

## **Design for Affordability, Failure and Re-use**

Lecturer: Amy Smith. Slides were used in class but not available for OCW publication.

Handout: Preliminary draft of "Designing Cheap" by Paul Polak, IDE. This paper has been submitted for publication in a book.

Now that team designs are underway, this class session will consider some things to keep in mind during the design process.

### ***Low-cost Drip Irrigation Kit: A Mini Case Study in Design for Affordability***

The ~\$2.50 IDE-India Affordable Drip Irrigation Technologies (ADITI) "Family Nutrition" is handed out each project team; see [http://www.ide-india.org/ide/pt/photo\\_gallery/aditi/familynkits/fnk.shtml](http://www.ide-india.org/ide/pt/photo_gallery/aditi/familynkits/fnk.shtml).

[See also Lecture 18 in SP.721, <http://ocw.mit.edu/OcwWeb/Special-Programs/SP-721Fall-2004/LectureNotes/index.htm> where IDE founder Paul Polak was guest speaker.

Compare this system with a more "conventional" drip irrigation system that sells for ~\$45 (students have a 1 page website printout on the DIG Corp. Drip Irrigation & Micro Spryer Kit, from [http://dripirrigation.com/product\\_info.php?products\\_id=33](http://dripirrigation.com/product_info.php?products_id=33)).

Slide shows a photo of the IDE drip system installed in Haiti.

### **Small group discussions**

Teams are asked to consider how these two approaches compare. What makes the IDE-India system so cheap?

After looking over the kit for a few minutes, students offer the following ideas:

- Reduced part count
- Fewer features, less flexibility
- Cheaper materials
- Shorter life of product (only 1-2 years)
- Elegance of design
- Less packaging
- Subsidized marketing
- Low precision
- Use off-the-shelf, available parts already produced at high volume
- "Stripped down" functionality
- Small size (allows gravity feed, lower water pressures, low-cost thin-walled tubing)

The tubing comes in three thicknesses – thicker equals more expensive. The thinnest often doesn't last a full season, medium thickness definitely lasts one season and maybe more, and the thickest will last several seasons. They find the middle thickness is the most popular.

### ***Back to lecture***

Slide: How do you balance the cost of materials vs. the cost of labor in manufacture vs. the cost of labor in operation? In developing countries, labor is really cheap. A farmer might buy a smaller system that can only cover half of the field, and halfway through the day go out and move the drip lines. In the capital-intensive practice of developed countries, you would almost never go this route.

Scale of production: they produce kilometers and kilometers of the tubing, which drives down cost. And there's only one emitter design, also produced in high volumes.

The "quality" tradeoffs are tough for designers that have never been in a developing country. One can almost always make things last longer or have "better" performance, but these aspects almost always make the device too expensive.

Q: Can you address the paradox of these devices being "labor-saving" when you also say labor is cheap?

A: A lot of the labor we're going after is uncompensated, i.e. women who are spending hours pounding grain instead of being able to get schooling. Another aspect is whether the devices can create new jobs with sufficient pay.

### ***Design for Failure***

Photo shows a plow made locally in Zimbabwe, somebody that Amy had worked with. Once the flat metal part of the plow buckles (i.e. when it hits a rock), they take it to the blacksmith to have it pounded out.

- Change shape so it's less likely to buckle
- Change material to something more durable
- Add a shock absorber (but it would have to be pretty finely tuned)
- Maybe the best solution: Make the fastener (bolts) the most likely failure mode – that's something the user can replace in the field.

The message: Your designs will break. Plan for it, and make it easy to repair the most likely reasons for failure.

### ***Design for Re-use***

What happens to the device after its useful life?

Slide shows some emergency relief shelters. The structural elements are PVC pipe that can be re-used for water transport. Waterproof sheeting can be re-used for all sorts of building needs.

Think about this aspect during your design process. Maybe with some small tweaks you can select parts that open up new re-use opportunities. But be careful that the re-use isn't more valuable than the original device (leading to theft problems).

A latrine building project wanted to make nicer latrines than what people were used to. They put locks on the doors thinking people would like the privacy, not realizing there were no other locked rooms in the village. Upon returning a year later, the aid workers discovered nobody was using them as latrines, they were using them as secure storage units.