PROFESSIONAL ETHICS AS AN ENGINEERING EDUCATIONAL OBLIGATION

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Summary:
Professional ethics is shown to be a proper subject for engineering education, indeed even an obligatory one. Using an operational definition of professional ethics, the concept, the need, and a means of implementing an educational program are developed and shown to be practical through an experimental course. Some strong conclusions concerning professional ethics within engineering education are recorded.

"Every art or applied science and every systematic investigation, and similarly every action and choice, seem to aim at some good."
Aristotle [1, p.3]

I. Introduction

Professional ethics is an essential ingredient of a free enterprise environment in which professionals interact, and the related professional ethical ideas, statements, and behavior are based upon important concepts that characterize them [2]. But even more important to the professional is the knowledge of the moral obligations and expected ethical conduct which binds a professional individually and collectively through professional institutions with the community and public at large. Few would deny that such knowledge is of great importance in the every day practice of the profession, for it more often than not is expected to guide all professional decisions with social content. Neither would there be many to contend that this type of knowledge, which involves the realization of ethical issues and the way they are to be met, is automatic and comes as a natural course of adulthood. Professional ethics then must be learned. But how? Can professional ethics be taught in a university setting? Is professional ethics a subject matter that should be included in the normal curriculum of undergraduate education? One of the outcomes of the student and social pressures upon university education in the 1970's is that the answers to these latter questions appear to be in the affirmative. We believe even more, that engineering educators have an obligation to so teach especially in the light of recent ethical problems faced by the profession.

Here we briefly discuss the rationale of these beliefs, outline an approach, and present the results of our experience to date, both at the University of Maryland and at a panel discussion undertaken at the Ninth Asilomar Conference.

II. Professional Ethics: The Concept and Need

The concept of professional ethics stems from ancient times with an active evolution in modern days. As appropriate and fitting to our times we take as a starting point of our presentation the following definition:

> Professional ethics is that body of moral philosophy and its practice reflected in professional canons and codes of ethics.

The ideas reflected in the codes show that they are motivated by a desire to preserve the integrity of the professions, and practicing individuals within them, by putting on record what is considered proper, as well as improper, behavior. Since these professions deal with specialized knowledge applied to the public and its welfare, there has been a clear need to assure the public it will be scrupulously treated. Professional ethics have evolved over the years to fill this need which is an important and vital one to all of us.

Professional codes have a rich history which could be traced to "The Laws of Eshnunna" [3, pp. 133-138], of Mesopotamia about 2000BC, this predating "The Code of Hammurabi" [3, pp. 138-167] by about 300 years, though "The Oath of Hippocrates" [4, p. 81], of Greece about 500BC, acts more as a model for modern codes. Modern codes abound in various fields; among those outside of engineering, and of interest to us here, are those of the American Medical Association [5], the American Bar association [6], and the National Education Association [7]. Within engineering most societies have their own codes of ethics with an interesting chronology beginning in 1912 [8, p. 59]; the two of most interest for our purposes are those of the National Society of Professional Engineers (NSPE) [9] [10], first discussed in 1935 and adopted in 1946, and the IEEE [11], adopted in late 1974, though that of the Engineers Council for Professional Development (ECPD) [12] is of importance. The more recent formulation of codes for subgroups should also be noted, as that of the IEEE Group on Engineering in Medicine and Biology [13].

Two events, one on each coast of the USA, have recently brought very much in the open that something is wrong, that in spite of engineering codes of ethics the public is not always properly treated. We refer to the situation behind the resignation of the Vice-President of the USA in Maryland [14] and the case of three engineers versus BART in California [15]. For their part in the former "kickback" situation, charges have been brought against twelve

Maryland engineers [16], while in the latter case a brief has been filed on behalf of the IEEE [17].

What is it that has gone wrong? We suggest that a primary root of the problems lies in the lack of proper education in the field of professional ethics.

