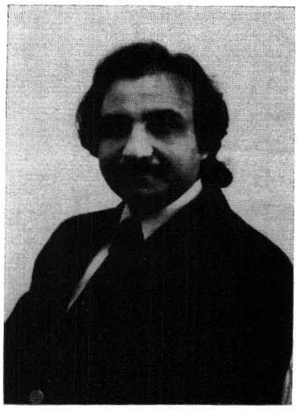
INTRODUCING THE REGULATORY PROCESS INTO THE CHEMICAL ENGINEERING CURRICULUM
A Painless Method

FRANKLIN G. KING AND
RAMESH C. CHAWLA
Howard University
Washington, D.C. 20059

ENGINEERING FACULTY CAN NO longer doubt that government regulations have had a major impact on engineering practice. Public policy decisions have resulted from social concerns and have mandated engineering solutions in many areas, such as environmental pollution, proper disposal of hazardous wastes, consumer product safety, and the control of exposure to carcinogenic and toxic materials. Because technological invention has such a great impact on our society, the scope of an engineer's responsibilities must include a sensitivity for social concerns and the participation in public policy issues involving technology. Engineers are directly affected because our designs are often covered by government regulations. Engineers must also provide the data and technical judgment needed to formulate public policy and to write realistic and technically feasible regulations to implement the policies. If all these things are true, then an argument can be made that engineering students should be exposed to the interaction of engineering and public policy as part of their professional education.

There are at least three different ways that an introduction to government regulations and the regulatory process can be integrated into the chemical engineering curriculum. The first approach would be to recommend an elective course on the topic. Many universities have introduced "Society and Technology" elective courses which usually focus on the impact of technology as a social phenomenon, rather than on the technical aspects of public policy issues. These courses are often not recommended by engineering faculty because they do not meet the requirements as a

Engineers are directly affected because our designs are often covered by government regulations. Engineers must also provide the data and technical judgment needed to formulate public policy. . .



Franklin G. King received his B.S. degree from Penn State, his masters in education from Howard University, his masters in chemical engineering from Kansas State and his D.Sc. from Stevens Institute of Technology. He has been teaching for the last 18 years at Howard University and at Lafayette College. His current interests include the development of personalized instruction methods, biochemical engineering and pharmacokinetic modelling of anticancer drugs. **(L)**

Ramesh C. Chawla is an Associate Professor of chemical engineering at Howard University. He did his undergraduate work at the Indian Institute of Technology, Kanpur and obtained his M.S. and Ph.D. degrees from Wayne State University. Dr. Chawla is a member of many professional societies including AIChE, APCA, WPCF, Sigma-Xi and SAE. He has received several teaching awards including Outstanding Instructor Award from the Howard University AIChE Student Chapter and Teetor Award from SAE. His research interests include kinetics, air and water pollution, and mass transfer. **(R)**

technical or a social science elective. Generally these courses are not taught by engineering faculty. Thus, engineering students are deprived of a role model and get the feeling that engineers are not concerned with the regulatory process and public policy issues. Also, since the courses are elective courses, many students may not select them voluntarily.

A second approach is the use of interdisciplinary project-oriented courses. The course would be team-taught by both engineering and social science faculty and the students could be both technical and non-technical. As an example, a course could be devoted to a project of cleaning up a river where the team would have to consider both the technical and the social aspects of different solutions. These courses require a considerable amount of faculty time to organize and develop. They also require cooperation of different departments operating on different budgets.

A third technique is to use engineering case studies to introduce public policy considerations directly into the engineering curriculum. The use of case studies can overcome the local problem of developing and sustaining projects with public policy issues. If case materials were available and if only part of a course involved issues concerning public policy, then many faculty might be willing to get involved. On the other hand, few engineering faculty would feel comfortable with or be willing to teach an entire course dealing with public policy. However, if faculty would give students even a small peek at public policy issues they should be able to foster an awareness of the relevance of the social science/humanities component in education. We, as engineering faculty, might even grow a bit as we come to understand the impact of policy issues on the practice of engineering education.

We would like to describe a project which was aimed at developing a number of case studies with public policy considerations and how we have introduced public policy into our undergraduate curriculum at Howard University. We would also invite you to get involved so that case studies can be developed that can be used in chemical engineering curricula.

