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ABSTRACT

The University of North Carolina's Electrical Engineering Department developed and delivered a course for undergraduate engineering students. The course integrated technical, social, and ethical perspectives on problems and issues faced in the world of practicing engineers. It achieved this integration by making use of professors in engineering, philosophy, and sociology and by focusing course segments on cases and issues presented by practicing professionals. Among the issues examined in the course were product safety, life support technology, genetic engineering, information technology, nuclear power, and whistleblowing. It is believed that the course succeeded in increasing students' awareness of the social dimension and the importance of the ethical aspects of the engineering profession. Three attachments that describe the course, course presenter notes, and a journal article are appended. (DB)

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Charlotte, NC 28223

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Total	$56,056

Summary

The Engineer and the Societal Dilemma:
An Interdisciplinary Approach

A course was developed integrating ethical and societal implications and dilemmas into real world problems involving technology. The course involved faculty from the engineering discipline, philosophy and sociology, along with industrial participants. Video recording makes the case studies available to a large audience of students, faculty and industrial participants.

The course is for engineering students, so a level of technical sophistication is assumed. Societal and ethical problems are studied within the context of the engineering profession, starting with a technical presentation by professionals in the field.

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"The Engineer and the Societal Dilemma"
The University of North Carolina at Charlotte
Charlotte, NC 28223

Project Director: Professor Robert J. Coleman
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EXECUTIVE SUMMARY

A. Project Overview

This project consisted in developing and delivering a course for undergraduate engineering students. The course integrated technical, social and ethical perspectives on problems and issues faced in the real world of practicing engineers. It achieved this integration by making use of professors in engineering, philosophy and sociology and by focusing course segments on cases and issues presented by practicing professionals.

The course was taught twice, syllabi and some printed "handout" materials developed, and the case issues presentations by practicing professionals were video taped. These materials are available to any interested parties and have been sent to numerous individuals requesting them.

The project served directly the 50 students who took the course. As indicated in the analysis prepared by an evaluation specialist, the course heightened student awareness of the breadth and complexity of the social and ethical dimensions of technology, and convinced them that the real world is a complex of technical and human concerns. The course at UNC Charlotte appears at present to be in limbo. It is not being inserted into a curriculum or program outline. It is a "stand alone" entity which may or may not be offered in the future. But there is an educational reform movement in engineering, moving toward greater integration in the curriculum. And the evaluation of our course establishes clearly the need for this kind of educational effort. So there is hope that our project will impact curricular change.

B. Purpose

The problem addressed in the project is that of integrating general education into the technical education of engineering students. We saw the need to combat certain widespread student opinions regarding their general, liberal education. These opinions include the belief that humanities courses are not important, hurdles to be gotten "out of the way" as easily as possible, that the "real" education is in technical courses, and that real world problems are essentially technical ones with technical solutions.

The purpose of the project was to not only change student opinion on those matters but also to give them (part of) a genuinely broad professional educational experience. And the project intended to establish a course to be taught on a periodical basis and perhaps inserted into a curriculum. The ultimate purpose was to assist in meeting the educational needs of engineering professionals.

C. Background and Origin

UNC Charlotte prides itself on its undergraduate teaching. This orientation persists through all the growth in enrollment, graduate and professional programs, research and urban outreach activities. Recently the general education program was revised, focusing campus attention even more on curricular reform and a desire to serve our students.

Our university also facilitates creative teaching situations by encouraging new approaches and by eliminating administrative barriers sometimes encountered in cross-disciplinary programs. And the two faculty members originating the project (Coleman in engineering, Toenjes in philosophy) both had good reputations with the faculty and the administration as faculty leaders concerned with the general and liberal education of undergraduates.

A project like ours might not be adaptable in situations with strong barriers between disciplines, extensive focus on graduate teaching or technical research programs. Of course, the persons who would teach the course would have to work well together. In other words, this project originated in and is rooted in the distinct history of our university and to an extent in the personalities of the faculty members. But where conditions and personal interests are right, the project might serve as a model or a structure that can work.

D. Project Description

This project designed a one-semester course, delivered the course, evaluated and revised it, and then delivered it a second time. The course consists a number of units, each focused on a distinct issue. Product safety, life support technology, genetic engineering, information technology, nuclear power, and whistleblowing were the main units of the second running of the course. For each unit there is a presentation by each of the three instructors, an engineering professor, a philosophy professor and a professor of sociology. The professors bring their own perspectives to each issue, rather than their own distinct technical, philosophical or sociological materials.

Each unit contains a presentation by a practicing professional in the field. We have had presentations from engineers, of course, but also from medical doctors, economists, genetic researchers and lawyers. These are video taped for use in subsequent offerings of the course when perhaps volunteer presenters will be unavailable.

A major feature of the course, one which was lacking the first time through but included in the second, is ample class time for wrap-up discussion. The variety of professional perspectives (technical, philosophical, sociological and "real world" practical) made their mark on students in the active discussion periods. Evaluation data (discussed below) attest to the importance of such discussion.

E. Project Results

This project results in an undergraduate course for engineering majors that succeeds in increasing their awareness of the social dimension and the importance of the ethical aspects of the engineering profession. The evaluation study prepared by Professor James R. Cook, Department of Psychology (attached) demonstrates that the students became better able

conceptualize ethical dilemmas. The study also confirms the importance of this kind of subject matter in the curriculum. Practicing engineers recognize the significance the program, and students in the course developed an appreciation for the societal dimension of technical matters. This course succeeds in making engineering students more aware of and appreciative of the humanities aspect of their education as assisting them with the social and ethical dimensions of technology.

Other results are the video taped presentations by practicing professionals, syllabi and other "handout" materials. These are available from Robert J. Coleman, project director. An article "Integrating Liberal Learning into Technical Education" has been published in Thought & Action, Vol. V, No. 2, Fall 1989, pp. 49 - 54.

There have been beneficial "public relations" results from the notice our course received in area newspapers and the corporations which supplied the practicing professionals who made presentations to the class. The stature and reputation of a university are based on many things. One is leadership in such areas as attention to social ethical dimensions in professional education.

F. Summary and Conclusions

This project created a team-taught course involving an engineer, a philosopher and a sociologist. Course units were focused on distinct topics (e.g., genetic engineering, nuclear energy). The three professors gave their own perspectives on the issues. Practicing professionals in the field made presentations to the class. The discussion format, especially the final full-period wrap-up discussion in each unit, succeeded in making a real impact on the students. These undergraduate engineering students came away better able to conceptualize ethical issues, and more appreciative of the humanities aspect of their education.

For the course to succeed, the variety of perspectives all contributed around the focal topic is essential. Therefore, the faculty members will have to work well together, sharing and exploring together.

