Design Criteria for Sustainable Development in Appropriate Technology:
Technology as if People Matter

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Abstract

This paper will seek to identify and describe criteria that may be used to predict success or failure of applications of new technology to meet needs or solve problems in developing countries. By identifying and examining the social contexts of a given culture along with the level of technological development selection of appropriate types of technology could be enhanced and prevent the waste of human and economic resources. An examination of several case studies will be included in the presentation.

Appropriate Technology (AT) is a concept which embodies providing for human needs with the least impact on the Earth's finite resources. AT is based on the idea that advanced technology is often inappropriate for the needs that it is attempting to address within developing countries. The ethic behind AT minimizes the use of nonrenewable resources to solve technological problems while promoting self-reliance.

The appropriate technology approach, which has concern for people and the environment at its center, has much to contribute to society, school aged children, and to developing nations around the world. Applying the criteria of *appropriateness* to technology (e.g., using renewable sources of energy; using materials which are environmentally sound) can provide educational challenges which bring the concept of sustainable development into the classroom. It is difficult to exaggerate the urgency of the educational community to facilitate understanding of this crucial topic.

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The term Appropriate Technology does not pertain solely to developing countries. National and local governments as well as private and community groups continuously strive to introduce forms of technology that are efficient and fit within fiscal limitations. This is true in developed as well as developing countries. The depth of need and the importance of choosing the most appropriate technology are magnified, however, in developing countries where the margin of error is narrow due to very limited resources. Consequently, the need to develop technologies that are appropriate is of exponential importance for citizens of developing countries. The following criteria have been developed by specialists in the field of appropriate technology to judge or attempt to judge beforehand whether a particular technology has a potential of being successful in a developing country or underdeveloped region (Bhalla, 1979; Darrow & Saxenian, 1993; Date, 1984; Dudley, 1993; Ellis & Hanson, 1989; Ghosh, 1984; Hyman, 1992; Jequier, 1979; Linnell, 1995; National Academy of Sciences-Commission on International Development, 1977; Perrings, 1994; Richardson, 1979; Schumacher, 1973; Segal, 1992).

Criteria to Judge the Appropriateness of Technology

1. *Systems-Independence*

Systems-Independence relates to the ability of the technological device to stand alone, to do the job with few or no other supporting facilities or devices to aid in its function (Jequier, 1979; Date, 1984; Ellis & Hanson, 1989). The stand alone criterion refers mainly to the cost of the technology in question. The cost of any new technology is always a barrier at some point; but if this cost is compounded because of the need for supporting devices, then the technology, no matter how desirable may be unattainable for the people who need it the most. An example of the failure to meet the stand-alone criterion can be seen in the methane gas plant experiment. In order for a gas plant to operate, the user must have at least 2-3 cows to provide the raw material, an easy supply of water, sufficient pasture to graze the cows, and an area to dispose of the fermented

dung (Jequier, 1979). All of these supporting elements are major barriers for the majority of poor people living in developing countries.

Hence an evaluation of the technology must include not merely the technological device in question but supporting materials and equipment necessary for its full operation. According to the criterion, technological advances should be selected only if the supporting facilities and devices are already in place, or if only moderate changes and improvements of existing systems are required for implementation.

2. *Image of Modernity*

When the appropriate technology is designed for a developing country, there is a special criteria that must be recognized: an *Image of Modernity*. The citizens of many developing countries just as citizens of many industrialized countries want to perceive themselves as modern and progressive, at least within their context. There is an innate desire within most of humankind to feel important and be perceived as worthwhile. It follows, therefore, that an image of being modern is important to the success of any technology. People must believe that a technological device brings with it a degree of sophistication which can elevate the user's social status as well as meet a basic human need.

An example of this phenomena is the development of an inexpensive high protein instant food to be sold throughout Latin America. In several countries this new cereal met with success, but in one country it was a complete failure. After a careful investigation concerning the cause of the failure it was found that it was perceived as a *poor peoples* food. It was not an image that the people wanted to be connected with, even though they could benefit from this food (Jequier, 1979). All people have dignity and must believe that their dignity will remain intact even if they are poor or living in an underdeveloped area. Therefore, the designers of appropriate technology must incorporate an *image of modernity* into whatever device they develop if it is going to meet with acceptance by the people who can benefit from it the most.

3. *Individual Technology vs. Collective Technology*

This criteria is related to the societal/cultural standards in which the technology will be operating. Some cultures advocate a strong commitment to the group process where the good of the whole is held in higher esteem than individual accomplishments.

Other cultures place a high priority on individual responsibility and accomplishment. These factors should be considered in detail when designing appropriate technology because they will contribute to the success or failure of any given device or strategy. If a given cultural group has a strong allegiance to the community or region then the technology may be more system dependent, where the overall group could take a greater responsibility for the operation of a larger system. Because of the group approach, the technological device(s) could be more sophisticated which in turn could provide a greater advance in development for a larger group of people.