THE EPEPP PROJECT

The Educating Prospective Engineers for Public Policy (EPEPP) project is administered by ASEE with the University of Washington as the academic sponsor and Professor Barry Hyman [2] as the project director. The project has the financial support from the National Science Foundation, Sun Oil Company, General Motors, and nine engineering societies. AIChE has become a sponsor for the 1984 program.

The goal of the project is to provide future engineers with the tools necessary to contribute professionally to the resolution of technically intensive public policy issues.

The goal of the project is to provide future engineers with the tools necessary to contribute professionally to the resolution of technically intensive public policy issues. The project is in response to the needs of society to have a greater technical input into the making of public policy in engineering and technology areas and to the needs of engineers to have a broadened awareness and understanding of the meaning of public policy. The project is geared to produce case studies on topics concerning public policy issues which have technical components. The objective of the project will be accomplished by the direct experience of a small number of students and faculty and by the integration of the case studies into the typical engineering curriculum.

The project has three major integrated components: 1) Washington Internship for Students of Engineering (WISE); 2) the development of case studies on engineering and public policy on topics based on the WISE program; and 3) a series of regional ASEE faculty workshops to promote the utilization of case studies.

The WISE Program provides an opportunity for about 15 third-year engineering students to spend 10 weeks during the summer studying the relationship between engineering and public policy. An objective of the WISE program is for the students to gain an understanding of the operation of the federal government so that they can appreciate the non-technical aspects of technology related public policy problems. The students receive a stipend of $1750 to cover expenses. They also receive 3 credits from University of Washington. Their goal for the summer is to complete a written report on their project to provide the basis of a case study. The students are selected competitively by the sponsoring engineering societies. Fortunately, five chemical engineers have been selected even though AIChE was not a sponsor.

TABLE 1
WISE Participants*

INTERNS	1980	1981	1982
Mechanical Engineering	5	4	5
Civil Engineering	3	2	3
Chemical Engineering	2 (SAE, NSPE)	2(ANS)	1(ANS)
Electrical Engineering	1	2	1
Agricultural Engineering	2	1	1
Industrial Engineering	0	1	2
Aeronautical Engineering	0	1	0
Manufacturing Engineering	0	1	0
Energy Systems Engineering	0	1	0
Nuclear Engineering	1	0	1
Engineering & Public Policy	1	0	0
Engineering Science	0	0	1

*One or more students were sponsored by the societies shown in parenthesis—Society of Automotive Engineers (SAE), National Society of Professional Engineers (NSPE) and American Nuclear Society (ANS).

Table 1 lists past WISE participants by background.

In pursuing their specific projects, the students spend about 5 hours a week in a classroom setting discussing the dimensions of engineering and public policy [4]. In pursuing their specific projects, the students interact regularly with ASEE headquarters, the Washington office of their sponsoring societies, government agencies, congressional staff, corporate lobbyists and consumer advocates. They also attend seminars by leading experts on current issues of interest to the technical community and to society.

The classroom work and field work is coordinated by a faculty-member-in-residence. The faculty-member-in-residence meets regularly with individual WISE students to monitor the progress of their activities. The faculty-member-in-residence is selected on the basis of first-hand experience with public issues, record of teaching, and familiarity with the case method of instruction. Professors Charles Overby (Ohio University), Paul Craig (UC-Davis), and F. Karl Willenbrock (SMU) were the faculty-members-in-residence for the first three years of the program.

TABLE 2
1980 WISE Case Studies

- Regulation of trihalomethanes in drinking water
- Subsurface disposal of hazardous waste
- Problems with implementing an effective automobile fuel economy program
- Management of high-level radioactive wastes
- Building energy performance standards

The second phase of the EPEPP project is to convert the student papers into draft cases and to coordinate the preparation for classroom testing of the drafts [1]. In autumn 1980, in response to a national questionnaire, about 75 faculty expressed interest in using a case on a specific area and to participate in workshops on the use of the cases. On the basis of the questionnaire, five topics were selected by the project director to be converted into draft cases. The topics selected are listed in Table 2. As part of the process of converting the papers into draft cases, additional introductory material was written describing the regulatory process. Exerpts from the *Federal Register* and transcripts of expert testimony on proposed rules were included where appropriate. An *Instructor's Guide* was also written for each case. The *Guide* contains suggestions on how each case might be used.

