Putting Environmental Ethics at the Center of Design: A Case-Study Approach

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The case-study approach is being used increasingly to teach engineering design. [1, 2] and also engineering ethics.[3] Experts use case-based reasoning in making decisions;[4] therefore, it makes sense to teach students the way experts learn.

Most of the cases that combine ethics and design are post-hoc analyses of failures like the Challenger, Chernobyl and Bhopal.[5] These failures are often the result of design decisions made years before, though the cases frequently focus on faulty decisions that occurred at the moment of crisis.

What is needed to complement these valuable cases are cases that incorporate ethics as a major design consideration right up front, shaping the whole design process. We are creating and piloting a set of such cases; we will present two as examples:

1) The design of an environmentally-intelligent fabric

William McDonough, Dean of the School of Architecture at the University of Virginia, agrees that designers and inventors ought to think about cost, performance and aesthetics, but also two additional constraints: will the design process and eventual product be ecologically intelligent and socially just? McDonough and Michael Braungart, the head of the Environmental Protection Encouragement Agency in Germany, are teaming up to change the way in which a wide range of chemical products are designed and manufactured. We are building a set of cases around their efforts. The goal of this series of cases is to expose students to an unusually rigorous set of environmental design criteria and to ask them whether it is desirable or even possible to implement them.

The first case in this series concerns a new ecologically intelligent furniture fabric developed by Susan Lyons at DesignTex, Incorporated, a New York textile design company. In early 1992 she wanted the company's next design to focus around an ethical issue, not just involve changes in aesthetics. Environmental responsibility was important to her, so she decided to design an environmentally friendly furniture fabric.

In December of 1992 while conducting research for the environmental design, she became interested in a sample of a fabric called Climatex^{R}, produced by Rohner Textil AG, a mill located in Heerbrugg, Switzerland. The fabric, a patented combination of wool, ramie, and polyester, was unique because it wicked away moisture from a person who was in contact with the fabric over long periods. It was intended to improve comfort in wheelchairs and transport lorries (trucks).

Lyons originally inquired about the recycling possibilities of Climatex^{R}. Albin Kaelin, director Rohner Textil's operations, pointed out that since Climatex^{R} was a blend of wool, ramie and polyester. No recycling was possible because it was very difficult to separate these constituent components for recycling.

Kaelin went on to add that, instead of recycling, the fabric could be burned and used to provide energy for the mill. In addition, he stated that Climatex® passed the rigorous inspections of the International Association for Research and Testing in the Field of Textile Ecology (OEKO-Tex) in May of 1993. The OEKO-Tex approval meant that Climatex® was free of most chemicals determined to have a negative impact on human beings.

Although the OEKO-Tex testing process represented one of the most stringent inspections for which a textile could be scrutinized, the Climatex® fabric and its waste trimmings contained chemicals that could potentially harm the environment when disposed. Susan Lyons was encouraged by the OEKO-Tex approval, and thought that Climatex was her best option for an environmental design by the middle of 1993.

DesignTex had a history of working with architects in designing their collections, so Susan Lyons brought in William McDonough, the world's foremost environmental architect, to verify that Climatex® was the best option. McDonough's evaluation startled Lyons. "Two key principles hit home really hard," Susan Lyons said, "the idea that waste equals food and the idea of a cradle-to-cradle design, not a cradle-to-grave design." In other words according to McDonough, any fabric would have to either be put back into an organic cycle and composted or put back into a technical cycle, in which all the materials in it would be re-used. In either case, the key to the project would be getting the fabric mills to open up their manufacturing processes to inspection by McDonough and Michael Braungart of the German EPEA, who were capable of doing the evaluations. In addition, the mills would have to examine the processes of the mill partners, the yarn spinners, twisters, dyers, and finishers, so that they could also meet the design protocol.

Students are asked to decide whether DesignTex ought to go forward with Climatex® or whether they ought to adopt McDonough's more rigorous environmental standards and attempt to design a totally compostable or recyclable fabric. They are given the additional information that no chemical company was willing to allow inspection of their manufacturing procedures--it would take great effort to persuade anyone to adopt the McDonough protocols.

This decision forces students to confront the difference between a utilitarian cost-benefit ethical perspective and a more absolute Kantian moral code such as the one advocated by McDonough, in which there is no compromise: a design must follow the highest possible environmental standards. (We have piloted this case in the course described in Ingrid Soudek's paper; the results from this pilot will be discussed in the paper by Edmund Russell).

We intend to develop a B or follow-up case which describes in detail the design process that led to the fabric and the kinds of social negotiations that had to be done to make ethics a top priority at Ciba Geigy, which produced the dyes. One of the lessons students learn from this case is that successful designers not only build devices, they also create networks. This kind of network-building is essential--one has to show companies that environmental ethics can benefit the bottom line as well as make the world a better place. A contrasting case we are working on is the Dow Corning breast implant, where litigation drove a company that thought its products were safe into Chapter 11. Dow Corning did not have a clear set of principles like McDonough's on which to base and defend its actions.