In another culture there may not be a collective commitment to the overall development of the society. In a society that is geared around the individual or single family unit the technological developments will need to be more system independent where devices are designed so that an individual can operate and afford the technology. A prime example of this approach is the use of the photoelectric solar panel to provide domestic electricity. Use of the photoelectric cell would appeal to a patriarchal or family oriented society. Therefore, based on this criteria, the appropriate technology design must take into consideration the culture in which the technology will be used in order to provide the best type of technology for that society.

4. *Cost of Technology*

The cost of appropriate technology is an extremely important factor to the people who need it the most. Ghosh (1984) indicates that the majority of appropriate technologies, although developed with cost as a central consideration, are still too expensive for most people in developing countries. In order for the appropriate technology to be helpful in meeting basic needs, the cost of the device must be reduced significantly for the people in the developing regions to afford the expense. Cost is a major obstacle to overcome in the design and construction of appropriate technologies for developing countries. One of the major difficulties in reducing the cost of appropriate technology is that many devices are developed for a one-of-a-kind use within a specific location under specific social/cultural limitations (Jequier, 1979). The advantages of mass producing a product in order to lower the cost are severely restricted because of these limitations. Nevertheless, the reduction of costs must be considered a high priority when designing technological devices for developing countries.

5. *Risk Factor*

The development of any new product carries with it a given degree of success and failure. Because of the nature of the device and the location in which it will be implemented the risk factor for the success of appropriate technologies in developing countries is of major concern and should be considered an important criteria for development.

There are two types of risk to be considered: (1) *internal* and (2) *external* (Jequier, 1979). Internal risks relate to the way in which the technology will fit the local production system (e.g., will it work under local conditions, is it adaptive). External risks relate to the needed supportive system(s) that may be required to keep the technology functioning properly (e.g., to what degree is the technology system dependent and system independent). These risks must be considered fully before and during the development of the technological device in order to contribute to its success.

Although the risk factor must be taken into consideration when developing appropriate technology it would be economically and politically unhealthy to try to remove all risks. Some risks are healthy to the growth and development of locally implemented appropriate technology. The challenge to the local economic and production system is essential for the technology to take root and gain ownership at local level. Therefore, the risk to the success of appropriate technology must be considered in detail but not necessarily be totally removed.

6. Evolutionary Capacity of Technology

The ability of the appropriate technology to continue to develop and expand beyond its originally intended function is an important criteria and one that should be incorporated into the development of the device as much as possible. If the appropriate device is static (i.e., performs one function and cannot be altered) then although it may provide for a basic need at the present time it will be a relatively short lived solution to a much larger problem.

Wherever and whenever possible it is preferred that the appropriate technology allow for (i.e., have design characteristics) a continuation of development. That is, to have the capability to expand and be reconfigured to accomplish a higher volume of work and/or more sophisticated production processes. This may allow the device to begin to

compete at the regional, national, and international levels which must be the ultimate goal of any developing country. Without this capability the technological device has simply elevated the owners/users to a new level of poverty.

7. *Single-Purpose and Multi-Purpose Technology*

Can the technology be used in more than one application? Because of the levels of poverty of many people in developing countries it is often thought advisable to develop appropriate technology that provides for a variety of applications (e.g., the tiller that tills the earth, powers a water pump and rice dryer, and can be used as a transportation source). This is different from a technology that can potentially expand (i.e., Criteria #6). This technological device has specific multiple purposes that may be very beneficial to the individual of a developing country who could not afford to purchase individual pieces of equipment. In addition, the economical advantages of this approach also decreases the technical knowledge and skills that are needed to keep the device functioning. Therefore, whenever possible, appropriate technology should be developed to accomplish a variety of applications.

Conclusion

The ideal device for appropriate technology probably does not exist in reality. The criteria presented in this paper are not exhaustive by any means; however, they do speak to the major aspects of appropriate technology as it applies to developing countries. The best approach to designing appropriate technology is balancing the criteria with the specific human needs.

It is recommended that continued research be conducted on this topic to further the development of appropriate technology. Devices that will enable developing countries to provide for themselves and gain a position within modern markets are essential. We all must learn to adjust and adapt in the ever changing world we live in. The design and implementation of appropriate technologies is one way in which the developing countries can do this.

Case Studies in Appropriate Technology

The following case studies are specific examples researched by the authors of how the use of appropriate technologies can be and have been used to solve practical problems and advance the capabilities of individuals and communities in developing countries.

Case 1: Domestic Technologies—the Laundry

We will call our city Macudo, a mythical name with some literary allusions. The data describing Macudo was gathered by the author in a Latin American city between 1982 and 1983, although somewhat dated it does provide an accurate representation of how appropriate technology design criteria has been used. Macudo has a population of 450,000 and has been growing at an annual rate of 6.5 percent for the past seven years. Some city services such as electricity and water are in short supply due to uncontrolled growth of the population; most of the growth is due to continued migration from the rural areas. Electricity in Macudo costs about twice what it does in say, Cleveland, Ohio, although it is widely available throughout the city. Water is in short supply and some neighborhoods, usually quite poor, are without city water lines. Citizens of Macudo who do enjoy city water must endure periods of up to three months of rationing when water is not available during certain hours of the day. This period of rationing coincides with three months of the dry season.