The third and final component of the project is the validation of the cases and their integration into engineering curricula. The validation and integration of the cases are to be accomplished by classroom testing and a series of workshops at regional ASEE conferences. The workshops are to encourage and publicize the use of EPEPP cases on many campuses. Ten of the faculty that expressed an interest in the project were invited to participate in a case workshop which was held in conjunction with the 1981 ASEE Annual Conference. The field test faculty were selected to get a mix of disciplines and geographical areas. The distribution by disciplines is shown in Table 3.

TABLE 3
Faculty Participation

DISCIPLINE	NUMBER
C.E.	3
Ch.E. (Howard, Suny-Buffalo)	2
M.E.	2
I.E.	2
E.E.	1

USING ENGINEERING CASE STUDIES

An engineering case study is a written account of an engineering activity as it actually took place [3]. A case gives the sequence of events of a real experience, often from the viewpoint of one or more participants. Unlike a technical paper which focuses on the validity of a solution, a case considers how the results were obtained. A case often shows how the participants interacted to accomplish the engineering task. A case is often written in segments to allow class study or discussion at critical decision points. Cases, like design projects, have no single correct answer and depend on many subdivisions of engineering. They often raise questions of human behavior and ethics as well as technical questions, and thus permit many possible solutions.

Engineering cases can be used in many different ways. A list of some of the more common methods is given in Table 4. Using cases as reading material is the simplest method, but it is probably the least effective. One of the other methods should probably be selected since students will be more involved in the learning process.

TABLE 4
Classroom Uses of Case Material

- **Reading assignments**
- **Background to specific problems**
- **Practice in formulating problems**
- **Subjects for class discussion**
- **Medium for relating engineering history and illustrating the engineering method**
- **Motivation for laboratory work**
- **Background and source for research or design projects**

Unlike a technical paper which focuses on the validity of a solution, a case considers how the results were obtained . . . Cases, like design projects, have no single correct answer and depend on many subdivisions of engineering.

EXPERIENCE AT HOWARD UNIVERSITY

We used the draft case study "Regulation of Trihalomethanes (THM's) in Drinking Water" as part of our first chemical engineering course "Introduction to Engineering Design." All of our students were concurrently taking their second semester of chemistry and calculus. The THM case was selected from the available cases because it had a strong chemistry component and the topic had the most interest to chemical engineers.

The students were all given a copy of the case study as a reading assignment and were given a short technical presentation on the formation of THM's in water. Every attempt was made to insure unbiased dissemination of information. The students were next organized, voluntarily, into one of six groups consisting of the EPA, Congress, industry, consumer groups, research centers and universities, and judges. Each group was asked to prepare themselves for a role-playing discussion of the topic. Each group then met individually to formulate their strategy. They were encouraged to explore the topic in as great technical detail as possible. The students were expected to present and defend the positions of their group, rather than express their personal views.

The discussion period consisted of a two-hour session which began by having each group's spokesperson summarize the group's role in the regulation process. Two faculty members and a senior student joined the judges group to moderate and guide the discussion and to bring out various aspects of the problem. The judges also acted to evaluate individual student and group performance. A lively debate followed, with each group questioning the others. The judges were successful in keeping the discussion going and getting most of the students involved in the discussion. The student judges were unanimous in siding with the consumer group, their evaluation being more on an emotional basis than a factual one. The faculty judges felt that the discussions should have been more technical, but everyone agreed that they had a better understanding of the regulatory process and why engineers must be involved.

We plan to continue using the case studies in our freshman class and intend to introduce them in the senior level design course. We expect to get a better technical response from the seniors, but both groups will gain a sensitivity for the social responsibility of engineers. □

REFERENCES

1. Federow, H. L., and B. Hyman. "Developing Case Histories from the WISE Program," Proceedings of the 1981 ASEE Annual Conference, pp. 1011-1015.
2. Hyman, Barry (EPEPP Project Director). Program in Social Management of Technology, FS-15. University of Washington, Seattle, Washington 98195.
3. Kardos, G., and C. O. Smith. "On Writing Engineering Cases." Proceedings of the 1979 ASEE Engineering Case Studies Conference.
4. Overby, C. M. "Engineering and Public Policy: Reflections by the 1980 (WISE) Faculty-Member-in-Residence." Proceedings of the 1981 ASEE Annual Conference, pp. 1004-1009.