III. Professional Ethics: Its Teaching

Since codes of ethics represent a body of knowledge and bodies of knowledge can be taught, it stands to reason that professional ethics, which the codes reflect, is a proper subject for education. Indeed in some societies codes of ethics are looked upon as instruments toward moral perfectibility of the members of the society [18]. If one believes in the moral adaptability of man, as we do, then professional ethics is a necessary part of education. But even if one does not so believe, the importance of the codes to the practitioner necessitates that a knowledge of the codes be acquired before practice is undertaken. As a practical matter, some states require examinations in ethics before legal practice in engineering can take place [19]. Consequently, our educational institutions are simply short-changing their graduating engineers if they are not teaching professional ethics.

The real question is then: how should professional ethics be taught?

Some would say that students should simply read what they feel important in an extra-curricular manner. We believe though that this is not the proper way for educators to proceed, even though it seems to have been the method used until recently at our own institution (which does not seem to be an exception). In this regard we believe colleges of engineering, primarily through their chief administrators as prime movers, have not been doing their job.

Simply because professional ethics is so basic to engineering, we submit that it ought to be an integrated portion of the curriculum beginning with the freshman year. Just as mathematics is used to develop design theories, so should ethics be used to develop the professional outlook. In beginning courses we would suggest that problems be introduced and developed with ethical content as part and parcel of the technical courses already on the books.

We would culminate a student's studies by requiring a single-unit course which approaches professional ethics with an applied and design philosophy. A realization of the importance of the field would be placed before the students by having heavy participation by outside professional practitioners whose every day job assignments places them in the realm of professional ethics. In order to emphasize the dynamic nature of the field we would have the students create and study ethical cases, go through the formulation and application of codes, and comparatively study ethical relationships among different professional societies, etc.. It seems to us vital that such a course be organized and run by engineers within the profession, by the same rules of logic that those of us in electrical engineering have found it important that electromagnetic theory be taught in-house.

IV. Professional Ethics: Our Course Experinent

The practicality of such a culminating course has been demonstrated for us by an experiment we ran during the Fall 1975 semester at the University of Maryland by giving the one semester hour course ENEE 418H, "Ethics for Engineering and Scientific Practice." Here we discuss some of the aspects of this course.

First we point out that we feel a course of this type must contain the following essential ingredients (even if only for one credit):

1. A conceptual basis for and the intellectual content of professional ethics (including historical background).
2. The role of professional codes of ethics in a profession (including their formulation and practical application).
3. A comparative study of professional codes (including those outside of engineering).
4. A study of professional ethics cases as reviewed by professional practice organizations (including board of review rulings).
5. Readings in the professional ethics literature.
6. Homework in applied professional ethics (including analytic and synthetic problems).

The program actually undertaken to carry this out can be discerned by referring to Table I, where the topical time schedule of the course is given along with the speakers who led the discussions. With reference to the six ingredient items listed above one can see that item #1 was primarily covered at weeks 9 and 10 by one of us; besides [8] as a reference for engineering ethics material, a good reference used for the historical basis was [20]. Item #2 was primarily covered at weeks 2, 3, 6 and 12, while weeks 5, 7 and 8 basically covered item #3; of particular note to the class here were the strength of the legal code [6] and the development of the NSPE code through case studies [21]. The importance of item #4 to the practicing engineer, an emphasis we judge of utmost significance to the success of the course, was brought out as early as feasible at weeks 4 and 6. Indeed at the fourth week recent and upcoming cases before the NSPE Board of Ethical Review were argued with the class and led to the students design of their own cases for presentation to such review at periods 13 and 14. These latter cases, given in Appendix 2, allowed for active participation by the students in professional ethical processes, thus incorporating items #5 and #6. Prior to these case designs, the students worked the exercises of Appendix 1 which were discussed at weeks 7 and 11. In all of these situations the readings referred to in item #5 above were chosen by the students, from material handed out or placed on library reserve, as fit their needs for the ethical situations involved.

Particularly we planned the involvement as lecturers or guests local professionals whose responsibilities routinely involve them with the practice of professional ethics. It is hard for us to overstate the importance this type of contact proved for our students, but a check of Table I will show that seven of the fifteen class periods were devoted to such. In this regard it also seems important to have an official of the local Society of Professsional Engineers. For us this was accomplished through the presence of Mr. H. Lehneis, the President of the Maryland Society of Engineers during the Vice-Presidential resignation, who among other items of interest discussed the recent Maryland law concerning professional ethics [22]. Of

particular note is the extreme eagerness with which almost all of our guests entered into the activity.