The institutional setting will have to be supportive of such expensive ventures. To achieve the high discussion level we limited enrollment to twenty-five. That is not a lot of students for three teachers.

The course is presently in "limbo" at UNC Charlotte. It will not be part of a regular program or curriculum. So, faculty members will only teach it "when the spirit moves them." That kind of spirit often fails to move when demands of other kinds weigh heavily.

But the course exists; it can be replicated; and it works.

"The Engineer and the Social Dilemma"
The University of North Carolina at Charlotte
Charlotte, NC 28223

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FINAL REPORT

Project Overview:

Our project grew out of the results of numerous studies and a general consensus that persons with technical education, engineers in particular, solve problems with insufficient regard for the ethical or social consequences of that solution. We proposed and taught a course for engineers that integrated liberal learning, specifically philosophy, ethics and sociology, directly into engineering and technology case studies. The course featured presentations by practicing professionals in the fields of the subjects discussed. The course was designed and taught by engineering, philosophy and sociology faculty and evaluated by a psychologist whose field of expertise is testing and evaluation. The course was taught twice with the second offering being modified in response to an evaluation of the initial offering. The course was well received by the students and rated very highly by the outside participants who gave presentations. The experience was a positive one for the faculty involved with the project. Several predictable problems did arise, however; this includes problems of acceptance into a very structured, conservative, engineering curriculum and lack of personnel, other than the initial

investigators, to carry on the course. Overall, the experience was positive for faculty, students, and technical community participants. It is anticipated that even if the course does not survive in the present format, elements will be incorporated into other course work.

Purpose:

Our project is an attempt to address a national need among engineers and scientists: the lack of appropriate general education, and the resulting mindset that problems can be addressed within a technical context, without thorough consideration of social or ethical implications. We have attempted to integrate liberal learning into the professional education of our students and to deal with social and ethical issues in technical, engineering problem solving. Engineering, philosophy and sociology faculty address different aspects of technical decision making in a unified format, followed by presentations by practicing professionals from the community who face similar problems in the "real-world". These are video taped for class discussion and later class use, and hopefully for wider training and dissemination. After the initial project period, we still see this endeavor as a pressing need among engineers and technical professionals. The problem will not go away. We still believe this format could be adopted on many campuses, with little regard to school size or location. The real problem is, and will remain, commitment of faculty and resources to address this need.

Background and Origins:

The University of North Carolina at Charlotte is well suited to carry out a genuine integration of liberal and professional learning. The entire faculty is committed to broad liberal education, as demonstrated by its adoption of a university-wide general education program in the Fall, 1986. This program is structured around student academic experience in six goal-defined areas, the third of which is "Understanding Values." The project involves a proposed course which could be submitted to satisfy the values requirement. Approval of courses as meeting the various goals is given by a faculty committee named the Council on General Education (COGE). To date, COGE has been limited to considering existing courses as meeting the values goal, for example, the standard Ethics course taught in the Philosophy Department. But COGE is seeking ways to encourage creation of new courses to meet the values goal more effectively; the project course is very much in the nature of what COGE desires. The proposed course has the strong support of the deans of the Colleges of Arts and Sciences and of Engineering. Support for the project in the Philosophy Department is clearly evident in the fact that its chairman, Richard Toenjes, is one of the two authors of the original grant proposal one of the initial faculty members involved in creation of the program.

Involvement of local industry in a project of this nature adds a dimension not present in most students' class experience. The Engineering Industrial Advisory Council for the College of Engineering was cognizant of the values which this type of inte-

grative experience could bring to engineering students. The research park adjacent to the campus houses numerous technical industries with key decision-makers willing and able to provide practical real world cases. The Charlotte area is the largest population center in the Carolinas. And UNCC, with the adjacent research park, is the local center for technical indus-try, research and education. Currently, some 1800 undergraduate students are enrolled in the College of Engineering, a number that continues to grow.

Some universities may not have the geographic location to draw upon speakers in high tech field from outside the university. Specific case studies and unit topics for the course would have to be tailored to the availability of speakers. If funds were available for dissemination, a few pilot projects could provide video tape for use where technical topics could not be covered by local authorities. (We were not able to get a dissemination grant for this purpose.) Many fine case studies could still be built around local medical or legal professionals or faculty involved in off-campus research and consulting.

Project Description:

The original proposal was developed around the concept of a case study involving the impact of science and technology and the resulting social and/or ethical consequences. The case studies consisted of a technical presentation on topics such as genetic engineering, nuclear power, high-tech medical care or modern information technology and the dilemmas often created by these

technologies. The case studies culminated in a visit by a practicing professional, e.g., a nuclear engineer, human reproductive specialist, critical care physician or industry CEO. These presentations were video taped to use in present and future classes.

Most of the problems encountered in the initial course offering were small and easily solved. Some scheduling problems occurred when high level officials in local corporations had to change plans and were unable to visit the campus for guest lectures. In every case we were able to obtain substitute speakers; but this resulted in the need to change plans for the week's lectures for us.

The major modification to our original proposal was in the media area. Originally, we had planned to video tape the guest speaker presentations in our regular lecture room. However, after several discussions, Mr. William Laukaitis, Production Specialist in audio-visual materials, convinced us of the desirability of producing video tapes in the Media Center, rather than in the classroom. The most important reasons are: the studio is equipped with four cameras, and microphones at each seat. Taping is done in a 3/4 inch format, which produces a higher quality master tape, from which 1/2 inch copies can be made. Also, editing equipment is available in this format but not in 1/2 inch format. Studio quality audio equipment is also available in the facility. The end product will still be 1/2 inch video cassettes. There is a $40 pe· hour studio charge and a $5 per hour operator charge for these services. The studio provides the 3/4 inch tapes. The Media

Center is a non-profit division of the University Library. We requested that funds allocated for educational supplies and printing and binding be shifted to pay these charges and the request was granted by FIPSE. The supplies and printing budgets were then covered by funds from the Philosophy Department and Electrical Engineering Department.

The initial planning and course offering involved only Drs. Coleman and Toenjes, of Engineering and Philosophy, respectively. We covered a wide range of topics, somewhat dictated by the timing and availability of speakers. Some of the topics did not require an in-depth study of the technical aspects, so the requirement that either professor be an expert in all areas was not stringent. Such cases often presented a clear dilemma and were considered for the method of analysis, not the specific technology involved. The first course syllabus is Attachment No. 1 in the Appendix.

