

Appropriate & Intermediate Technology

Class Outline for September 16, 2009:

- History of Development (1970-1990): Appropriate and Intermediate Technology
- Case Studies: PeePoo and PlayPump

History of Development (Continued):

Last time, Bish talked about some different dimensions of development: the social and economic aspects, the political aspects and the technological aspects. You can imagine that after World War II, people had visions of emerging independent nations moving out of colonial rule with large-scale technological innovation. It did not exactly happen as people had hoped.

As a class, we can discuss some reasons why development did not happen the way people envisioned. There was a lot of corruption and inequality that did not get reduced over time. In many cases, the elite ended up getting richer and the poor ended up getting poorer. Jobs were not created to the extent that we needed. Mass migration to the cities was encouraged, but the jobs did not necessarily materialize as promised. Technology infrastructure did not advance as much as necessary for supporting urban industries. We cannot really take advantage of the cheap labor force and spur mass production without good roads to transport the materials and products. The decrease in agricultural labor as people migrated to the cities was compounded by an increase in population, leading to strains on the food supply. Many resources were being depleted in rural areas. Industries were dominated by monopolies that extracted resources without developing in-country capacity. Several countries ended up with authoritarian regimes, rather than the democratic structures that we wanted to thrive. It was complicated because colonialism took away much of the functioning tribal or indigenous leadership. The regional imbalances from unstable government and tribal/ethnic tensions discouraged foreign investment. Prior to the 1970's, researchers were looking at macroeconomic indicators, not as much at the human indicators like the statistics on health and education from the World Fact Quiz in the first class. It is also important to remember that the informal sector is larger than the formal sector of employment in many countries, but is not considered in most of the statistics from multilateral organizations. Take India, for example, where much of the food is purchased locally from subsistence-level smallholder farmers and sellers. There is often this perception that decentralized farming is not working from looking at the numbers, and yet interestingly there is now a movement back toward supporting local agriculture in the US where food is being transported long distances through cold storage infrastructure. If we have learned anything for sure, it is that no single factor is going to end global poverty. We cannot say that poverty will be eliminated by job creation, because we still need a healthcare system, access to markets, and so forth. Bish reminds us that we need institutions for development, but while government is important, it cannot do everything on its own. Likewise, nongovernmental organizations (NGOs) play an important role, but are also not as effective if working alone. Organization is important, but it is more complicated than that.

In 1973, a very influential collection of essays was published by E. F. Schumacher called *Small is Beautiful: A Study of Economics as if People Mattered* which challenged the idea that larger scale and increased productivity are paramount to development. Schumacher argues that it is important for people to feel like they are doing meaningful work and take pride in it, rather than only push for automation and higher throughput. This set the stage for moving in a direction that takes into account the human aspect, and not simply financial success. For example, there has been increasing attention on concepts such as the triple bottom line, which looks at the impact on people, planet and prosperity.

Intermediate Technology:

From this shift in perception toward more holistic approaches, what started to emerge was this concept of intermediate and appropriate technologies. There are several ways in which technologies are considered to be intermediate: 1) in price, and 2) in time, as some technologies are meant to be transitional and support people in moving from manual labor using hand tools to large-scale mechanized technology. Take pressing peanut oil as an example, where the existing technologies might be an indigenous method of pressing oil by hand, which is both time-consuming and labor-intensive, and mechanized oil presses at the other extreme, which may require a very high capital investment of thousands of dollars and infrastructure such as electricity. In this situation, an intermediate technology might be a \$200 ram press that uses a lever to press out oil with more force than current manual methods, helping to improve the speed and output of the production process. Similarly, a \$375 press that produces 500 bricks a day can be considered intermediate technology in helping with the transition from molding bricks by hand to using an industrial brick maker that costs \$23,000 and produces 10,000 bricks a day.

Another example of intermediate technology is the treadle pump, which enables farmers to provide a greater amount of water to their plants more easily compared to watering by bucket, while requiring much less infrastructure than constructing irrigation dams and pipes. Other examples include a mixed method of making roofing tiles that utilizes both motorized machinery and manual work. One workshop that is using this method is run by a cooperative of women who have been widowed and socially ostracized. These women have been able to sell every tile they make and transport to market, enabling them to support themselves and be independent. In this case, one of the immediate limitations is actually transport rather than production, since the cooperative is at the bottom of a hill and the women have to get the tiles to market.



Courtesy of Alfinio Flores. Used with permission.

There is an interesting niche here, as intermediate technologies work when it is too expensive for mass manufacturers to get their larger-scale technologies to certain communities because of diminishing economies of scale. Intermediate technologies are more affordable and can be more decentralized, helping to bridge that last mile of distribution. Additionally, where specific skilled labor is required, intermediate technologies may have an important place. For example, you can imagine that it may not make sense to use a mechanical combine for flower picking.

