

AC 2007-2164: INTRODUCING SAFETY AND HEALTH ISSUES INTO AN ENGINEERING TECHNOLOGY CURRICULUM

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INTRODUCING SAFETY AND HEALTH ISSUES INTO AN ENGINEERING TECHNOLOGY CURRICULUM

Abstract

Engineers and Engineering Technologists have played major roles in many of the technological advancements that have benefited humanity. While many of the technological advancements in recent decades have been of tremendous benefit, some have created new forms of hazards for the safety and health of mankind. As a result, safety and health issues have played a key role in many fields of engineering and engineering technology. This is especially true in the Biomedical Engineering field whose growth rate has outpaced other traditional engineering disciplines in recent years. In the health care industry, patient safety and health issues lead to many injuries and death with resulting litigation every year. Even though the importance of health and safety considerations is well established for many fields of engineering, it is not taught as an integral part of most engineering or engineering technology curricula, and is not tested as part of the Fundamentals of Engineering (FE) or Professional Engineering (PE) licensing exams¹. The recognized importance of safety and health in engineering, however, has led to the development of relatively new degrees in Safety Engineering. The Electrical Engineering Technology (EET) program at Southern Polytechnic State University (SPSU) has recently instituted an option in Biomedical Engineering Technology (BMET). Recognizing the inherent hazards to health and safety in the medical environment, a required course in Health Care Safety was included in the curriculum. This course was intended to focus predominantly on the health care environment, but it was quickly realized that the course could be used as a vehicle for introducing many of the issues related to safety and health that are generic to many engineering disciplines. This paper discusses the rationale, considerations, and development of the Health Care Safety course.

I. Introduction

Numerous technological advancements over the last couple of decades have tremendously benefited humanity. Engineers and Engineering Technologists have played major roles in many of these technological advancements. However, while many of the technological advancements in recent decades have been of tremendous benefit, some have created new forms of hazards for the safety and health of mankind. As an example, nuclear energy has provided the potential for a cheap, clean source of electrical energy. However, the waste byproducts from nuclear power plants and the possibility of nuclear explosions provide sources of hazard to the safety and health of humans. As another example, the use of Magnetic Resonance Imaging (MRI) in medicine has considerably improved the accuracy of medical diagnosis. Though these machines are invaluable for medical diagnosis, they pose serious hazards for patients with metal implants or implanted pace-makers.

As a result of concerns related to some of these new technologies, safety and health issues now play a key role in many fields of Engineering and Engineering Technology. This is especially

true in the Biomedical Engineering field whose growth rate has outpaced other traditional engineering disciplines in recent years ². In the health care industry, patient safety and health issues lead to many injuries and death with resulting litigation every year. Unfortunately, even though the importance of health and safety considerations is well established for many fields of engineering, it is not taught as an integral part of most engineering or engineering technology curricula, and is not tested as part of the Fundamentals of Engineering (FE) or Professional Engineering (PE) licensing exams ^{1, 3, 4} (see Table 1.). In most engineering registration examinations, very few questions actually deal with safety and health. Many Engineering and Engineering Technology programs only include safety and health topics as part of their capstone design courses, not as a separate course. The importance of safety and health in engineering has been recognized by the National Council of Examiners in Engineering and Surveying (NCEES) which conducted a survey of practicing engineers to gather information on their job functions. Representatives from engineering societies at the National Congress on Engineering Education in 1986, passed resolutions regarding educational requirements for engineers which included recommendations that training in safety and health be strengthened and that design constraints such as safety, are essential in engineering courses ^{1, 5, 6}. This recognition of the importance of safety and health in engineering has led to the development of relatively new degrees in Safety Engineering. These degrees tend to be multi-disciplinary in nature.

In developing the new EET degree option in Biomedical Engineering Technology at Southern Polytechnic State University, it was decided to include a safety course as an essential requirement for the degree.

