

A major criticism of appropriate technology is that it is often preoccupied with developing low-tech products that may not foster the development of technology capabilities in emerging nations.

In the following section, Barrett Hazeltine provides an excellent summary of appropriate technology.

4.4 Appropriate Technology

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4.4.1 DEFINITION OF APPROPRIATE TECHNOLOGY

What is "appropriate technology"? Every type of technology might be appropriate somewhere, so in a trivial sense, all technology is appropriate. The term **appropriate technology** is used here in a narrow sense. The U.S. Congress's Office of Technology Assessment (OTA, 1981) characterizes appropriate technology as being small scale, energy efficient, environmentally sound, labor intensive, and controlled by the local community. The Intermediate Technology Development Group in London, an organization that works toward the betterment of developing countries, uses nearly the same description in its journal *Appropriate Technology*, but adds that the technology must be simple enough to be maintained by the people using it.

A central concept of appropriate technology is that the technology must match both the user and the need in complexity and scale. Some examples of how these two can be mismatched follow. A village in Botswana received ten combines (grain harvesting machines) as part of an aid project. When these machines broke down there were no trained mechanics and no spare parts. The combines lie rusting at the edge of the fields as the farmers use traditional methods to harvest their grain. The underpinnings necessary to support this equipment do not exist in the community. A small fishing community in the Marshall Islands receives a space age photovoltaic system to provide electricity for lighting. Only after installation is it determined that there is no significant need for a system so sophisticated. The well-known tragedy caused by the explosion of a fertilizer factory in Bhopal, India, is another example of technology not matching local conditions, in this case presence of trained staff. In the United States, people point to the use of electric heating in houses, especially if such systems require new power plants, as a mismatch between a fairly simple need and an elaborate solution. One could say the same thing about one person using a full-sized automobile for commuting.

The proponents of appropriate technology believe it is applicable to many situations both in the United States and in the so-called Third World. Certainly, it is an alternative approach that should be seriously considered. On the other hand, it does not make sense everywhere. Like other alternatives it needs critical and serious evaluation.

4.4.2 HISTORY OF APPROPRIATE TECHNOLOGY

Small-scale technology has been used for a long time, of course. The people who colonized America, for example, had no other options. The modern appropriate technology movement is attributed, however, to E. F. Schumacher, a British economist. Schumacher (1973) was an economist for the Coal Board and also an advisor to the government of Burma — now called Myanmar — and later that of India. He wrote several papers from 1955 to 1963 entitled “Economics in a Buddhist Country,” “Non-Violent Economics,” and “Levels of Technology” which were eventually incorporated in a book called *Small Is Beautiful*. His ideas inspired the creation of the Intermediate Technology Development Group referred to earlier. The approach gained attention during the 1960s coincident with the social responsibility movements of those years. Several world leaders, including President Carter, became active supporters and many projects and support groups were formed. Their methods are now being used in many places. In the United States, the National Appropriate Technology Center offers information by telephone or mail, and most states have either government or private groups doing relevant research or actually building projects. U.S. AID, the foreign aid division of the State Department, now supports appropriate technology projects in many parts of the world.

4.4.3 EXAMPLES OF APPROPRIATE TECHNOLOGY

Appropriate technology can be used for energy, for food, for health care, for sanitation, for transportation, and for meeting other needs. Water wheels, wind generators, and photovoltaics produce electrical energy. In the United States photovoltaic devices are the cheapest way to provide electricity to certain remote sites. Solar hot water systems are also less costly than oil or gas powered systems in many places in the northeast. Efficient cook stoves use one-third the fuel of ordinary stoves. Vegetables are grown intensively with hand tools and without chemical fertilizers, herbicides, and pesticides. Aquaculture can be done on a small scale. Oral rehydration therapy is a simple technology that has saved many children struck with diarrhea. Composting toilets and pit latrines are effective and can be constructed by a nonprofessional. Methane digesters, which can also be built and operated by a nonprofessional, convert manure and other wastes to a combustible gas and an odorless fertilizer. A bicycle can be adapted to carry much baggage and more than one person. Many houses in the Third World are built by the eventual owner of pressed earth bricks.

4.4.4 BENEFITS OF APPROPRIATE TECHNOLOGY

Schumacher’s focus was on jobs — people in the Third World desperately need employment. He argued that the capital investment required to create western, high-technology jobs is too large to be practical. A modern foundry requires, perhaps, \$20,000 for each job created. Existing technologies, such as those used by a village blacksmith, correspond to an investment

of \$2 per job. Something in between, intermediate, is needed, say, \$200 per job, similar to a small machine shop in the United States. This intermediate technology could be much more productive than what now exists and could serve to move a country out of poverty without requiring huge capital investments.