It could be argued that one semester hour is too little to devote to such an important activity. However, in this case no more time was available since reluctance from a small number of Electrical Engineering faculty made it necessary for the instructors to donate their time over and above normal duties for the course which was only allowed as a free elective for the students. Two students, though, did take the option of preparing an outside paper for an extra hour of credit. Although the students did find they were limited as to the academic use they could make of the course credit, they almost to a man emphasized its value to them even registering with us their feelings on the need for requiring such a course within the currixulum.

As in all educational undertakings, there are differences in philosophy as to how to proceed. Thus, between us we have not agreement as to the preferred order of presentation of the six ingredients listed above. For example, one of us (ND) prefers an ordering following the numbering of the items, this giving a logically structured sequence. The other of us (RWN) prefers an order closer to that actually given, of Table I, since this presents a motivation and a need for theory and history prior to their actual presentation. In any event we believe either are possible and could succeed; any actual offering must of course accommodate the availability of guests.

V. Professional Ethics: A Panel Discussion

In order to make contributions to a field and enrich the educational objectives one does not just teach a course but gets involved in other related activities. For this interactions with others who have thought, and those who may wish to think, about the problems of the field are incalculably valuable. Consequently, in parallel with the course we organized a panel discussion [23], in order to obtain a feeling for a broader outlook, at a national meeting, the Ninth Asilomar Conference on Circuits, Systems, and Computers. Table II gives the schedule and outlines the content for this panel. From the Table it can be seen, as purposely planned, that this involved, besides one of us, an engineering (ex) dean, a lawyer involved in the formation of business codes, and a practicing professional engineer associated with one of the publicized professional ethics cases.

If anything the discussion indicated that when rationally faced there is seen to be a more serious need than even we had previously realized for education in professional ethics. Faculties have not previously seen clearly focused needs nor had clearly defined paths to follow. Practitioners have pressing needs of protection when placed in unethical situations, especially since supervisory engineers are normally led to place their loyalties in management rather than the profession when conflict arises. There is thus a need to educate management of the professional ethics responsibilities of engineers. Too, the differences between incompetent mistakes and unethical practices, as well as means of protection for engineers placed by others in unethical situations, need further study.

VI. Conclusions

Based upon our investigations and experience reported here we have arrived at a number of conclusions which we classify into three main groups.

A. Concerning the Subject

1. Professional ethics has received unduly minimal emphasis within the undergraduate engineering curriculum.
2. The subject matter is of great importance to the practicing engineer, ranking high on their lists of priorities [24].
3. Professional ethics contains considerable intellectual content and there is sufficient specialized knowledge to teach.
4. The subject matter can be organized and presented in a stimulating manner. It is a challenge to the intellect of both students and instructors and can be dealt with in depth. It offers numerous opportunities for analytic and synthetic homework exercises.
5. Professional ethics can be interwoven with the technical knowledge of the engineering student and enriches the professional outlook and capabilities after graduation.
6. Professional ethics is amenable to being taught by engineering faculty who should have an obligation to do so. Many scholarly activities can be developed which encompass professional ethics.

B. Concerning the Students

1. Our students appreciated their lack of knowledge in what they came to consider as an important area.
2. The students were attentive and had a sympathetic response. Even if the course were not elective they felt their response would be about the same.
3. Prior to taking the course most students were vaguely aware that they have professional ethical obligations upon graduation. They were unaware of how to find out what these obligations are, how they are encountered, and from where they could receive guidance as to how to face professional ethical problems.
4. Some students found the course of considerable assistance in preparation for professional registration.
5. On finishing the course our students were emphatic on their feelings that the course should be required of all engineers; they even felt all students in the Division of Mathematics, Physical Sciences and Engineering should have such a course.

C. Concerning the Faculty

1. One of the greatest needs that we see in US universities today is that of education of the faculty (and administration) in the area of professional ethics. Without faculty knowledge and interest in the area, a pressing need of the engineering profession will go unattended.
2. A threshold of faculty interest is needed, and this threshold can properly consciously be met by strong administrative stimulation. We find this stimulation lacking and in our case even negative.
3. In order to have quality education in the field some engineering faculty should be recruited with particular reference to their expertise in professional ethics.
4. There are available various assistances to faculty wishing to do research in the area [25],

and the opportunities for creative activities seem only limited by the innovative capabilities of the individual.