Appropriate Technology:

What makes a technology appropriate? Students threw out areas of consideration such as:

- Need
- Affordability
- Local materials, local production
- Low ecological impact
- Cultural acceptability, appropriateness for social context
- Fit within infrastructural environment
- Transparency, understandability
- Ease of use, match to local skills
- Durability, reliability
- Maintainability, reparability
- Quality
- Benefits, such as increased production

Connecting back to the roots of this movement from *Small is Beautiful*, the traditional definition of appropriate technology also includes creating meaningful jobs, using decentralized renewable energy, small-scale, and open source as part of its ethos. Each of these areas could be explored in much more depth than we have time for today. If you are interested in continuing the discussion, take a look at the *D-Lab: Design* course that is offered in the spring.

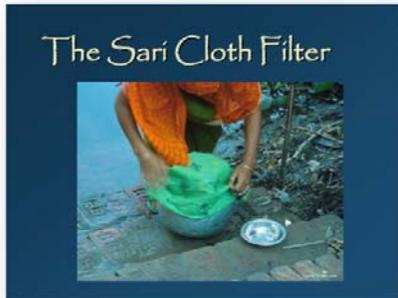
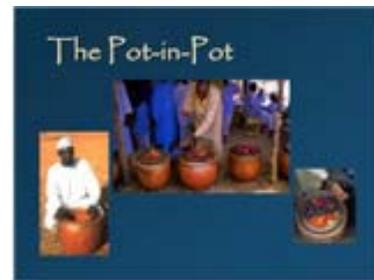


Photo courtesy of the National Science Foundation.

An example of appropriate technology is the sari cloth filter. It was found that the transmission of cholera could be reduced by 50% during an outbreak if people fold a sari (women's clothing in India) several times and use it to filter water. This is something that is low-cost, simple, locally available, easy to implement and yet has an incredible potential for positive impact – what is important here is knowledge transfer. Also, every technology has its limits so there is a need to communicate the limits of the sari cloth filter as well. Cholera bacteria is much bigger than other bacteria and viruses, so this type of filtration cannot ensure that the water is safe to drink.

Another commonly cited example of appropriate technology is the pot-in-pot evaporative cooler. It works by having a pot within a pot, separated by a layer of dirt that can be moistened, so the interior is cooled as the water evaporates. In these pots, vegetables can last 2-3 weeks without refrigeration instead of just a few days, enabling households to store food longer. The coolers also enable farmers to wield more negotiating power and command better prices in the market by helping to reduce the pressure to sell before the vegetables go bad. Local potters can be trained to make these “desert refrigerators,” but the key word is “desert” because this technique works much better in areas of low humidity. The pot-in-pot coolers do not work as well during the wet season or in certain climates, and can be difficult to transport. In Nigeria, a teacher from a family of potters named Mohammed Boh Abba developed these coolers utilizing locally available materials and traditional knowledge. There are now tens of thousands of these pots in Nigeria and other parts of the world, and the teacher has also done well for himself with a university appointment and several awards.



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The definition of appropriate can also change based what support infrastructure is available. For example, Whirlwind makes wheelchairs out of materials that may not have fit into the traditional definition of locally available – yet if something is available locally, then it is locally available. The bearings in Whirlwind's wheelchairs are actually old bearings from ceiling fans, but they can be sourced locally instead of imported. Whirlwind engages local labor in taking advantage of locally available resources, rather than limiting themselves to raw materials that can be grown or dug up. There is certainly a lot of skill from indigenous manufacturing, but sometimes the existing infrastructure can support more and we do not have to constrain ourselves to the traditional definition of appropriate. Plastic sheets may soon start to be considered a locally

available material, as new supply chains are being built up and communities are starting to accumulate more plastic waste to recycle into sheets.

There are many other examples of organizations taking advantage of the evolving infrastructure, or even developing their own infrastructure to help support certain technologies. When solid-state white LEDs (light-emitting diodes) first came out, they were about \$12 each. An organization called Light Up the World would purchase lower-quality white LEDs, which might have had a lifetime of around 10,000 hours instead of over 20,000 hours, and then assemble small circuit boards locally to make small lights for housing and street-side vendors. Iqbal Quadir started a movement called Grameen Phone to provide phone service in rural Bangladesh. Interestingly, he had to start a telecom company to do it because the necessary infrastructure was not there yet. It is also important to consider different types of infrastructure, such as the financial infrastructure. At the time that Grameen Phone started, cell phones were not particularly cheap so they needed a method of financing, which is where microfinance came in. In order to cater to people living in poverty, it is important to understand their cash flows. Harish Hande, founder of SELCO Solar Company in India, argues that every technology can become affordable with the right financing. He often shares the story of his interview with a woman who said that she could not possibly pay the full price of 300 rupees a month for a small solar photovoltaic system, but she could pay 10 rupees a day. Harish Hande turns the notion that solar energy is expensive for the poor on its head, saying that the rich are the ones who need subsidies. A big takeaway here is that if we can get the supply chain in place and make the price affordable, our technology may become more appropriate. While there is a lot of room for improvement within the appropriate technology movement, there are also many positive lessons that we can retain.

