technologies conveys the message that technologies are more for males than females.

For project design purposes, then, consideration of the messages represented by the agents of technology transfer, as well as by the systems of transfer, is important to increasing women's involvement in and benefit from technologies.

CONCLUSION

In the discussion above, we have presented categories for analyzing the impacts of technologies on production and consumption and for thinking about the characteristics which may affect these impacts. We have also noted the central importance of the transmitting agent. We have cautioned against looking for a simple technological fix to the problems of development, and to the problems of technology transfer as well.

Simply having smaller technologies will not bring development. Simply recruiting women to work as instructors of technology use will no more solve problems of development for women than the corresponding process has done for men.

What is needed is the development of systems for transferrence of technologies in their broadest sense, including know-how and technique, in a manner which promotes the recipient's own ability to become, him or herself, a technologist. How does one develop the capacity to invent? Familiarity with existing technologies is certainly one part of the answer. This is why issues of access to both knowledge and use of technologies is so crucial for longer term development. Those who do not have access to technological knowledge or experience will never be as likely to become developers of their own technological solutions as will be those who do.

Technological familiarity provides several things. It instills the idea that some things can be done better, with less effort, with more favorable results, more cheaply, etc. It also teaches that a person can make that occur by control over a technique. It teaches various mechanical, chemical and biological processes which form the bases for new discoveries, inventions and adaptations. It empowers people to solve their own problems of production. It is clear, therefore, that the marginalization of any group in relation to technology development and use not only leaves them out of current benefits to be derived from technology, it consigns them to an inferior position in relation to future developments, and it limits, if not prohibits, their ability to participate in these.

BIBLIOGRAPHY

Canada's Role in Science and Technology for Development. Proceedings of a Symposium held at the Ontario Science Centre, Toronto, Canada. 10-13 May 1979.

Carr, Marilyn. "Women and Technology in Rurally Oriented Projects" World Bank, 1981.

Das Gupta, Jyatirindra. Authority, Priority and Human Development. Delhi: Oxford University Press, 1981.

de Cubas, Jose. Technology Transfer and the Developing Nations. New York: Council of the Americas and Fund for Multinational Management Education, 1974.

Domination or Sharing. Paris: The UNESCO Press, 1981.

Driscoll, Robert E. and Harvey M. Wallender, III, eds. Technology Transfer and Development: an Historical and Geographical Perspective. New York: Fund for Multinational Management Education and Council of the Americas, 1974.

Dulansey, Maryanne. "Can Technology Help Women Feed Their Families?" Paper prepared for AAAS Workshop on Women and Development, March 26-27, 1979, Brookings Institution, Washington, D.C.

Elzinga, Aant and Andrew Jamison. Cultural Components in the Scientific Attitude to Nature: Eastern and Western Modes? Lund, Sweden: Research Policy Institute, 1981.

Foster, George M. Traditional Societies and Technological Change. New York: Harper and Row, Publishers, 1973.

Goulet, Denis. The Uncertain Promise. New York: IDOC/North America, Inc., 1977.

Hoskins, Marilyn W. with Fred R. Wilber. "Household Level Appropriate Technology for Women. Part I--Issues and Project Considerations" Manuscript prepared for Office of Women in Development, Agency for International Development, Washington, D.C., 1981.

Hughes, Thomas P. "Technology" in Henry Friedlander and Sybil Milton, eds. The Holocaust: Ideology, Bureaucracy, and Genocide. Milwood, NY: Kraus International Publications, 1980.

----------. Changing Attitudes Toward American Technology. New York: Harper and Row, Publishers, 1975.

ISIS. Women in Development. Geneva: ISIS International Women's Information and Communication Service, 1983.

Laswell, Harold, Daniel Lerner, and John D. Montgomery. Values and Development: Appraising Asian Experience. Cambridge, MA: MIT Press, 1976.

Rabinowitch, Eugene and Victor Rabinowitch, eds. Views of Science Technology and Development. Oxford: Pergamon Press, 1975.

Restic, Slobodan. The Collective Self-Reliance of Developing Countries in the Fields of Science and Technology. Japan: The United Nations University, 1980.

