

Environmental Ethics and Invention:

A Case Study

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Pre-proposal for EVST, NSF

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This proposal will lead to the development of a case-study that can be used in a wide variety of engineering classes to illustrate how environmental ethics can affect the invention process, from goals to marketing. The focus will be on an inventor of solar heating systems who combines a concern for profit and helping the global environment. Students will also be given a chance to design their own environmentally-appropriate technology. The case will be piloted and evaluated in a special course on invention and design intended for students from both engineering and the liberal arts.¹

Objectives

From this case, students should learn the following:

(1) That ethics can play an important role in shaping decisions about what and how to invent. Humanistic concerns are not matters to be addressed after a product is designed; they should be built-in from the beginning.

(2) That inventors--especially those who are environmentally conscious--must create markets for their products. Like humanistic concerns, marketing needs to be built into a product from the start. To succeed as an ethical inventor, one must understand the psychology of the potential user.

¹Development of this course was supported by the Leadership in Science and Humanities program of the NSF, NEH and FIPSE.

Implementation

This case will be introduced into a course on invention and design which sets-up a collaborative learning environment; students and faculty from a variety of disciplines explore issues in design together. Standard university curricula tend to compartmentalize engineering, humanities and social sciences. But real world engineering decisions defy such compartmentalization, as students discover when they take this course.

Currently, we use three cases in the course--the invention of the telephone and the computer and the design of a medical diagnostic system. All cases involve ethical considerations and these are discussed in the course. For example, the medical case involves students in developing an expert system to diagnose cases of sexual assault. Students have to make sure that their system is capable of keeping all client information confidential. They also have to deal with the politics of providing diagnoses for insurance purposes. Is it ethical to label a client in accordance with an insurance code, simply in order to obtain payment? Could an expert system eventually be used to make diagnosis and treatment more 'efficient', thereby robbing abuse victims of the necessary human contact and empathy?

We would like to add a case which focuses specifically on the role of environmental ethics in invention and design. Ethical concerns are often seen as implications or results of designs; we want students to see that ethical decisions are embedded in an invention.

The case we have selected involves the development of a solar heating system by a modern inventor who was motivated by ethical and environmental concerns. A.C. Rich decided to work in the solar energy field because he saw it as one solution to problems like global warming. During his college years, he became active in the environmental movement, organizing and participating in senior seminars and conferences.

After graduating in 1979, he worked as a district manager for a solar company that went out of business when the tax-credit for alternate energy was repealed. In order to stay in the solar industry, he became a one-man sales and servicing company, working with the existing technology. Constant interaction with consumers made him increasingly aware of the shortcomings of existing designs; from these perceived shortcomings, he developed a set of constraints which guided the development of a new solar water heater.

Why a water heater? Because Rich thought that the way water was heated in homes was monumentally inefficient, from an environmental standpoint. Why generate power from a distant source that generated pollution and acid rain when the sun could heat water right at the remote location? Obviously, standard technology would have to be used as a back-up, but the amount of power consumed could be drastically reduced.

Rich went on to develop a design that was a radical departure from current practices in the solar industry, involving two patents and wholesale substitution of materials--for example, instead of glass he used plastic and instead of copper pipe, polypropylene. His goal was to develop a low maintenance, low cost system that would last for twenty or more years and could be installed and operated in virtually any climate zone within the United States.

Therefore, this case complements the emphasis on technological creativity that is the main theme of the course while adding an important ethical component. It also incorporates some of the business and management aspects of inventing. Rich had to survive a severe recession in the solar industry; his company is still struggling, held together in part by his Utopian dreams of a day when millions of people are using the sun to heat their water. Therefore, his case allows us to raise the issue of sustainable development; to put this issue into broader context, we would use readings like Schmidheiny's (1992) *Changing Course* and Kennedy's (1993) *Preparing for the Twentieth Century* and selections from Martin & Schinzinger's (1989) *Ethics in Engineering*.

Rich was invited to speak to the Invention and Design class this last semester, and also interacted with an undergraduate research team studying inventors. Therefore, we have video-taped him discussing his process and acquired copies of his research materials, patents and business plans. He has agreed to be an active collaborator in this project.

By the end of this case, students will have learned that there is an important ethical component to invention and design. An inventor can be driven by a desire to improve the world, and this desire has practical consequences, both in terms of her or his design process and the way he or she struggles to create markets for sustainable technologies.

Design Component

Every case in this course has a design component, in which the students work in groups on an invention problem consonant with the goals of the unit. In this unit, we would ask students to come up with a design that promoted sustainable development in an area of their own choosing. Groups would have to begin with problem definition: what major environmental problem could they begin to alleviate with a feasible design? Their goal would be to 'sell' their idea to a panel of judges that would include faculty with expertise in energy, resources and the environment. They could use Rich's process as an example--and even try to improve on his invention--but they could not simply imitate it.

Evaluation

The original grant funded an extensive and thorough evaluation of this course. This proposal includes funding for a similar evaluation of this specific case that would include three major components:

- (1) A survey administered at the beginning and the end of this case. Students would be asked questions about whether and to what extent they thought inventors factored ethical concerns into their designs, and whether ethics ought to play an important role in the earliest stages of the invention process, or enter later when the questions of use and marketing come into play.

(2) Focused interviews: Selected students would be interviewed to look for issues that were missed in the surveys and questionnaires.

(3) Video-taping: All class sessions and all group meetings outside of class would be taped for later analysis. We would focus specifically on the ways in which ethical or environmental decisions affected the invention process, and also students' plans to market their designs.

Final End Product

One end-product would be a case module that could be used in a wide variety of courses. For example, all first-year engineering students are required to take a course on engineering design. We intend to write-up the solar heater case, complete with supplementary materials, for use in such a course.

Another would be a series of articles describing the case and its use in the classroom, in journals like *Science, Technology and Human Values* and the *Journal of Engineering Education*.

Budget Narrative

Support for the PI: In order to prepare and supervise the introduction of this new case, the PI would need one-sixth released-time, or the equivalent of one course out of the six he teaches each year. To supervise the evaluation and write-up the results for dissemination, he would need an additional month of summer support.

Estimated cost.....\$38,051

Consultant: A.C. Rich has already agreed to serve as a consultant on this unit. We would like to fly him out from California to conduct an extended seminar with the students. They would have studied materials regarding his case in advance, and would be able to ask him focused questions about his invention process and the politics of marketing environmentally-appropriate technology.

Estimated cost.....\$2,000

Graduate Student: To conduct the evaluation under the PI's close supervision, a graduate student is necessary. The PI cannot, for obvious reasons, conduct confidential interviews, distribute surveys and videotape groups in a course he is coordinating. A graduate

and videotape groups in a course he is coordinating. A graduate student in Systems Engineering has spearheaded the evaluation of the initial phase of this course; this student or another could be hired for a semester and one month of the summer to complete a thorough evaluation of the environmental ethics unit.

Estimated cost.....\$10,480

Supplies:

This category includes the cost of obtaining and reproducing Rich's invention notebooks, patents, promotional materials and also the cost of videotapes and other materials related to the evaluation.

Estimated cost.....\$1000

Total:.....\$51,531

Estimated indirect costs.....\$24,500

Grand total:.....\$75,720

References

Kennedy, Paul (1993) *Preparing for the Twenty-First Century*. New York: Random House.

Martin, M.W. & Schinzinger, R. (1989). *Ethics in Engineering*. (2nd Edition). New York: McGraw-Hill.

Schmidheiny, Stephan (1992). *Changing Course: A Global Business Perspective on Development and the Environment*. Cambridge: MIT Press.