Case Studies:

Next, the class discussed some technologies from the readings, starting with the PeePoo bag and the PlayPump. Students started by responding to a quick, informal survey about their impressions of the technologies on a scale from 1 to 5, with 5 being an excellent idea. Most people thought the PeePoo was around 3 and the PlayPump fell at about 4. The class then discussed what they liked and did not like about the technologies, based on the information that they had.

PeePoo:

Amy wondered how many classes at MIT get to talk about something called PeePoo. Students seemed to have mixed feelings about the technology overall. One person thought that one-time-use bags would require a lot of distribution, upkeep and maintenance cost. Another student pointed out that if the bags are being used in slums, the population tends to be more dense, potentially making distribution easier. Someone came back with the argument that full-compliance in use is important for preventing disease transmission, particularly in crowded areas (in surveys, 85% of people said they would use the PeePoo). When Amy asked how many students in the class would use PeePoo bags for the next week, only 5 raised their hands. It is especially important to consider the cultural context and the use of bags may not be appropriate in some communities, especially for the women. In some slums, however, people are already defecating plastic bags and throwing them away as “flying toilets.” People may already be used to open defecation and less self-conscious about privacy. There are possibilities of finding situations where these bags can be effective, but the creators may not be thinking in that way. Advertising has compared the bags to having the same impact and being as revolutionary as computers. One student was

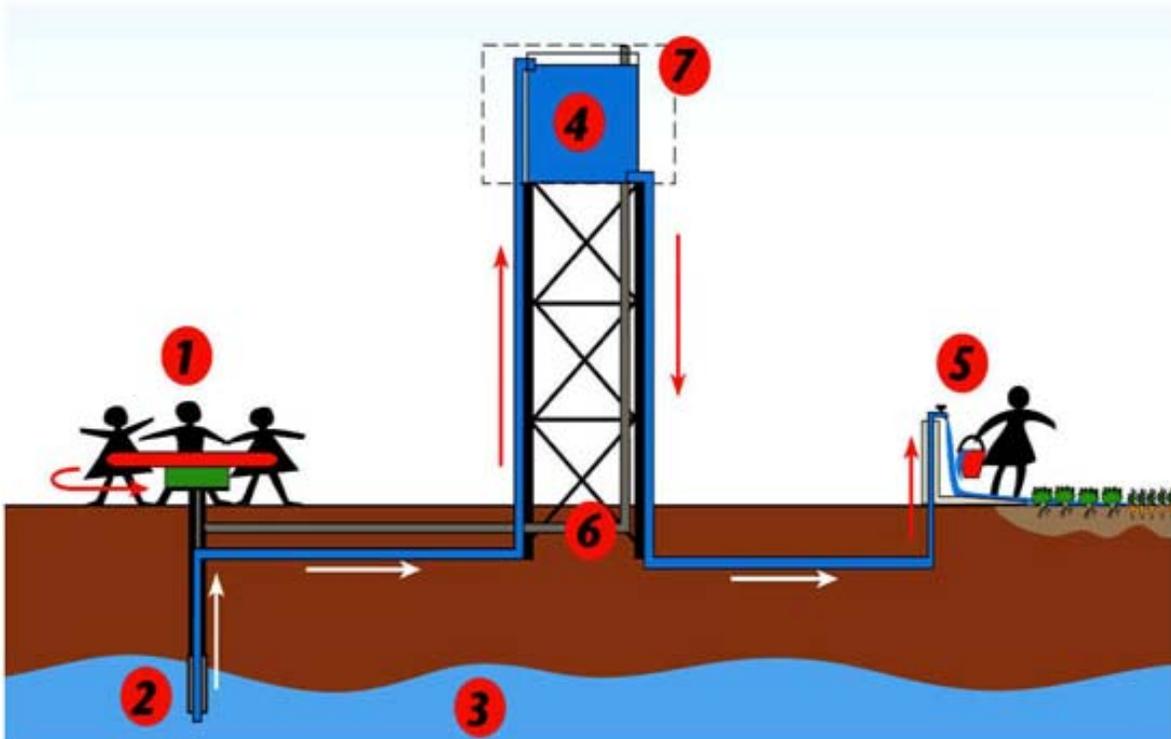


Photo courtesy of
Peepoople
(info@peepoople.com).

frustrated with the way PeePoo presented itself in the brochure, and how it kept saying that the bags were affordable without ever mentioning the actual price. A few thought the PeePoo's impact was better than nothing, and liked the opportunity for income generation by selling the waste as fertilizer. Someone else was concerned that the bags are made out of petroleum products, which may not be sustainable in the long-term. Many students in the class agreed that the PeePoo may work better as a transition technology, with the eventual goal of putting in latrines and sewer systems.

