

General Engineering Education for Non-Engineering Students

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Abstract

This paper addresses the issue of general engineering education, specifically for non-engineering students. General engineering education involves defining technology and the role it plays in society, developing problem solving skills, and introducing students to a sequential design process that instills in the students the ability to question a process or procedure. It is intended to relieve the students' fears of using new technologies, and instill confidence in their ability to adapt in an emerging highly technological society. This paper further describes the first attempts made at LSSU with an innovative course called Exploring Technology (ET 100) that endeavors to address some of these issues.

Introduction

No matter where one turns today, technology has left its mark and changed the way people think, interact, and work. Because of this, every individual must utilize new technologies in some aspect of their day-to-day activities. Typically, engineers and scientists are directly involved with the creation of new technologies, and other individuals must utilize the final products. Unfortunately, the general public is usually not well informed as to the proper application of these new technologies, the processes involved in developing these technologies, or the existence of alternative solutions to their problems.

Students who are not engineering majors can benefit from an exposure to engineering design processes and problem-solving methods. Non-engineering students will be affected by engineering decisions, and should have an understanding of the decision making methods.

This paper will further discuss the need to expose non-engineering students to modern engineering and technology, present general considerations for such courses, and then present an example of one course that has been offered at Lake Superior State University.

Rationale Behind General Engineering Education

This section endeavors to define the idea behind general engineering education for all students so that they can adapt to the changing technological society of today and tomorrow. Society, as we know it, is changing rapidly, and a familiarity with new technology is no longer a luxury, but a necessity. Engineering students are able to keep abreast of the changes in technology, but non-engineering students may find themselves lost in newly emerging technologies such as computers, the Internet, etc. This is also a part of the renewed interest in general education today, and it has arisen from a public concern about the quality of education. This has occurred at a time when nations across the world are shifting their focus from global military and space competition to global economic and industrial competition. In response, many schools and universities are re-thinking their general education requirements, and are beginning to emphasize technical education for all students.

General engineering education is defined as an introduction to technology, the role it plays within society, problem solving skills, and an introduction to a sequential design process. It is intended to relieve the fears of using new technologies, and instill confidence in their ability to adapt in an emerging highly technological society. It is also intended to instill in the students the ability to question a process or procedure. It is not intended to teach students specific topics in engineering such as circuits, finite element analysis or design of robots, but give them an introduction to computers, engineering ethics, and a basic survey of the different fields. The outcome of such a course should be that students should gain confidence in using computers, other modern equipment, and tools such as the Internet. Innovative problem solving techniques and sequential design processes should be part of their arsenal when they approach any problem. Communication skills and team work should become second nature to them.

The Strategy

General engineering education for non-engineering students is a challenge, and should not be taken lightly. This responsibility naturally falls on the shoulders of engineering faculty, and in fact, has been encouraged by the recent ASEE project report, *Engineering Education for a Changing World*.^[1] This report encourages engineering faculty to become more effective and visible partners within the university community, and specifically mentions the creation of engineering courses that are designed for non-majors.

When faculty develop courses for non-majors, they need to carefully consider both the desired outcomes of the course and the needs of the intended audience. The course should be structured so as to be consistent with the mathematics background of the students, but yet it should present engineering design processes and problem solving methods. The course should be such that it ties lectures and laboratory work so as to give the students some type of tangible outcomes that they can see and feel.

An example course topic is leading the students through the design-analysis-fabrication-test procedure for a mechanical component that shows them the sequence of events that lead to a successful component design. Students can start with an AutoCAD drawing of a component, then use finite element analysis to figure out the stresses in the component under loading conditions (they do not have to know FEA, but can be given the code that works), then fabricate it on a CNC machine (again, they can be given the code that works), then attach strain gauges on the part and measure stresses, and see if they match the previously obtained FEA results. This whole process to be done by non-engineering students demands a leap of faith from the traditional teaching methods in engineering. Design, manufacturing and analysis tools such as FEA, CNC machines, and strain gauges are usually used by junior and senior level engineering students who write their own code, and understand exactly what is happening. Non-engineering students going through the above process may seem strange, but if they do go through it, and can make the connection between the original drawing and the final component, and the FEA results and the strain gauge results, then they have achieved a lot. They have seen with their own eyes that drawings are the starting point that culminate in a finished product, and in between there is a sequence of events that guide the engineer. The whole process has tangible outcomes at every step that can fascinate the students, and increase their understanding of intangible outcomes such as design processes, problem solving techniques,

communication skills, and team work. If done well teaching techniques such as team teaching, collaborative learning, and group projects can lead to a highly successful general engineering course for non-engineering students.