Schumacher further argued that the \$200 technology would be close to existing methods and so would lead to improvement in skills for many local people. The \$20,000 technology would be so technical that highly trained specialists would be required. The cost of training is high, so it would not be possible to train many specialists. The conclusion is that intermediate technology increases the knowledge level for most of the population, whereas high technology produces a class of experts separated from the rest of the economy. If technology only slightly different from that existing is introduced, for instance, an improved farming method, then even those not directly involved with the new method can learn about it. More people therefore benefit from the improvement.

A final difficulty with \$20,000 technology, like an integrated circuit fabrication plant, is that it uses imported supplies, produces mostly export items, and needs expertise and components from outside the country for maintenance and improvement. Thus, the high-technology factory is not an effective way for the country as a whole to develop.

A major reason for using appropriate technology, as Schumacher argues, is that it provides goods, services, and jobs that will not be provided any other way. No company or organization will be able to invest enough in high-technology factories in developing countries to provide sufficient jobs. An analogous argument is that the cost of tearing down old houses in U.S. cities and replacing them with modern high-rises is more than the government can afford. If a limited amount of money is available for low-cost housing, an appropriate technology approach, such as training people to rehabilitate their houses themselves, will have much greater impact. In the Third World few farmers can afford the equipment and chemical supplies to make farming there similar to that in the United States, but for a reasonable cost many farmers could be given the small machines and training necessary to improve their productivity.

Introducing a new technology related to an existing one has two other advantages over a completely new technology. It is less disruptive to the social structure and it can be adapted. A factory or mine, which takes young people from villages to a city, affects village life much more than a small workshop located in the village. Augmenting the training of traditional doctors — so-called “herbalists” — often improves health care more than building Western-style hospitals, because people feel more comfortable using herbalists and the cost is less. If a new technology is similar to the existing one, the user can adapt it most effectively to the local situation. The user can adapt high-efficiency wood stoves to burn straw, or whatever fuel is available, while gas or electric stoves are much less flexible. Even methods of producing sophisticated equipment can be adapted. In one assembly

plant in Taiwan, for example, small groups working in teams, not on assembly lines, produce pocket calculators, just as people worked together in traditional society. The process is more cost effective than U.S. production methods.

Appropriate technology benefits a society more than high technology because it fosters self-reliance and responsibility. Compare a person who has renovated her own house with one who has been assigned an apartment. Who is probably more prepared to take responsibility in a job? Similarly, an experienced owner of a small farm is probably better prepared for a leadership role in the community than a worker on a mechanized farm. Appropriate technology not only teaches skills, it also gives people experience in solving problems and getting things done. Many people would much prefer to be their own boss, to be responsible for themselves, than to work for another. Appropriate technology is more likely than high technology to give this opportunity, because smaller organizations mean more organizations, with more leaders. A trend in health care is to involve the patient more in both decisions and treatment—kidney dialysis at home is an example. This trend resonates with the self-reliance aspect of appropriate technology.

This same quality, of being responsible for one's own success, applies to groups also. Appropriate technology is small scale and thus the people directly involved can have significant control. A small machine shop, with general-purpose machines, can adjust its products and meet market needs more effectively than an automated factory, partly because the tools are more adaptable, and partly because fewer people have to be convinced in a small group. Community self-help groups are often more effective at meeting housing needs than bigger, city-wide organizations because the community groups are closer to the people and their needs. Of course, situations do exist where large size is essential; it is hard to think of an economic car factory which is small, and a small group of artisans making pottery may need a large organization to do their marketing, because it may be difficult for a small company to gain access to a market.

Advocates of appropriate technology point out that not only does it foster self-reliance and responsibility, but it also fosters other desirable attitudes, including cooperation and frugality. If machines are not available, then people's strength must substitute, and this usually means that groups of people must work together. In the colonial United States the neighboring farmers gathered to help put the roof on a new house. Neighborhood associations or cooperatives have done many of the successful appropriate technology urban projects. The reason appropriate technology promotes frugality may be simply that the users have less to waste or it may be that hand work encourages care and concern, which translates into less waste.

A related reason why some people are attracted to appropriate technology is the *type* of job it produces. It is not surprising that a person operating a self-sufficient farm is willing to work 55 hours a week while an assembly

line worker feels 40 hours are too many. The farmer has more interesting, challenging, and rewarding work. The satisfaction one gains from seeing a farm succeed is, for some people, worth much more than the money one could earn in another job. The types of jobs promoted by appropriate technology are easy to integrate into a lifestyle that many people aspire to — self-reliance, fulfillment through one's profession, and concern for others.