2) **The design of a solar water heater**

Cases of success need to be complemented by failures, because as Petroski6 and others have shown, failure can be a great teacher. The goal of this case is to show students that having a good, ethical design is not enough--one must be able to build a network that will promote it. The inventor in this case built a technology he firmly believed would make the world a better place, and is on the verge of bankruptcy at the present time.

A.C. Rich invented and patented a new form of solar water heater that he claimed would significantly reduce home heating costs. As he said, "The average home water heater emits over a ton of hydrocarbon pollutants into the atmosphere each year, as much as the average car! A solar water heater can prevent over 1400 lbs. of these pollutants from being emitted. " Rich claimed that, "If 50 per cent of the homes in the United

States had a solar collector, it would eliminate 12 large nuclear, coal and oil-generating plants." Rich was part of a movement towards relatively simple, passive technologies like insulation and improved windows that could be used to greatly reduce America's energy needs.7 His goal was to be the Henry Ford of the solar heater industry. Like McDonough, Rich hoped to do well by doing good.

Rich got the idea for his system from repairing others. He had been selling solar heating systems for Sears Solar when the tax credit for energy-saving improvements to the home expired in 1985. He hung on as a one-man company, repairing and maintaining a variety of systems that had been installed on homes, and learning their weaknesses. He designed a system that looked like a skylight, was easy to install and maintain and was affordable if manufactured in volume. His "Skylite" was a 'closed-loop' system, in which the water in the heater was separate from the water in the house and provided heat by circulating around a special water tank. He intended it to be sturdy enough to last for 20 years with little maintenance. Innovative features included a special floating valve that allowed all the water in the heating tubes on top to flow back into a drainback tank at night and when the temperature outside was too low, and a venting system that would allow steam to escape when the weather became too hot. (For a diagram of Rich's system, see *http://jefferson.village.virginia.edu/~meg3c/id/id_acrich/solar.gif*). Rich received grants to research the benefits of his solar heater, and found that even in wintry New Hampshire, it could significantly reduce the amount of power required to heat water for the home.

Students were asked to evaluate Rich's design in terms of McDonough's criteria and also to decide whether he should remain in Virginia when his business did not take off as expected: he set up a manufacturing plant to produce the systems in bulk, but the orders never materialized. As such, the systems remained expensive: around $1500. Students were given a table of subsidies available in other states to use in their analysis.

After students decide, they were given a B case which shows that Rich moved to California to work with a utility. Unfortunately, this relationship soured--one of Rich salespeople was accused of unethical behavior, despite Rich's argument that it was just an honest mistake, and leads dried up. Rich took out a second mortgage on his home, and eventually had to declare personal bankruptcy.

Students are asked to recommend Rich's next step, and to consider whether inventors like him deserve subsidies in order to produce environmentally-friendly technologies. Should the A.C. Riches of the world be allowed to fail? (The accompanying paper by Edmund Russell will discuss what the students actually did).

World-Wide Web Access

The environmental fabric case, named after the company DesignTex, is available on the World-Wide Web at URL
http://jefferson.village.virginia.edu/~meg3c/id/id_dtex.html.
The A.C. Rich case, named after his company, American Solar Network, is available at
http://jefferson.village.virginia.edu/~meg3c/id/id_acrich_A_mod.html
and the B case at
http://jefferson.village.virginia.edu/~meg3c/id/id_acrich_B_mod.html.
There is also a teaching note for the ASN case at
http://jefferson.village.virginia.edu/~meg3c/id/id_asn_note.html.
(The B case and the teaching note are kept separate so students won't read the B case before making their decision on the A case). All these materials are linked to an Invention, Design and Discovery home page at
http://jefferson.village.virginia.edu/~meg3c/id/id_home.html.
Special resources for secondary educators exist at
http://jefferson.village.virginia.edu/~meg3c/id/id_sep.html.
This site also includes links to sources on invention and discovery and samples of student work. The cases are designed to be adaptable to a wide range of teaching situations; we welcome comments.

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References

1. Fitzgerald, N. (1995). Teaching with cases. ASEE Prism (March), 16-20.

2. German, M. E., Richards, L. G., Scherer, W. T., & Kagiwada, J. K. (1995). Teaching invention and design: Multi-disciplinary learning modules. The Journal of Engineering Education, 84(2), 175-186.

3. Panitz, B. (1995). Ethics instruction: An undergraduate essential. ASEE Prism(October), 21-25.

4. Kolodner, J. (1993). Case-based reasoning. San Mateo, CA: Morgan Kaufmann Publishers, Inc.

5. Martin, M. W. &. S., R. (1989). Ethics in Engineering (2nd cd.). New York: McGraw Hill.

6. Petroski, H. (1994). Desire paradigms: Case histories of error and judgment in engineering. Cambridge, UK: Cambridge University Press.

7. Lovins, L. H., Lovins, A. B., & Zuckerman, S. (1986). Energy Unbound: A Fable for America's Future. San Francisco: Sierra Club Books.

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