Table 1. FE Exam Standards ^{3,4}

<ul style="list-style-type: none"> • The topics for the morning exam: <ul style="list-style-type: none"> 15% - Mathematics 10% - Engineering Mechanics (Statics & Dynamics) 9% - Electricity & Magnetism 9% - Chemistry 8% - Engineering Economics 7% - Engineering Probability & Statistics 7% - Fluid Mechanics 7% - Material Properties 7% - Strength of Materials 7% - Computers 7% - Ethics and Business Practices 7% - Thermodynamics • During the afternoon exam, examinees can opt to take either a general exam or one of six discipline-specific exams: chemical, civil, electrical, environmental, industrial, or mechanical engineering.

II. The BMET Option in EET

The Electrical Engineering Technology (EET) program at Southern Polytechnic State University (SPSU) recently instituted an option in Biomedical Engineering Technology (BMET)^{7, 8}. The curriculum for the option is shown in Table 2.

Table 2. ECET courses in the BSBMET degree program option.

Course Name	Semester Number	Weekly Lecture Hrs	Weekly Lab Hrs	Credit Hours
Orientation	1	2	0	2
Fundamentals	1	2	3	3
Circuits I	2	3	3	4
Digital I	2	3	3	4
Circuits II	3	3	3	4
Electronics I	3	3	3	4
Introduction to Biomedical ET*	4	3	0	3
Digital II	4	3	3	4
Electronics II	4	3	3	4
Data Communications	5	3	3	4
Test Engineering	5	3	3	4
Applications of C++, JAVA and HTML	5	2	3	3
Health Care Safety*	5	3	0	3
High Frequency Systems	6	3	3	4
Embedded PCs	6	3	3	4
Biomedical Instrumentation*	7	3	3	4
BMET Elective (ECET)	7	3	3	4
BMET Elective*	8	3	3	4
BMET Capstone Project/Internship*	8	3	3	4

The curriculum adds five new technical courses to a core of ECET, mathematics, English, science, and social science courses. The program is structured within the 130 credit-hour limit set by the Georgia Board of Regents. Eighteen (18) hours are allocated to Biomedical Engineering Technology specific courses created for the program (indicated by asterisks); Fifty-two (52) hours constitute a core of ECET technical courses; Sixty (60) hours are for the mathematics, science, English, and social science core.

The BMET option has been structured so as to retain the main core of the EET program. The EET curriculum was recently revised with input from the Industrial Advisory Board⁹ (IAB) to allow the ECET students more flexibility in designing their curriculum. This has allowed for the proposed BMET option to be easily accommodated within the EET program.

III. Health Care Safety Course

Recognizing the inherent hazards to health and safety in the medical environment, a required course in Health Care Safety was included in the curriculum for the BMET option. This course was intended to focus predominantly on safety and health considerations in the health care environment. The catalog description for the course is as follows:

A discussion of the safety considerations and practices employed in health care facilities. This course emphasizes the examination, study, and review of safety codes and procedures within the health care field. Topics include: JCAHO, BRH, CAP, OSHA, NFPA, and AAMI codes; first aid and CPR; electrical, fire, and radiation safety; infectious control; and hazardous communications

The primary objective was to review the risks and hazards posed by biomedical instrumentation in health care facilities. In developing the course content it was quickly realized that the course could be used as a vehicle for introducing many of the topics related to safety and health that are generic to many engineering disciplines. It was deemed important for the students to get an understanding of the laws, regulations, standards, and licensing issues associated with safety and health. This includes knowledge of regulatory agencies and licensing bodies as well as the inter-relationships between the many disciplines involved in safety and health issues. Since the hazards of medical instrumentation were being considered, an understanding of product liability issues and related worker compensation issues were also deemed important. The importance of record keeping needed to be emphasized as much as possible.