A Pilot Course Offered At LSSU

The School of Engineering and Mathematics at LSSU has developed a new course called Exploring Technology (ET 100), that is one of the first attempts to offer general engineering education to non-engineering students.^[2] This course was developed by a course and curriculum development grant from the National Science Foundation, and was approved as a general education natural science elective at LSSU.^[3] Both engineering and non-engineering students can take the course. Engineering students take the course as a free elective, and non-majors can take it as a general education elective. It has already been offered three times with great success. This section describes this unique course, as well as the unique way it is taught.

ET100 Exploring Technology

The Exploring Technology course is a four credit hour course with three lecture periods and a laboratory each week. The course is structured as fourteen modules, one for each week. The only prerequisite for the course is a high school algebra course or meeting the university's mathematics competency requirement. The instructor for each module provides the students with all the information the students need for the module, so the students do not purchase a textbook.

The course is taught by a team of six faculty members, where each faculty member covers modules within their specialty.^[4] One faculty member serves as the course coordinator, and handles scheduling and grade assignments. The students complete quizzes and laboratory exercises for the module instructor, and also maintain a weekly journal that is reviewed by the course coordinator.

All of the weekly modules contain laboratory exercises which are structured to allow the student to experience the engineering process. Although the students do not have a technical background, they can be led through the laboratory process where they can record observations and make conclusions.

The first module serves to introduce students to the general fields of engineering and technology, and includes exercises to allow the students to get to know

each other and the course instructors. The second module covers computer literacy because computers are used throughout the course. The remaining twelve weeks are equally divided among the electrical, mechanical, and manufacturing areas.

During the four weeks in the mechanical area, the students are introduced to AutoCAD, computer analysis methods, computer-based manufacturing, and materials testing. They solve problems dealing with forces, and experience the engineering design process of drawing, analyzing, machining, and testing a metal part.

The four weeks in the electronics are used to cover electricity, analog and digital electronics, and introduce microcontrollers. The students solve electricity problems, test electronic circuits, and program a microcontroller.

The final four weeks are dedicated to automated manufacturing. The students investigate and program different types of robots, and participate in the development of an automated assembly process. There are discussions on the sociological aspects of automation and modern technology.

Within each module, collaborative learning techniques are utilized, and the students are encouraged to interact with engineering faculty members as well as senior engineering students who act as teaching assistants. This allows the students to understand the decision-making processes followed by engineers and scientists in the design and manufacture of products. Further, it helps to develop communication skills, both oral and written, that are so necessary in today's work environment.

Excellent student response to the course was evident by the students excellent attendance, enthusiasm, and interaction with each other. A review of the assessment instruments indicates that the students enjoyed the course content, active-learning structure, and team teaching method. The students appreciated the opportunity to learn engineering concepts in a non-threatening, small group environment.

Conclusions And Recommendations

This paper has described the need for general engineering education for all students based on the emerging highly technology-based society of today and tomorrow. Engineering students get the flavor of the changes in technology in their curriculum, but the non-engineering students need specially developed courses that take their backgrounds in to account. Hence it is the responsibility of engineering faculty to develop such courses with the intended audience and desired course outcomes in mind. Some of the outcomes worth keeping

in mind are that non-engineering students who have taken such a course will have confidence in using computers and other modern equipment, have problem solving and communication skills, and understand the role of technology in society. A course that attempts to address these issues has been presented in this paper. This course, called Exploring Technology, has been a great success at LSSU, and has been a guiding light for students and faculty who have been associated with it.

Acknowledgments

Lake Superior State University recognizes and appreciates the support of a Course and Curriculum Development Grant, DUE 9354822, from the National Science Foundation. This grant supported the development of the new course, ET100 Exploring Technology: A Survey of Modern Technology for Majors and Non-Majors.

Faculty at Lake Superior State University who have been involved in the development and/or teaching of the Exploring Technology course include: Ray Adams (Mechanical Analysis and Testing), Lawrence Bolio (AutoCAD), James Devaprasad (CAM, Robotics, and Automation), Ajay Mahajan (Robotics and Engineering Ethics), David McDonald (Electronics), Alan Niemi (Computers and Microcontrollers), and Maurice Walworth (Robotics and Automation).

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