Fitting the Essentials into the ChE Curriculum: Ethics, Professionalism, Environmental Health & Safety

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The essence of chemical engineering is creating processes, materials, and devices that enhance society. Far from "extras" to fit into an already "full" curriculum, the teaching of ethics, professionalism, and environmental health & safety is *essential* in any B.S.Ch.E. program. These are chemical engineering topics as important as transport phenomena, as fundamental as thermodynamics, and as crucial to the professional success of our graduates as a firm grounding in material and energy balances and process design.

In this paper, instruction modules for ethics and professionalism and for environmental health & safety are presented. We use these modules in the senior design class; however, they stand alone and can be used most anywhere in the curriculum. More details are available in a new, recently published textbook for the capstone design class.[1]

Ethics and Professionalism

The purpose of this module is to teach students their ethical and legal responsibilities as professional engineers and to help them develop strategies to make the best choice when faced with an ethical dilemma. The goal is to help them obtain moral autonomy, which is defined as the ability to make one's own ethical decisions. Much of this is accomplished via class and small group discussions. One source of material for discussion is a set of case studies from several different references.[1] Another is the web site for the Ethics Center for Engineering and Science.[2] One example we always use is the case where a student has accepted one job offer only to receive another, better offer. Students are asked how they would respond. This is a particularly interesting case because students' responses have changed over the last decade or so. Back then, almost all students said that accepting the first offer committed them to that company. Now, students say that they would have no problems accepting the better offer. The most often cited justification is lack of corporate loyalty to workers ("They would not hesitate to fire me if they had to."), and that it is now rare for someone to spend their entire career with one employer ("People quit jobs all of the time."). In the discussion, the faculty resist giving their opinions of right and wrong, unless there are clear legal issues. The goal is for the students to confront their own values and learn to solve their own ethical dilemmas. An added benefit from these discussions is that faculty learn more about their students' values and concerns.

Videos and movies are also a rich source of material for class discussion. We show the movie *Acceptable Risks*, originally aired on ABC in 1986. It presents a Bhopal-like scenario involving a chemical plant in a one-industry town under pressure to increase production at all costs while local developers are simultaneously building housing communities very close to the plant. The results are predictable, yet still provide a good source of material for class discussion.

Another video we use is *Gilbane Gold*, produced by the National Institute for Engineering Ethics of the NSPE. It is a fictitious story about a whistle-blowing incident.

During this module, the importance of professional registration is also discussed. The format of the FE exam is discussed, and students are encouraged to register for the exam.

Environmental Health & Safety

The module on environmental health & safety includes an introduction to environmental regulations, safety issues, inherently safe design, and HAZOPs. Some of this material is presented in a lecture format. Class exercises involve students doing a HAZOP analysis on a portion of the process that they are designing.

A particularly good video is one produced by Chevron entitled *Process Hazards*, which is an introduction to API Standard 750. With this video, we introduce Process Safety Management, the procedures by which government agencies create new regulations and modify old ones, the role of professional organizations, and the connections between all of the core chemical engineering courses and the EHS aspects of the chemical engineering profession. We combine this with another video available through SAChE of the 1989 explosion at a Phillips 66 plant in Houston, Texas.

Environmental regulations, pollution prevention, and the Risk Management Program are introduced through handouts, lectures, and cooperative learning exercises that focus on the role of the chemical engineer in safeguarding environmental health and safety. The Responsible Care® program is described, and tie-ins to the ethics and professionalism module are made.

Conclusions

Students learn best when they understand and value the context of the technical material. What could be more important to a student about to enter a profession that has profoundly improved the safety of our houses, our transportation, the food we eat, the air we breathe, and the water we drink than to understand the ethical, environmental health and safety aspects of their profession. To understand the potential positive and negative impacts of a chemical engineering decision is to understand why we need to get the material and energy balances right, why we need to be able to understand and to use transport phenomena, and even why one would ever want to use fugacity.

Ethics, professionalism, environmental health and safety—these are the essential elements of chemical engineering that provide the context and motivation for students. Far from displacing the "technical" aspects of the curriculum, these essential elements can enhance a student's understanding of everything from calculus to enthalpy and from optimization to extraction—or even entropy.

References

1. Turton, R., R. C. Bailie, W. B. Whiting and J. A. Shaeiwitz, *Analysis, Synthesis, and Design of Chemical Processes*, Prentice Hall, Upper Saddle River, NJ, 1998.

2. http://www.cwru.edu/affil/wwwethics/

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