This extensive (and sometimes exhausting) topic selection was discussed and evaluated after the first offering. The course was evaluated during the last week of classes by two means. First, it was evaluated by the standard course evaluation used for all classes in the College of Engineering. Then, the course was evaluated by Dr. James Cook of the Psychology Department. Dr. Cook is a resident expert in testing and evaluation and conducted an in-class evaluation during the final week of class. The results of these evaluations were used to revise the course and to refine the evaluation process. This was done in Summer 1988.

The second year, in addition to engineering and philosophy faculty, a sociologist was involved in the class. Also, the course

was modified to include fewer topics but more in-depth coverage of each. The second course syllabus is Attachment No. 2 in the Appendix. These modifications were the result of student evaluations of the initial semester and upon recommendations of Dr. Cook. This second course offering was evaluated by Dr. Cook using a more refined and thorough method. Cook elicited student reaction directly, as he had in the first evaluation. As in the first offering, students were very positive toward the course. Cook also evaluated pre-test/post-test data indicating clearly student development toward the goals of the course. In addition, Dr. Cook elicited evaluative information from the practicing professionals who had made presentations in the course. These people attest to the importance of the endeavor of our project and of the need for continued effort. The full evaluation prepared with support of the FIPSE grant is Attachment No. 3 in the Appendix. The participation of the outside speakers seems to be particularly well received and we made use of portions of the video tapes from the initial course offerings during this last semester.

Project Results:

Overall, all of the participants rate the project a success. Perhaps the most encouraging thing of all is the student response to the course. For many of the students enrolled in class the course was not required for elective credit or they did not need additional humanities credits. Still they enrolled, due to the subject matter and a desire to learn material in a manner unlike most of their past experience. Their enthusiasm, among other

things, has made this a rewarding experience for the three faculty members directly involved in this course.

We have a major invited article in the Fall, 1989 (Vol. V, No. 2) issue of Thought and Action, the NEA Higher Education Journal. This is Attachment No. 4 in the Appendix. We had an article entitled "The Engineer and Societal Dilemma" accepted in an international meeting of IEEE - SSIT (Society of Social Implications of Technology) in Los Angeles in October 1989 and presently have a paper submitted to the Southeastern Section Annual Meeting of the American Society for Engineering Education in April, 1990. Also, Drs. Coleman and Cook plan an article on the method of evaluation utilized in the course. We have received numerous requests for course syllabi and video tapes from interested faculty at other universities and community colleges.

The course was not offered during the Fall 1989 term and will not be offered during the Spring 1990 due to prior commitments by the faculty originally involved. Dr. Forrest has become a department chairman, Dr. Coleman an associate chairman and Dr. Toenjes continues as chair of his department. We are attempting to involve other faculty in another offering of the course.

Summary and Conclusions:

There is a national examination of undergraduate engineering education in progress. This is being done by engineering educators, engineering professional societies and engineering accreditation bodies such as the Accreditation Board for Engineering and Technology (ABET). Early results of these studies

predict some basic changes in the general education of engineering students. A similar trend is occurring in other fields of professional education such as medicine and business. There is a well documented need for all professionals to place greater emphasis on the ethical and social implications of their work.

Engineering students have traditionally viewed the humanities/social science portion of their education as something to be gotten "out of the way" as quickly as possible, where they can get on with the "important" technical courses. Frankly, this attitude is not going to change over night. Perhaps one reason this attitude has developed is because the student views his or her career as detached from social or ethical areas. A course like the one we have developed can help to change this attitude, by integrating social and ethical considerations into the engineering context. A single experience cannot provide all of the needed awareness to ameliorate the problem; but greater insight into the "usefulness" of the humanities and social sciences would help the student in their general education courses.

We anticipate that the results of a pilot project like ours will be welcomed by engineering educators faced with the problem of providing a broader base of general education. Also, for any engineering programs, a model which involves faculty from other colleges and the participation of outside professionals may result in a better understanding on both sides; not only do engineers and engineering faculty have to consider the ethical and social consequences of their work, but the non-technology trained person must understand the power and the limitations of technology.

The major problem with any project such as this one is a commitment of the faculty and administration to provide funds and involvement beyond the grant period. In many traditional engineering schools, faculty are evaluated and paid (and often tenured) largely on the basis of sponsored research. Therefore, one must bring in "new" funds to keep advancing on the "ladder." Involvement in a course such as this probably would fall on "non-research" faculty or at least on faculty who could take this on as additional load. This is not very conductive to a rapid spread of this type of educational experience among engineering faculty. We hope that there is a sufficiently large cadre of faculty who feel this is a necessary component of engineering education to make this experience available to future students.

Course Syllabus

ENGR 3090

The Engineer and the Societal Dilemma

Instructors: Dr. Richard Toenjes
Dr. Robert Coleman

Spring 1988

Two one-hour quizzes and a term paper required.

Lecture 1 "Galloping Technology: A New Social Disease" - Dr. Toenjes

Lecture 2 "Some Significant Technological Innovations and their Social Impact" - Dr. Coleman

Lecture 3 Continuation and Discussion of previous topics

Seminar 1 "The Role of the Professions in the Holocaust" - Dr. Susan Cernyak, Department of Foreign Languages (Holocaust Survivor)

Lecture 4 "Consequentialism and Deontology" - Dr. Toenjes

Lecture 5 "Technological Forecasting and Social Consequence: The Delphi Technique" - Dr. Coleman

Lecture 6 "Nuclear Power Reactors: Pressurized and Boiling Water Types" - Dr. Coleman

Lecture 7 "Environment Ethics" - Dr. Toenjes

Lecture 8 "Nuclear Effluents, Radioactive Inventory, Accident Potential and the Wash-1400 Study" - Dr. Coleman

Seminar 2 "Nuclear Power: A Utility Engineers Perspective" - Mr. Maurice McIntosh, General Manager, Nuclear Support, Duke Power Company

Seminar 3 "Ethical Aspects of Some Primary and Secondary Consequences of Several Technologies" - Mr. Jesse Riley, Consultant, Celanese Chemical, Retired

Lecture 9 "Employee Responsibility and Whistleblowing" - Dr. Coleman

Lecture 10 "Ethical Aspects of Whistleblowing" - Dr. Toenjes

Seminar 4 "Whistleblowing" - Mr. Ned Fowler, N. M. Fowler and Associates, Consulting Engineers; and Mr. Robert Harbage, Vice President and General Manager, Duff-Norton Company

Lecture 11 "Product Safety and Product Liability" - Dr. Coleman

Lecture 12 "Ethical Aspects of Product Safety" - Dr. Toenjes

Seminar 5 "Product Safety: A Legal, Technological and Economic Perspective" - Mr. Thomas Griswold, Division Counsel, Homelite Textron Company

Seminar 6 "Genetic Engineering" - Dr. Ronald Ostrowski, Department of Biology, UNCC