Finally we might conclude that, as with other things, variety might be the spice of professional ethics education; certainly the field offers variety. With Aristotle, we believe that education in this field "is a matter of real importance. It would be nearer to the truth to say that it makes a very great difference indeed, in fact all the difference in the world." [26, p. 56]

Acknowledgments. We take this opportunity to thank all those who have contributed to our ideas, particularly our students and participants in our course and the Asilomar Panel Discussion on the subject; too, those who by their opposing ideas have forced us to solidify and strengthen our ideas are acknowledged.

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Appendix 1. Exercises

EMEE 418H "Ethics for Engineering and Scientific Practice" Exercises in Applied Ethics for Professional and Scientific Practice MD/RWW 10/14/75

Motivation: These exercises afford the student an opportunity to review the ethical concepts discussed in class and illustrated by representatives of working professional organizations and to apply them in possible new situations which he can foresee.

References:
a) Reading material and Code handouts
b) Library reserve book references
c) Consultation with the instructors
d) Consultation with the experienced professionals participating in this course whose normal duties involve the handling of professional ethical assignments.

Exercises:

1. Formulate the essential concepts that constitute the realm of professional ethics. Differentiate these with regard to "scientific ethics" where differences may occur.

2. What is the role of the code of ethics in a profession as an embodiment of these essential concepts? Give
A) an identification of these concepts with reference to the codes distributed in class (eg. particular articles)
B) an identification of which of these concepts are missing from the various codes.

3. Three professional engineering ethics cases were presented by one of the speakers, involving ethical issues considered within the borderlines of code articles. Identify in each case the essential ethical concepts (as determined above) involved.

4. Conflict between ethical articles and the individual's professional benefit is a major source of questionable professional conduct. From the cases brought before the class by the speakers identify such a situation.

5. Place a professional in situations in which such a conflict of the types of Exercise 4 might

develop, roughly two per student each of the following:

A) The professional makes a design and also makes a recommendation to his supervisor for the purchase of hardware for the design.
B) The professional acts as the acceptor of hardware and at the same time is responsible for the performance of the people specifying the hardware.
C) The professional acts as the supervisor of hardware purchasers and of personnel recruiters.
D) The professional acts in an advisory capacity to recruit and screen applicants to fill an important supervisory position within his firm, and at the same time he promotes his own qualifications.

Elaborate how he would create or avoid unethical situations in each of these cases.

Appendix 2, Student Designed Case Studies Prepared by the ENEE 418H Class on December 2, 1975.

Ethics Case I

Situation:

Engineer Floyd is assigned to a task force to develop a job description and qualifications for a supervisory engineering position, and to select those who qualify. The task force interviews several candidates, eliminating some and advising them that they are no longer under consideration. It becomes apparent to some task force members that there was not the quality applicants for the job expected. These members approach Floyd to resign from the task force so that he himself may be considered for the position in question, "in the interest of the company."

Questions:

1. Is it ethical for Floyd to resign and present himself as a late candidate?

2. Is it ethical for the task force (of engineers) to consider Floyd?

References: NSPE Code of Ethics, Sections 1g, 7a, 8a, 11a.

Ethics Case II

Situation:

Home Company purchases vacuum tube motor controllers from Vend Company. Mr. Maker, a sales engineer for Vend Company, has recently been transferred from the design division where he was the designer of these controllers. At a sales meeting Mr. Maker reveals to Mr. Buyer, a design engineer and personnel recruiter for Home Company, that he is unhappy in sales and that the motor controllers can be manufactured more cheaply and efficiently using solid state components instead of vacuum tubes. Mr. Buyer thinks about what he has heard and considers hiring Mr. Maker. After some thought Mr. Buyer decides to do nothing because solid state advantages are common knowledge and because he knows of a personal conflict between a member of the Board of Directors of Home Company and Mr. Maker.

Question:

Are either Mr. Maker or Mr. Buyer acting ethically?