PlayPump:

Many students were amused that everyone says the PlayPump can make it less work to pump water, since people still have to lift the same amount of water, plus now there is additional friction and moment of inertia from the roundabout structure to take into account. It may be nice for children to have something new to play on, but not if they have to "play" all day instead of going to school. If no children are around, how does the community pump water? There have been photos of women having to turn the heavy roundabout by hand instead. One student asked if the PlayPump could be hooked up to livestock instead? Another was concerned about the high capital investment involved, particularly if the aquifer ends up running dry or the groundwater ends up being contaminated like in Bangladesh where there is arsenic. Amy clarified that PlayPumps are typically installed where hand pumps are already being used with existing naturally-replenishing aquifers, so people would have the same source of water for better or worse. Maintenance of the PlayPump is another issue, however, since many of the parts are specialized and may have to be shipped in. One person was relieved that at least it seems like user error with PlayPumps cannot really make the situation worse, unlike with the PeePoo bags. Someone else commented that this technology appears very inefficient with so much extra material, then was reminded that the image of having cute children running around is attractive to donors and the money is earned through advertising. PlayPumps may be considered hip, which is good for design magazines, but do they really work well for the communities that have them installed? People who are interested in learning more should watch the following video update called "Troubled Water," which shows the fate of PlayPumps now: <http://www.pbs.org/frontlineworld/stories/southernafrica904/>



Schematic from the PlayPump website

1) Roundabout 2) Borehole pump 3) Underground aquifer 4) Polyethelene tank 5) Tap
6) Excess water (overflow) returned to borehole 7) Landscape billboard screen for advertising

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Below are a few guiding questions within different dimensions of analysis, which we used in our class discussion. Comments are in *italics*.

Technology:

- Does the technology work?
 - If so, does the technology work all the time?
 - Is it susceptible to user error?
 - *For example, the PeePoo website says that people have to avoid touching certain parts of the bag, which may be hard to do in practice.*
- Does the technology address the problem?
 - *Sometimes a technology addresses the problem only partially for certain situations. If this is the case, what aspects of the problem are addressed by the technology? What aspects are not addressed?*
- Can the technology be maintained locally?
 - *The PeePoo will need the right supply chain to be in place for distribution and collection. People will be more incentivized to market the bags and help maintain the system if they can make decent money from doing so.*

Context:

- Does using the technology require behavior change?
 - *This is one of the most difficult barriers to address for technology adoption, especially if the behavior change requires more time or effort. People living in poverty are busy enough trying to survive and already have high demands on their time and limited resources. Remember how Bish said that some people*

choose not to look for a job in the morning so that they will not have to eat as much that day. If they get a job, then they can eat more and work more, but otherwise they have to conserve energy. There are many trade-offs to consider. Try to understand people's rational decision-making and their framework for doing so.

Cost:

- Is the technology affordable?
 - *PeePoo says it is aiming for a cost of 2-3 cents a bag, but projections are often too optimistic (take the example of the \$100 laptop) so this could actually mean 3-4 cents a bag. If we give them the benefit of the doubt and use a cost of 3 cents in our estimates, this comes out to about \$200 a year for a 5-person household, which is actually enough to build a decent latrine. Remember to look at the numbers carefully because people can publicize statistics in a way that sounds more attractive.*
 - *Let's try another example. PlayPumps cost about \$7,000 each, according to their publicity, although the actual cost may be higher. Their average flow rate is supposedly about 400 gallons per hour, which may sound high, but it seems much lower if you look at the per minute rate (which is less than a treadle pump's flow rate). Say an average person requires a 5 liter bucket of water each day. How many people could a PlayPump support? What will the cost come out to be per person?*
- Does the technology have recurring costs?
- Does the technology provide income? If so, for whom?

The case studies reminded us to be wary of anecdotal evidence. People tend to be polite, so we cannot always assume that they are giving real feedback. Someone being interviewed about the PeePoo is likely to say nice things about it if the interviewers are foreigners who came all the way to their community to bring these bags. Keeping this in mind, we need to be careful about managing the temptation to hype something up. Not only is it embarrassing if the hype turns out to be undeserved; the real negative impact is that it is irresponsible and can waste resources. PlayPumps received over \$16 million, which could have gone to programs that worked. This work is hard, and there have been many projects that got a lot of hype but did not quite deliver on what was promised, such as the LifeStraw. Let's try to be humble and true about the way that we share the work we are doing, instead of promoting an ethos of praising untested technologies. We can be excited and say that our design is awesome and works, if it is really awesome and really works. Better yet, we can focus our attention on working hard with our community partners to have a better chance of building awesome projects that work well.

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