Lecture 13 "Genetic Engineering: Technology and Ethics" - Drs. Coleman, Toenjes and Ostrowski

Lecture 14 "High-Risk High Tech: Decision Scenarios" - Drs. Coleman and Toenjes

Seminar 7 "Making Babies: The New Birth Technology" - Dr. Ronald Ostrowski, Department of Biology, UNCC

Lecture 15 Class discussion of Genetic Engineering and Birth Technology - Drs. Coleman and Toenjes

Seminar 8 "Human Reproduction: Ethics and the New Technology" - Dr. John Lincourt, Department of Philosophy, UNCC; Medical Ethicist, Charlotte Memorial Hospital

Lecture 16 "Life Support Technology" - Dr. Coleman

Lecture 17 "Life Support vs Quality of Life" - Dr. Toenjes

Seminar 9 "Biomedical Ethics: The Human Factor" - Lionel Gilmer, Chaplain and Medical Ethicist, Charlotte Memorial Hospital

Lecture 18 "Medical Technology and Ethics" - Dr. Toenjes

Seminar 10 "High Technology Medical Intensive Care: An Economic and Ethical Analysis" - William Porter, M.D.

Lecture 19 "Technology of Nuclear Weapons and Delivery Systems" - Dr. Coleman

Lecture 20 "War and Ethics" - Dr. Toenjes

Seminar 11 "Nuclear Weapons, Military Technology and Society" - Dr. William Gay, Department of Philosophy, UNCC

Lecture 21 "The Arms Race in Historical Perspective" - Dr. Coleman

Lecture 22 Discussion of the Arms Race - Drs. Toenjes and Coleman

Seminar 12 "SDI: Mutual Assured Survival, Enhanced Deterrence, or First Strike Weapon" - Dr. Michael Corwin, Department of Physics, UNCC

Lecture 23 "Privacy, Job Satisfaction and Information Technology" - Dr. Toenjes

Lecture 24 "Data Banks, Technology and Privacy" - Dr. Coleman

Seminar 13 Information Technology: Privacy vs. Rights of Access" - Mr. Jim Appleyard, Manager, Information Security Systems, Duke Power Company

Lecture 25 Discussion on Electronic Information Technology, Privacy and Ethics - Drs. Coleman and Toenjes

Lecture 26 Course evaluation - Dr. Jim Cook, Department of Psychology, UNCC

Lecture 27 "Ethical and Human Concerns in Applications of Expert Systems in Education" - Dr. Marvin Croy, Department of Philosophy, UNCC

Course Syllabus **Attachment No. 2**

ENGR 3090

The Engineer and the Societal Dilemma

Instructors: Dr. Richard Toenjes
Dr. Robert Coleman
Dr. Thomas Forrest

Fall 1989

Two one-hour quizzes and a term paper required.

8-24	Introduction to the course
26	Video Tape "So This Is Philosophy," discussion of ethics
29	Dr. Forrest: "The nature of sociology"
31	Dr. Toenjes: Ethics: Consequences and Duties
9-2	Dr. Coleman: Technological Innovations, Social Consequences of Inventions
Labor Day	
9-7	Dr. Forrest: Formal Organizations, "The O-Group"
9	Group; Discussion on Ethics
12	Dr. Forrest: Deskilling
14	Dr. Toenjes: Information Technology (selections from video of Jim Appleyard, Duke Power Co.)
16	Dr. Forrest: "Acceleraton Syndrome"
19	Group; Discussion of acceleration in life caused by technology
21	Dr. Toenjes: The Right to Privacy (selections from video of Jim Appleyard)
23	Dr. Coleman: Whistleblowing
26	Group; Discussion of whistleblowing. Students write response to "Harvester Case" (a pre-test exercise)
28	Dr. Charles Kelly, of C. M. Kelly and Associates, "The Destructive Achiever"
30	Group; Discussion of the Kelly talk; selections from the video of Robert Harbage, Duff-Norton Company.
10-3	Dr. Forrest: Technology in the home
5	Continued discussion of technology in the home
7	Dr. Forrest: Future trends as revealed in advertisements

10-10	Recess
12	Quiz One
14	Dr. James White, IBM Corp., "Personal Choices in an Engineering Career"
17	Dr. Coleman: "Forecasting: The Delphi Technique"
19	Dr. Coleman: "Introduction to Nuclear Reactors"
21	Group Discussion
24	Dr. Forrest: "The Environment and Values"
26	Dr. Forrest: "The Environment and Social Policy"
28	Group Discussion
30	Dr. Peter Schwarz, UNCC Department of Economics, "Economics and the Environment"
11-2	Group Discussion
4	Dr. Toenjes: "Tragedy of the Commons"
7	Environment: Wrap-Up Discussion
9	Dr. Forrest: "Health, Money and Society"
11	Dr. Forrest: "Medical Care and Access"
11-14	Drs. Toenjes & Forrest: "The Medical Care System"
16	Group Discussion
18	Dr. Toenjes: "Death and Dying: Definitions and Issues"
21	Dr. George Barrett, M.D.: "The Social Impact of Medical High-Tech"
Thanksgiving	
28	Discussion of Dr. Barrett's Talk
30	Dr. Susan Cernyak-Spatz, UNCC Department of Germ...: "The Role of the Professions in the Holocaust"
12-2	Course Evaluation Dr. James Cook, UNCC Department of Psychology
4	Capt. David Lamp, USAF: "The Fearmakers: on National Security and Insecurity"
7	Group Discussion
9	Second Quiz

The Engineer and the Societal Dilemma: Course Evaluation for Fall, 1988

James R. Cook, Ph.D.
Department of Psychology
The University of North Carolina at Charlotte
September 18, 1989

In an effort to evaluate the course entitled "The Engineer and the Societal Dilemma", three strategies were adopted. First, students enrolled in the course were invited to discuss their impressions of the course with the evaluator during a class period. Second, the professional persons who presented various topics to the class were asked to comment on the course and its relevance to professional engineers in the field. Third, an assessment of change in students' ability to conceptualize ethical issues was made.

STUDENT IMPRESSIONS OF COURSE

On December 2, 1988, students in the course were invited to express their views about the class. As was done in a previous evaluation of this course, the discussion focussed on both process, the mechanics of the course, and outcome, the actual changes that occurred in the students. The following is a summary of the comments made by the students during that class period, with an assessment of the changes in the course since it was offered in the previous semester.

Process

The students were overwhelmingly positive in their impressions of the course. They seemed to enjoy and learn from the outside speakers, some of which were live and others on tape. The selection of speakers has clearly been sharpened, with all of the speakers receiving very favorable ratings. A new topic introduced in this semester, "the acceleration syndrome" was viewed quite positively.