A final set of advantages for the appropriate technology approach is related to the environment. Appropriate technology farming is an example. It minimizes the use of chemical fertilizers and pesticides. It uses manure and other waste products as fertilizer. It avoids the use of heavy machinery, which damage the ground. It entails growing several different crops at once. All these help to preserve the soil and the surrounding groundwater. Solar collectors reduce the amount of fuel required to heat a home, so the air is less polluted. Craftpersons working in small groups are often more careful than unskilled workers on an assembly line, so small-scale hand production may generate less waste than mass production. Appropriate technology can often be less of a burden to the environment than other technologies. One must, however, be careful with this argument. Use of a wood stove would seem to offer many of the advantages of appropriate technology, but if most people used wood stoves, air pollution would be serious and the forests would be severely depleted. Few people recall that a major reason automobiles were originally encouraged was to reduce the serious pollution problem caused by horses in city streets. Now most people would consider automobiles much more of an environmental threat than horses.

A related environmental concern is diversity. So-called "modern" agriculture consists of planting a single crop using the most productive seed variety. A plant disease endemic to that variety then can wipe out a whole season's yield for an entire region. Such came close to happening with corn in the United States in 1974. The appropriate technology approach uses a variety of crops, so it is less likely a disease would spread widely, and a diversity of species, so at least some should survive a blight.

4.4.5 CONCERNS ABOUT THE USE OF APPROPRIATE TECHNOLOGY

A major concern is whether appropriate technology can provide sufficient goods and services. It does not appear that small-scale hydroelectric systems would by themselves give sufficient energy for the United States. Could small farms provide enough food? Could small factories produce at sufficiently low cost or are they inherently always inefficient compared to mass production? Questions like this have to be answered case by case but examples do exist where appropriate technology provides more at less cost.

A related concern is whether people will accept the appropriate technology approach or the inventions designed by appropriate technology. Even if oil-heating costs were higher than solar, would people prefer to use oil? Do many people really prefer a high-technology solution such as a complex kitchen gadget to a more effective lower tech one? (The Defense Department

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is accused of this bias toward high tech.) Would most people really prefer to work 40 hours a week at a boring job and then pay someone else to improve their house when they have leisure time, or would they prefer to do their own work if they could?

A concern for Third World countries has been whether appropriate technology does in fact lead to national development, in the sense of a trained workforce. Will a nation following the appropriate technology approach end up with a population generally conversant with technology, but with a technology that is of no use in the modern world? The question is: Will people with a background in appropriate technology have an easier time learning newer technologies compared to people with no background at all? An analogous question in the United States is whether people trained to rebuild their own homes can use those skills elsewhere.

Some Third World leaders are understandably suspicious of people from the industrial countries and wonder if appropriate technology is a way to discourage the Third World from industrializing and becoming competition. One answer to these leaders is that there may be no other way for the nations of the Third World to industrialize on their own besides through appropriate technology.

Another area of concern is that the appropriate technology approach seems to be difficult to plan or manage. Would it not be better to take established technologies from the United States, say, and spend one's time and effort making them work? By definition appropriate technology is specific to a locality, so transferring expertise from one country to another is difficult. Because appropriate technology is small scale and done by many independent people, it is difficult for a government official to understand what is happening and take action when needed. People who object to appropriate technology for this reason, however, may be too optimistic about the problems in transferring an established technology and too pessimistic about the problems in transferring appropriate technology.

4.4.6 THE FUTURE OF APPROPRIATE TECHNOLOGY

A reason we should care about appropriate technology is based on what we see in the future. Certainly, we see more people on the earth and thus greater threats on resources and the environment. Appropriate technology can use fewer resources and be easier on the environment than the alternatives, for the same output.

Appropriate technology may be beneficial for intangible reasons also. Technological changes will certainly take place. Better communication and transportation will mean people, ideas, music, and so forth will travel further, faster. The risk is loss of cultural diversity. Unless care is taken, communities all over the world will look the same, have the same music, grow the same food, and so forth. Another risk of better communications is the temptation to build larger organizations, to centralize more decisions so individual members of the organizations have less control. As technology becomes

more complex, a threat develops that fewer people will understand it. It is dangerous when only a few understand the essential industries of a society and the rest must proceed on trust. A complex technology is also a threat if it results in a split society, with a very few people having rewarding, challenging jobs and the great majority having meaningless, dull jobs. Appropriate technology may be a way to make people's lives richer and safer.

A more general reason we should care about what happens to appropriate technology is that appropriate technology represents a choice. Appropriate technology may not be the best choice in all situations but cases do exist where it is best. Because appropriate technology is often well matched to the needs of the Third World and the underdeveloped parts of the United States and Europe (e.g., blighted urban neighborhoods) it may offer there a possibility of relative parity in standard of living without unrealistic investment. We should care about the future of appropriate technology because the hardware promoted can be more effective than the alternatives, because it promotes valuable social attitudes, and because the approach reminds us to take a full range of factors into consideration when making a choice.