Rothschild, Joan. "Technology, Women's Work and the Social Control of Women" in Marguerita Rendel ed. Women, Power, and Political Systems. London: Croom Helm, 1981.

Sagafi-Nejad, Tagi and Robert Belfield. Transnatical Corporations Technology Transfer and Development. New York: Pergamon Press, 1980.

Singer, Hans. Technology for Basic Needs. Geneva: International Labor Organization, 1982.

Solo, Robert A. and Everett M. Rogers. Inducing Technological Change for Economic Growth and Development. Michigan State University Press, 1972.

Stewart, Frances. Technology and Underdevelopment. London: The Macmillan Press, Ltd., 1978.

Volti, Rudi. Technology, Politics and Society in China. Boulder, Colorado: Westview Press, 1982.

White, Benjamin and Endang Lestari Hastuti. "Different and Unequal: Male and Female Influence in Household and Community Affairs in Two West Javanese Villages." 1980.

JOURNALS

Ames, Edward. "Communications." American Economic Review, 51 (1961), pp. 370-381.

Beneria, Lourdes. "Reproduction, production, and the sexual division of labor." Cambridge Journal of Economics (1979), 3, pp. 203-225.

Bhaneja, Balwant and J.A.S. Walker. "Comment." Impact of Science on Society, 28 (1978), pp. 95-104.

Bourguiba, Habib, Jr. "Development and Transfer of Technology." Cultures, 3, no. 3-4 (1976), pp. 126-130.

Brown, Richard Harvey. "Appropriate Technology and the Grassroots: Toward a Development Strategy from the Bottom Up." The Developing Economies, 25, no. 3 (Sept, 1977), pp. 253-279.

Brozen, Yale. "Invention, Innovation, and Imitation." American Economic Review, 41, (1951), pp. 239-257.

----------. "Technological Change, Ideology, and Productivity." Political Science Quarterly, 70, (1955), pp. 522-542.

Carroll, James D. "Participatory Technology." Science, Jan-March 1971, pp. 647-653.

Curru, Lauchlin. "The 'Leading Sector' Model of Growth in Developing Countries." Journal of Economic Studies, 1, no. 1 (1974), pp. 1-16.

Dean, Genevieve C. "Science, Technology and Development: China as a 'Case Study'." China Quarterly, July, 1972, pp. 520-534.

----------. "A Note on the Sources of Technological Innovation in the People's Republic of China." Journal of Development Studies, 9, (1972-73), pp. 187-199.

Eckhaus, Richard S. "Notes on Invention and Innovation in Less Developed Countries." American Economic Reivew, 56, no. 1-2, (1966), pp. 98-109.

Etienne, Mona. "Women and Men, Cloth and Colonization: The Transformation of Production-Distribution Relations Among the Baule." Cahiers d'Etudes Africaines, 65 (1978), pp. 41-65.

Findlay, Ronald. "Relative Backwardness, Direct Foreign Investment, and the Transfer of Technology: A Simple Dynamic Model." The Quarterly Journal of Economics, 92, no. 1, pp. 1-16.

Goulet, Denis. "The Suppliers and Purchasers of Technology: A Conflict of Interests." International Development Review, 18, no. 3 (1976), pp. 14-20.

Jackson, M.N. "Science and Depoliticization." Impact of Science on Society, 28 (1978), pp. 359-367.

Macioti, Manfredo. "Technology and Development: the Historical Experience." Impact of Science on Society, 28 (1978), pp. 313-319.

"The Mechanization of Work." Scientific American, September 1982.

Nelson, Richard R. and Richard N. Langlois. "Industrial Innovation Policy: Lessons from American History." Science, 219 (1983), pp. 814-818.

Sagasti, Richard R. "Underdevelopment, Science and Technology: The Point of View of the Underdeveloped Countries." Science Studies, 3 (1973), pp. 47-59.

"Science, Technology, and the Global Equity Crisis: New Directions for United States Policy." Stanley Foundation, 16, pp. 16-34.

"Science in Underdeveloped Countries." Minerva, 9 (1971), pp. 101-121.

Szyliowicz, Joseph S. "Science, Technology, and Development in the Arab World." Middle East Review, 10, no. 3 (1978), pp. 24-29.