The structure of the course was not the subject of criticism. Students expressed the opinion that there was plenty of time available to express their views and discuss the topics. Evaluation of students was not an apparent issue. They did express the desire to have Dr. Coleman express his views more frequently, particularly wishing that he would provide the perspective of the engineer in the class discussions.

The only "negative" comments about the course were that the topics were quite depressing and emphasized the adverse effects of technology and problems caused by engineers. They wished that time could be devoted to possible ways of resolving some of the thorny ethical issues raised in the class.

In sum, the structure of the class seemed to be much improved over the previous semester. Even with the addition of a third instructor, the presentations seemed to be well organized.

Outcomes

Students were quite pleased with what they learned in the class. The students unanimously felt that they were glad that they had taken the course and would enthusiastically support making the course a core requirement for all engineering students. They indicated that the course was a great "eye opener" for them, teaching them how to think through and approach problems. Several commented on

a tendency to view advertising and news stories in a more enlightened way. They expressed a greater sense of social responsibility and professionalism. There was a greater appreciation of the engineer as part of a broader political system, and some expressed disdain for the perception of engineers as technical automatons.

There was a clear sense that they had a more realistic picture of what it means to be an engineer, and this had different effects on different students. A small number of students indicated that they were reconsidering their decision to become engineers. The majority, though, described an increase in respect for engineers and the issues that they must confront. For most, there was a great concern for how they might be able to "change the system" to address the issues raised in the class. There seemed to be concern that significant problems were brought to their attention, but that they were lacking in the skills and/or knowledge to attempt to resolve those problems. They expressed a need for clearer ethical standards.

Summary

From the students' perspective, the course appears to be an overwhelming success, of great benefit to the students. The issues raised in the evaluation of the previous offering of the course seem to have been addressed very well. The course seems to be very successful in helping students understand the unintended effects of technology and the dilemmas that engineers must face. In fact, the course was so successful in this respect that most students felt a strong desire to learn about ways to bring about change in their future workplaces and in society more generally.

Recommendations

Based on the student evaluations, it is recommended that

(1) very few changes be made in the process and content of the course.

(2) additional time be devoted to approaches that professional engineers might take to begin to address some of the topics of the course. In particular, some emphasis might be placed on where they might turn for consultation regarding ethical dilemmas, or ways that they might use their skills in socially responsible endeavors.

(3) additional emphasis be placed on existing ethical standards for engineers.

PRESENTERS' VIEWS OF THE COURSE

Eighteen professionals, representing such professions as medicine, engineering, chemistry, philosophy, economics, computer science, physics, the military, business, and education, presented to students during the two semesters the course was offered. In order to ascertain these professionals' views about the relevance of the topics presented in the course, each was sent a listing of the topics covered in the course and letter asking them to: (1) evaluate the importance of the particular topics that were addressed; (2) indicate any other topics that

should be added to the course; and (3) assess the importance of this course for engineering students. Their responses were obtained through a telephone interview conducted by the evaluator. Responses were obtained from 14 of the 18 presenters. Although most of the presenters did not have detailed knowledge of the course content or format, they were quite willing to provide thoughtful comments about what they thought should be in a course like this.

1. Importance of topics

In general, the presenters seemed to be quite impressed with the array of topics addressed in the course, using such terms to describe the list as "excellent" and "outstanding". While there was some variation in which topics were considered most important or of somewhat less importance, the holocaust was mentioned rather frequently as one that may be of limited relevance to engineers. It was suggested that that topic might be broadened, perhaps to include other instances of genocide.

2. Possible new topics

Several new topics or expansion of existing topics were suggested. These included:

environmental issues (e.g., the environmental impact of using magnesium in power equipment);

assessment of the accuracy of information that professionals must rely upon to make decisions (e.g., in medicine, most information about medicines comes from pharmaceutical companies);

the evolution of ethical thought in management and the ways the corporate culture encourages ethical (or unethical) behavior;

the ethical implications of affirmative action in hiring;

the consequences of our commitment to a fossil fuel economy and the long-term vs short-term effects of new energy sources;

population and the number of people the earth can support; and

clarifying the distinction between what is ethical and what is legal, (e.g., is it ethical to accept a weekend at the mountains from or to date a vendor?).

There was also concern that there should be some examples of people doing things right so that students can know what positive things they can do. It seems that many of these concerns are addressed in some way in the course already, and could be integrated into the existing structure of the course.

3. Overall importance of the course

The presenters were overwhelmingly enthusiastic about the course and its importance for engineering students. They indicated that the course was "profoundly important", "an essential course", and "the most important single class that engineers or people in management can take". Many commented on the

need for this type of class as a requirement for students of all disciplines. Since engineers often assume management positions and must make decisions that are not strictly "technical" and for which they are poorly prepared, this course is particularly salient. Concern was expressed that people in science often come to believe that science is inherently "good", and fail to see and assume responsibility for the problems that science and technologies create. The involvement of a multidisciplinary team of faculty was cited as a good model that would provide a broad perspective.

While there was general concensus that this type of course is important, there were several presenters who expressed the belief that students should be exposed to ethical issues throughout their course of study. It was suggested that a course of this type might be provided for seniors to help integrate the ethical education provided in the previous years. There was concern that students lacked the maturity or background, particularly the language and concepts, needed to adequately address ethical issues. There was recognition, though, that exposure to ethical issues throughout the course of study would require some education of existing engineering faculty and the provision of ethics coursework at the graduate level.

Summary of presenters' evaluation

There is no question that presenters from all the disciplines represented were highly impressed with the course and overwhelmingly saw it as an important addition to the curriculum for engineers. While many "new" topics were suggested, only one existing topic would be a candidate for elimination or substantial revision. Since no "new" topics were mentioned more than once and many of them could be seen as extensions of existing topics, it is urged that any new topics be integrated into the existing structure rather than replace existing topics.

A number of specific suggestions were made about the ways the course could be taught, examples that might be used for different topics, and textbooks that could be used. Interestingly enough, many of the suggestions had already been incorporated into the course. It was suggested that a casebook of ethical situations for engineers might be published.

CHANGES IN STUDENTS' ABILITY TO CONCEPTUALIZE ETHICAL ISSUES

Evaluation of the students' ability was assessed through the use of vignettes that illustrated particular ethical dillemmas. Course final examinations included several vignettes, and students were asked to describe the issues involved and the actions that they might take if faced with those situations. For the purposes of the evaluation of the course, three of the vignettes were chosen for the administration of a pretest that was compared with the posttest given at the end of the semester. The purpose of this was to see if there was change in the students' ability that might be attributed to the course.

Method.