Given, then, the socio-economic reality of Macudo, how does one approach the universal necessity of the household laundry? When a Macudo woman washes clothes, she fills a small plastic bucket with water from a city water tap or a steel drum of standing water. She then goes to a cement sink, which has a rippled stone washboard on one side of it. She pours water from the bucket over the single garment she wishes to wash. After wetting the garment, she rubs soap on it from a cylindrical bar of common lye soap manufactured locally. She then rubs the garment against the stone washboard squeezing the soapy water through it. She does this much like the old washboard method our grandparents used to use, rubbing the garment on the washboard, slapping it and pounding the soapy water through it. To rinse, she again pours clear water from her

bucket onto the garment and squeezes the water through it to rinse out the soap. The procedure is repeated for each individual garment.

One can imagine how slow and labor intensive this method is. This approach to doing laundry has survived because it is economically and socially feasible in Macudo. The middle and upper middle classes rely on domestic service recruited from the poorer classes to do their laundry using this method. Domestic servants who do this work are paid from $25-$55 per month plus room and board. Unemployment also supports this technology. In Macudo the unemployment rate is about 35% overall and about 55% among women. Thus, this obviously archaic technology remains in the late twentieth century. What could alternatives look like?

The middle and upper middle class person could buy an imported washing machine—perhaps one with a water or suds saver on it, one that could operate at three different water levels. However, there would be some difficulties. Proper operation of the washer might require a level of water pressure not always available. Then, there is the cost of electricity. Finally, the initial cost at about $1,000, given freight costs and the 120% import taxes, lies beyond the reach of all but the wealthiest.

Should women in Macudo be forced to wash clothes in this labor-intensive fashion for the rest of the twentieth century, using a method virtually identical to that used during the colonial period? Or are there intermediate technologies that use the resources at hand and, at the same time, create jobs and contribute to the economy? The most obvious in the case of laundering clothes is the hand operated wash tub which requires only a single element from modern technology—the availability and popular pricing of detergent.

Detergent, in fact, is being manufactured in very small quantities in the country under discussion. It is also being manufactured in large quantities in two neighboring developing countries. Using detergent, a technological prerequisite of the automatic washer, as we know it, inhabitants of Macudo could do their laundry in batches rather than by single garment. They could do it in a much gentler manner, which would prolong the life of the garments. They could do all of this quite within their modest means.

All that is needed to effectively use detergent are two 10 or 20 gallon plastic buckets. Filling one bucket with water and detergent, a resident of Macudo could launder

10 to 15 garments at a time by agitating the water and clothes with a common toilet plunger, a device available in Macudo for $7.50. The action of the plunger pressing down on the clothes is exactly the same as that of an automatic washer, the action of pressing water through the garment. The second plastic tub holds ten gallons of rinse water. After wringing the soap water from the garments by hand, the clothes are agitated with a plunger in clear water which essential rinses the clothes much the way an automatic washer does, but with a tenth the amount of water. And the water, both wash and rinse can be reused. Clothes can be laundered in one third the time, laundered better, and laundered in a way that does not wear out the clothes—all this using an appropriate technology already available in the country under discussion and in neighboring countries where plastic container factories already exist. Their production is small to date because the demands to improve production have not been present. The method, if promoted and marketed would create commerce which in turn would create jobs, which in turn, would give domestic service employees, perhaps, more choice in future employment opportunities.

Case Study 2: Domestic and Commercial Technologies—the Photoelectric Cell

A technological innovation, which has proven useful to some third world countries, is the photoelectric cell. In the U.S. the most successful application of the photoelectric panel is on telecommunications satellites in space. However, since 1970, the cost of photoelectric panels ahs gone down practically 10% to 15% yearly (Healy, 1988). This has allowed the export of this technology to some developing countries. A group of three hundred electrical engineers and scientists met in New Orleans in the spring of 1987 to discuss uses of the photoelectric cell in underdeveloped regions (Healy, 1988). The most novel application appears to be the use of photoelectric cells in Columbia to supply relatively small quantities of electricity needed to operate telephones. The basic problem in Columbia is its mountainous topography, which makes normal telephone systems difficult to install and maintain. The combining of photoelectric power with radio telephones and linear telephones will enable Columbia to increase rural telephone communication by 250,000 lines by the year 2000 (Healy, 1988).

The success of the photoelectric cell in Columbia, a country that enjoys periods of intense sunlight almost every day, has spawned three Columbian companies that now

manufacture photoelectric cells for domestic use. The marketing approach of these companies is directed to rural inhabitants. The appropriate technology design objectives are to make the phone system self sufficient in electricity by investing in batteries and photoelectric cells which comprise a complete photoelectric system for domestic use. This strategy for implementation centers on rural families in areas where 85% of the population does not now have electricity. Even when new hydroelectric projects are able to produce electricity, lack of capital prevents the installation of wires to remote regions (a costly task which has plagued rural electrification projects in developing countries).

The real advantages to photoelectric cell technology are in its low maintenance costs. Although initial costs are relatively high, maintenance costs, which are typically the bane of Latin American, projects using diesel generators, are very low. The maintenance of photoelectrical panels require little more than keeping the panels clear of dust that could block the sun's rays (Healy, 1988).

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