The first iteration of this course was taught during the fall semester 2006. Table 3 shows the topics included in this initial rendition and the approximate amount of lecture hours spent on each topic. Even though the course material encompassed a broad discussion of issues related to safety and health, the discussion included numerous examples and case studies taken from the health care industry. This allowed the course to stay true to its initial objectives while at the same time introducing students to general topics related to safety and health. Health care specific topics included Electrical Hazards and Safety, Fire Hazards and Safety, Radiation Hazards and Safety, Infectious Control Safety, and Hazardous Communications Rules and Regulations. In addition, First Aid and CPR were discussed, especially as related to electrical shock hazards. Safety Management and Electrical Equipment Maintenance rounded off the list of topics covered.

Table 3. Health Care Safety Course Topics

TOPICS	LECTURE HOURS
Introduction/Health Care Environment	1
Safety and Health for Engineers and Technologists	2
Safety and Health Professions	2
Concepts and Terms	2
Laws, Regulations and Standards	4
Product Liability	3
Record Keeping and Reporting	3
Electrical Hazards and Safety	4
Electrical Safety of Medical equipment	3
Fire Hazards and Safety in Health Care Facilities	3
Radiation Hazards and Safety	3
Infectious Control Safety	3
Hazardous Communications Rules and Regulations	2
First Aid and CPR	2
Safety Management	3
Medical Equipment Maintenance	2

IV. Initial Course Feedback and Current Status

The initial course offering was well received by the students and the majority of them expressed a deeper appreciation of the issues related to safety and health issues in engineering in general, and Biomedical Engineering Technology in particular. As part of their required course evaluations, the students were requested to provide written comments about the course content, how it could be improved, and the suitability of the course as an elective for other majors in the department. The latter request was solicited because the department has received numerous enquiries from students as to the suitability of the Health Care and Safety course as an elective within their disciplines. Some student's comments indicated that the course could be useful to all disciplines within the ECET department and not just those who wish to specialize in BMET.

The students also expressed an appreciation of the emphasis on the interrelatedness and cooperation required among many disciplines, engineering as well as non-engineering, involved in safety and health. It helped them to have a greater understanding of the role of Engineers and Engineering Technologists in our modern society.

Based on initial feedback, the course is undergoing some revision to improve the quality of the content and to provide greater emphasis on topics more closely related to Biomedical Engineering Technology.

V. Conclusion

Engineers and Engineering Technologists will continue to play major roles in developing new technologies to benefit and improve the quality of life for humans. Unfortunately, as history has shown, some of these new technologies will result in the creation of new forms of hazards for the safety and health of mankind. It will therefore be prudent for the Engineers and Engineering Technologist to be trained in issues related to human safety and health. Safety and health education should become an integral part of all Engineering/Engineering Technology programs in the same manner that Ethics education has become integrated into many such programs.

The Health Care Safety course offered by the ECET department at SPSU will continue to undergo improvement to the course content. Based on the initial feedback from the students, it is anticipated that an elective course in Safety and Health for Engineers/Engineering Technologists will be developed in the near future. This course will be offered to all majors (EET, CpET, and TCET) within the ECET department. It is expected that the broad scope of this proposed course will make it attractive to other majors in CET, MET, IET, and Systems Engineering and perhaps even CS, CE or IT majors. For this course, the case studies and examples chosen will be closely tailored to the disciplines of the students enrolled in the course. This will be well in line with the recommendations adopted by the National Congress on Engineering Education in 1986, and address the issues raised in the NCEES survey findings.

References

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- [3] URL: <http://www.ncees.org>
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http://www.kaplanaecengineering.com/kaplanAECEngineering/menu_id%601199%60misc.aspx
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- [6] ABET Inc. Web Page: <http://www.abet.org>
- [7] URL: <http://ecet.spsu.edu/home/Programs/Programs.php>
- [8] Austin B. Asgill, "Curriculum Development for an EET Degree Option in Biomedical Engineering Technology," ASEE annual conference, Chicago, IL, June 2006.
- [9] URL: <http://ecet.spsu.edu/home/Advisory-Board/Advisory-Board.php>