Pretest responses were not viewed by the course instructors during the course. For the purposes of the course evaluation, names and any other identifying

information were removed from pre- and posttest answers, and the responses were screened by the evaluator for indications that the responses might have been given in the middle versus at the end of the semester. Ten students' responses were chosen for each vignette, and students' responses were randomly arranged and coded to allow the course instructors to rate the responses while being blind to the timing of the response and the student who made the response.

Before being presented with the student responses, the three course instructors met with the evaluator approximately 7 months after the end of the course to establish criteria for assessing what types of responses would best demonstrate improvement in students' ability to conceptualize ethical issues. Three types of ratings were made for each student response. First, students were rated on their ability to identify the relevant stakeholders, the people who have legitimate interests in the case. Second, the students were evaluated on their ability to see the case as part of a broader social system and that they could identify various systemic issues. Third, the degree to which the students recognized the variety of possible responses, without an unwarranted level of certainty about any specific action, was assessed. For each response to the 3 vignettes, 3 raters made assessments about 3 different aspects of the students' responses.

Analysis

A multivariate analysis of variance (MANOVA) was used to determine whether there were significant differences between pre- and posttest performance. Significantly higher ratings were obtained for posttest versus pretest responses ($F = 9.96$, $df = 9, 1$, $p < .05$). This suggests that students did learn to develop more appropriate responses to the ethical dillemmas posed in the vignettes. There was also a significant difference between the types of ratings, with the students doing best, overall on the rating reflecting their appropriate level of certainty ($F = 9.53$, $df = 18, 2$, $p < .01$). Two- and three-way interactions did not achieve significance.

Discussion

The evaluation of students' pre- and posttest responses to the vignettes indicates that the students were better able to conceptualize the ethical issues after participating in the course. Although a change over time does not clearly warrant a conclusion that the course "caused" the improvement, this finding is clearly consistent with the notion that course had an effect on the students in it. An alternative explanation might be that the different demand characteristics for the pre- versus posttest (class assignment versus examination, respectively) were responsible for the posttest improvement, since students might be more highly motivated to fully explain the issues when taking an examination. However, the pretest responses did not appear to be shorter than the posttest responses, suggesting that there was a qualitative difference in responses that may not be totally explained by motivation.

OVERALL SUMMARY

Based on all three criteria - the students' reports, the presenters' comments, and the changes in students' ability to conceptualize ethical issues - the course "The Engineer and the Societal Dilemma" appears to be a clear success. Students were quite pleased with the course, and felt that they had learned a great deal about the role of the engineer. Students indicated that they better understood ethical issues confronting engineers and society, and their performance on the pre- versus posttest confirmed this. Most impressive is the fact that the students not only understood the issues, but were inspired to want additional understanding of how they might become positive forces for change in their workplaces or in society more generally. The professionals who presented to the classes were likewise highly enthusiastic about the need for the course and the topics addressed in it. This was true for professionals from many disciplines, including engineering. The major recurring concern from the professionals was that there may be a need for more than just a single course addressing these important areas.

Notes taken from presenters for Coleman course. 14 of the 18 were able to be reached.

1. IMPORTANCE OF TOPICS

technical forecasting an important issue - it is important to be able to have dispassionate assessment of cost-benefits of new technology e.g., PET scanners in medicine. It is generally assumed that competition brings down costs, but this is often not the case in medicine with expensive equipment. Perhaps another model need to be developed.; arms race important because of questions about appropriateness of having the majority of R&D into weapons. Can a democracy thrive in this way?

questions holocaust as far afield; perhaps of limited relevance to engineers.; In medicine, weighing loss of life vs. loss of home or loss of power over one's own body; SDI - should deal with what weapons and power are supposed to do, namely create fear. We need to determine how to that at some level, and not go beyond that. How can we prevent people from acting militarily?; in info tech - how do we maximize the use of computers without assuring the accuracy of the information;

questions holocaust;

all topics excellent;

questions holocaust, deskilling, arms, acceleration; seems to miss a focus

holocaust of interest historically, but limited in how applicable would be to them; tech fore - low, very speculative; acceleration- low; others important;

holocaust - perhaps could be broadened; but engineers supporting a national effort can be a positive thing. May be overdoing the medical topics. Think that whether a person chooses to work for a weapons manufacturer is a personal decision and university should not take a position. Hopes the course discusses issues not takes a stand.

can't relate to holocaust; whistleblowing - sees as self-interest, disgruntlement or unknowledgable, conplaining and "below engineers".

holocaust may be too narrow - better to focus on genocide;

list really outstanding; most neutral about privacy, info tech, tech in home

all topics important; need more people trained in business ethics.

2. NEW TOPICS

environmental issues - e.g., the environmental impact of using magnesium in power equipment

Assessing the quality of the information that you receive? In medicine, e.g., the drug companies provide much of the information and fund much of the research on drug effects. What about in the defense dept? How much can you rely on information presented by biased sources?

the evolution of ethical thought in management; seems to be getting worse, glorifying power and greed; organization pressures to behave iun unethical ways and how to deal with these; why do we promote or elect people to positions of power? - do wish to advance our special interests at the expense of ethical standards when we assume competitive posture.

general notion of why people aren't automatically ethical; why should we be concerned about ethics in engineers?

the notion of the corporate culture and how it encourages ethical (or unethical) behavior; How do you assess it in terms of whether you want to work there, e.g., how well does the company protect employees from minor economic downturns or provide medical care? A company that does not look out for its employees is likely to have employees who are not concerned about the product, safety, etc with the customer losing. There should be some examples of people doing things right. Let them know what positive things they can do.

affirmative action, taking into account past discrimination in hiring.

spend more time on general ethical concepts, with specific cases used as examples.

what are the consequences of our commitment to a fossil fuel economy - especially automobiles. What are the long-term vs short-term effects of new energy sources; Population and the number of people the earth can support (see Save the World, pub by World Watch). Need to look at consequences of engineering activities, but also examine the capital investment to enact decisions and technologies.

sorting out the difference between what is ethical and what is legal, e.g., the skywalk in KC. Maybe everyone met specs, but perks are often used to swing a contract. Is it ethical to take advantage an offer for dinner, or a weekend at the mountains, or to date a vendor?