References: NSPE Code of Ethics, Sections 1, 1g, 7, 7a, 9e, 11.

Table I
ENEE 418H Schedule
Fall 1975

Week	Topic	Speaker
1	Organization; Discussion on purpose of course; Ethics in general & in a profession	Instructors
2	Professional codes	R. Newcomb, P.E.
3	NSPE Code, formulation and meaning	M. Lunch (NSPE)
4	NSPE ethics case problems	M. Lunch (NSPE)
5	Business ethics	L. Stich (IBM)
6	Professional engineering ethics in Maryland- the Vice-Presidential case	H. Lehneis, P.E. (MSPE)
7	Further professional codes; Analytic ethic exercises	Instructors
8	Legal codes of ethics	R. Willoner (DPW&K Prof. Assoc.)
9	Historic review of professional ethics	N. DeClaris
10	Professional ethics theories to modern times	N. DeClaris
11	Analytic ethic exercises (results and discussion)	Instructors
12	Biomedical engineering ethics	G. Webb (J. Hopkins)
13	Ethics case synthesis - formulation	Instructors
14	Ethics case synthesis - finalization	Instructors
15	Ethics in engineering education and accreditation	Dean R. Beckmann (cancelled due to illness)

Table II
Panel Discussion
Professional Ethics: An Engineering Socio-Economic Concern
Asilomar
Monday, November 3, 1975
8:00-10:30 pm, Session M12 - Acacia

Participants	Time	Specific Points of Discussion
Professor Robert W. Newcomb, P.E. Electrical Engineering Department University of Maryland College Park, Maryland 20742	8:05-8:30	Lead-Off Paper: "Professional Ethics: An Engineering Socio-Economic Concern" (authored by R. Newcomb & N. DeClaris). (codes, their need, relevance & formulation, cases)
	Discussion	
Professor William W. Happ Electrical Engineering Department California State University Sacramento, California	8:30-8:50	Engineering Ethics: An Engineering Dean's -eye view.
Mr. Malcolm A. Head Counsel for General Products Division IBM San Jose, California	8:50-9:10	Business Ethics: Formulation, significance, a Lawyer's - eye view
	Break	
Mr. Gilbert A. Verdugo, P.E. 3190 Old Tunnel Road Lafayette, California 94549	9:20-9:40	Professional Ethics: The BART situation, a Practicing Engineer's - eye view
Moderator: R. Newcomb	9:40-10:30	Panel Discussion

Professor Robert W. Newcomb was born in Glendale, California, June 27, 1933, and received the degrees BSEE, Purdue 1955, MS, Stanford 1957, and Ph.D., University of California, Berkeley, 1960. He has been on the professorial faculties at Stanford and, presently, at the University of Maryland, as well as at Louvain University, Belgium (1967-68). During 1963-64 he was a Fulbright research scholar to Australia and in 1976 a Fulbright-Hays scholar for curriculum development to Universiti Teknologi Malaysia. He has taught most topics in electrical engineering and has assisted in introducing the University of Maryland Microwave-Circuits Laboratory as well as courses on professional ethics and ties between art and engineering. His major fields of reseach cover networks and systems theory in which he is the author of four books and the supervisor of research throughout the world under the "Microsystems and Generalized Networks Program" which he directs. He is a registered Professional Engineer and the founder of the Z. Aziz Fellowship.

Professor N. DeClaris, received his undergraduate degree at Texas A&M and the doctorate from M. I. T. His academic experience includes a dozen years in the faculty of Cornell University (with the ranks of Assistant, Associate and Full Professors) and seven years as Head and Chairman of the E. E. Dept. at the Univ. of Maryland. His current academic interest emphasize research, teaching and lecturing on several diverse aspects of System Theory and its Application. While at Cornell he established and directed the Systems Research Laboratory, one of the first of its kind. At the Univ. of Maryland, under his administrative leadership the E. E. Dept. underwent remarkable growth and transformation. His professional experience includes services, as a Consultant to G. E., I. B. M. and others and as an advisor to several U. S. and European government and research agencies. A Fellow of the IEEE (for his contributions to Network Synthesis System Theory and Electrical Eng. Education, he is listed in the Who's Who in America.