3. IMPORTANCE OF COURSE

should get more of this throughout their course of study; in law school thre is a required course in ethics - engineers should probably have same; good to have different faculty involved to give a broad perspective;

"profoundly important"

"an essential course"; should be required; people in science often assume that "science is good", and any problems are others';

class is a good idea, a step in the right direction; students are incredibly naive; need to have a values component integrated into all the engineering courses, but this would require it in graduate courses and education for existing faculty. Students don't have the language and concepts to deal with ethical issues

"The most important single class that engineers or people in management can take" Should be required for all students. If standards are not in place, nothing else can work in terms of thje long-term welfare of society.

a useful course for engineers, and something similar is probably needed in business

"very importar. topic ... becoming more and more important in society"; would like to see if required, but can understand competition for other training needs.

of value to all engineers, have no problems with it as a required course. At the very least people should be encouraged to take it.

good ... as engineers get into management - most people trained as engineers do not get an adequate dose of humanities. The are required to deal with issues that are not technical. Because ot a lack of training, they are ill-prepared to deal with these non-technical issues. Duke Power's experience is that some training in these types of areas will be beneficial. No matter how good an engineer you are, you won't go far if you can't deal with people. Good to have as a course specifically for engineers - engineer

very enthusiastic about course, but didn't sense an receptiveness to ethical issues in students; these issues are not as important to technicials as "professionals"

worthwhile to pursue, most engineers are thrust into situations they are not ethicaly prepared for

very desirable course to have; very essential; lack in the past is element in situation we are in. But are students mature enough? Maybe we should spread it out over the curriculum, with a senior course where it is all tied together. We need faculty to increase their consciousness, perhaps through continuing ed. Faculty is a key, they need to show some sensitivity.

Needed for every degree program, not just engineering.

SUGGESTIONS BY PRESENTORS

Provide handouts to students prior to lectures; warn speaker of classroom arrangement and suggest how to use it; let presenters know what students have had up to then; help speaker work group better.

Need to help students develop a vocabulary to deal with human rights and ethical duties; suggested class format - that you present a case, question facts, identify issues, what questions need to be answered, what are some answers, what is your answer, who are the enemies and their answers, address those answers

See Kelly's books, Destructive Achiever and Power and ethics in the american corporation

break each topic down on a personal level into the small scale decisions that people have to make daily rather than simply deal with large, overpowering topics and scenarios, e.g., treating employees fairly re medical care; how do you handle the chemicals that you use, and if you hire someone to dispose of it, where does it go?

need to basically teach people that there is more to decisionmaking than the bottom line and doing what they are told. You have personal responsibility.

Look at engineer's creed - ASME - see how these docum nts might guide them.

engineers hould see themselves as having "special responsibilities" - if they don't assume them then others will - this should be repeated; emphasize engineers as problem solvers, who evolved from technicians to decisionmakers

FOWLER wants feedback re the feedback given by others. Should probably send him a copy of this report. Suggests developing a casebook.

Engineers should see selves as professionals with mooral sensitivity and social responsibility, even if they don't work on particular problems addressed in course. Should be concerned with broader environment. Being a professional means more than being an engineer. Suggest to the students groups that they might become a part of or do to address social problems, such as scientists for social responsibility, ethics committees in medical settings, emergency management agencies, churches in their social outreach, writing letters to the editor drawing on their knowledge.

Need students to understand the consequences of their actions. Use case studies to provide discussion of pros, cons and consequences of actions. Have students put themselves into the situation, go through active problem solving.

SUGGESTIONS RE SPECIFIC TOPICS

nuclear power and environment
environmental impact of using magnesium in power equipment

employee responsibility and whistleblowing
need to be responsible to concerns of management and use internal avenues before going outside

product safety and liability
C5A wings falling off as example of product safety and liability, with contractors having to underbid; medication errors;

high tech med care
PET scanners in med as example of costs of technology; allocations of heart transplant vs prenatal care - over 1/3 of medicare funds spent on people in last month of life;

nuclear weapons, arms race, sdi
Nuclear weapons and ethics are mutually exclusive.

information tech, privacy, job satis - AIDS testing, random drug screening

acceleration
maybe we shouldn't adapt, but should question the change; cited specific examples - see Bill Gay

home and workplace - kitchen as example of technology not keeping up

Thought & Action

THE NEA HIGHER EDUCATION JOURNAL

Inside

The age distribution of higher education faculty necessitates immediate implementation of innovative early retirement programs. Society can pay with money to solve the problem now, or society will pay with diminished educational quality and opportunity when it attempts to solve the problem later.

Our educational future remains in crisis, and the outlook is bleak as long as we insist on outmoded practices. The old, industrial revolution model of teacher-centered education has no place in the future.

Over the past three years, American colleges and universities have experienced a disquieting resurgence of racial and ethnic intolerance — most notably bias-related violence. Apparently no college or university is immune.

Senior colleagues should support and mentor junior faculty members who are willing and able to "pay the price." Members of other professions network and help one another. We must learn to do the same thing —.especially when the future of our profession is at stake.

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Contents

Integrating Liberal Learning Into Technical Education

By Robert J. Coleman and Richard H. Toenjes

Academic advisors in professional schools hear the question countless times: "Why do I have to take history—or philosophy—or sociology—or psychology? I came here to be educated as an engineer—or a manager—or a lawyer—or a physician!"

Students in professional schools usually want to get their humanities and social science courses "out of the way" as quickly as possible, so they can concentrate on the "important" courses. This attitude will change only when students in technical disciplines are convinced that course work in liberal education will advance their career goals.

A pilot project at UNC-Charlotte is instilling this healthier viewpoint in undergraduate engineering students. Our approach is feasible in professional curricula where the humanities and social science teaching expertise resides outside the professional education unit. We developed a team-taught course that integrates social and ethical considerations into the engineering context. Professors of engineering, humanities, and social sciences join with community-based professionals to demonstrate the "usefulness" of the humanities and social sciences for solving technical problems.

Calls abound for basic changes in the general education of engineering students. The Association of American Colleges, which advocates the importance of liberal learning, recommends strengthened humanities and social sciences components of engineering degree requirements. A recent

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Rapid technological advancement and employer demand for students "trained" for productive technical work lead to greater curricular specialization.

recent AAC report describes large-scale, innovative programs that integrate liberal and professional education and suggests strategies for further integration.[2] But 90 percent of American engineering schools currently offer no courses that integrate the perspectives of liberal arts and engineering.[3]

Overspecialization is the heart of the problem. Rapid technological advancement and employer demand for students "trained" for productive technical work lead to greater curricular specialization. Some observers ask if specialization is fair to our engineering students. Philosopher Paul Durbin remarks that engineering schools "are turning out overspecialized engineers and technical people who will have to be retrained every time they go for a new job."[4] Narrowly specialized education does not prepare people for the real world of problem-solving. Many observers believe that liberal education can help professional students apply knowledge and methods from one discipline to solve problems in other contexts.

Our UNC Charlotte experiment challenges the view that engi- solve technical problems ck ethical, social, and human dimensions. Professional education reflects an American culture that glorifies scientific expertise, and views "value" or "ethical" issues as personal, emotional reactions that are inapplicable to the "real" issues of science and technology. Students who learn precise analytical methods in one discipline tend to discount the "inexact" social ethical dimension as unimportant, or even nonexistent. Our students in Charlotte learn instead that the social and ethical dimensions of technology are real—and amenable to humanistic and social scie.. tific analysis.

The accreditation requirements of the Accreditation Board for Engineering and Technology (ABET) compound the curricular problems that professional schools face. ABET does not relate its humanities and social sciences accreditation requirements to the working world of engineers. ABET's preference for "stand-alone" courses, notes Polytechnic Institute president George Bugliarello, only perpetuates the neglect of the human dimensions of technical problems.[5]

Most efforts to integrate liberal and technical learning introduce technology and its consequences to nontechnical students. These popular "science, technology, and

"Science, technology, and society" programs fill a useful niche. But integrative courses for scientists and engineers should complement these STS courses.

society" programs fill a useful, desirable niche. But integrative courses for scientists and engineers should complement these "science, technology, and society" courses. The technologist must have a social and humanist "Plimsoll Mark," lest society suffer from the effects of technology.

The high level of interest in our Charlotte pilot course reflects a concern with integrating technical and liberal education that extends into other fields of professional education—particularly medicine and business. The federal government's Fund for the Improvement of Postsecondary Education (FIPSE) supported our work, in part, because of its applicability.

Our pilot course, entitled "The Engineer and the Societal Dilemma," is aimed at engineering students with course work in calculus, general physics, and inorganic chemistry. This background permits a moderate level of technical content in readings and lectures. Since the questions and dilemmas that technology raises—rather than the technology per se—impel the course, team-teaching humanist and liberal arts professors may leave the technical topics to faculty in engineering or another technical discipline.

Accreditation and curriculum guidelines can affect course innovation. Course approval may take an academic year, and students need assurance that a integrative course fills a degree requirement.

Where in the curriculum is such a course most efficacious? An introductory course stimulates thought and questions throughout a student's academic career and provides guidance in course selection, and, perhaps, career goals. But beginning students lack technical sophistication and maturity. A capstone course attracts a more mature student population, and draws upon the student's other social science and humanities course work. While a capstone course cannot influence the undergraduate career, it might influence engineers on their first job. Our two-year experience does not permit a strong recommendation one way or another.

Faculty members in sociology and philosophy departments, and in the engineering college, design and teach our pilot course. Physicians, engineers, and attorneys—and other professionals who rely upon advanced technology—present "real world" dilemmas that involve human and technical dimensions. Volunteer professionals are easy to enlist, but tight sched-

We investigated the social and ethical aspects of nuclear power, whistle-blowing, product safety, genetic engineering, life support, and military technology.

ules sometimes necessitate videotaped presentations. These tapes are then available for class use and for wider training and dissemination. We intend to provide interested educators with a course syllabus and sample video tapes.

In our program, we have investigated the social and ethical aspects of nuclear power, whistleblowing, product safety, genetic engineering, life support, military technology, and information technology. But the chosen topics go beyond what the engineering student will likely encounter. Case studies from the medical field, for example, dramatically illustrate the social or ethical implications of the engineer or technologist's work. Few engineers may face situations with the immediate human impact that physicians confront, but engineers must appreciate the dilemmas and the responses their work generates.

Students from a v technical discipline—nursing, pre-med, business, and law—can benefit from this format. Faculty members can vary case studies to utilize available professional talent. But instructors should limit classes to the social and ethical impli of the field's technical . Otherwise, students lose focus.

Several features in our course integrate liberal and technical education. A typical course unit (4 to 5 classes) includes a technical presentation, discussion of the presentation's ethical, philosophical, and social implications, analysis by an outside professional, and an integrative discussion. Student participation is encouraged throughout the class unit. We administered brief pre- and posttests during some units to identify changes in student perception of social issues.

Each year, the course devotes less time to understanding technology and more time to social and ethical issues. This strategy permits tailoring the case studies to a faculty member's expertise or to an outside participant's availability.

The success of our project results from adherence to three principles:

- We assure ample technical content—a failing of traditional science, technology, and society courses—by including engineering faculty members and professionals from high tech industries, and by limiting enrollment exclusively to engineering, science, mathematics, or computer science majors. The background and orientation of the *students*—as well as the course content—provides the technical orientation.
- When practicing professionals transmit the "liberal education is useful" message, students listen. These professionals offer proof that social and ethical concerns continually interact with the technical aspects of their businesses. Students see before them the answer to the question, "Why do I have to study history and philosophy?"
- The UNC-Charlotte project successfully integrates the field specializations of the teaching team by focusing on topic areas and case studies. Engineering, philosophy, and sociology professors bring their own perspectives—rather than distinct historical, philosophical, or sociological material—to each issue. Instructor styles, interests, and commitments affect course outcomes. The "philosopher" must talk about value dimensions in real situations—not meta-ethical theories. The engineer must speculate on the sociological dimensions of technological invention and change.

Successful courses require adequate administrative and institutional support. UNC Charlotte erects few barriers between the liberal arts college and the professional schools. Older institutions may impose more hurdles. Professional schools administrators and faculty must make the initial overtures to the liberal arts division. Liberal arts administrators must recognize that cooperative efforts strengthen their division and the professional colleges.

Professional school administrators who understand the pressing need for liberally educated technical students must reward *all* participating faculty members. These rewards include: release time from normal duties or teaching assignments, opportunities for research and publication in a new area, and financial compensation. Liberal arts faculty members who teach large service loads may find that team teaching renews or expands their academic interests. Professional colleagues should use soft money to offer liberal arts faculty release time or extra financial rewards. Universities located near centers of high-tech industry, medical teaching and research, or business should approach these agencies for funds as well as speakers.

In a period of rapid technological change, decision-makers must anticipate the social and ethical implications of change. General education improves the student's ability to anticipate these implica-

Practicing professionals offer proof that social and ethical concerns continually interact with the technical aspects of their businesses.

tions, but the student must see utility in the experience. Integrative courses can convince the future engineer, physician, or entrepreneur that a general education affects "the bottom line." ■

Notes

[1] Association of American Colleges, *Integrity in the College Curriculum* (Washington, D.C.: Association of American Colleges, February, 1985).

[2] Joseph S. Johnston, Jr., Susan Shaman, and Robert Zemsky, *Unfinished Design: The Humanities and Social Sciences in Undergraduate Engineering Education,* (Washington, D.C.: Association of American Colleges, 1988).

[3] Ibid, p. 64.

[4] *The Chronicle of Higher Education* (March 4, 1987).

[5] Ibid.