Undergraduate Design and Research Experience at UW-Platteville

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Introduction

Although there have been many different approaches and program mixes, the main focus in undergraduate engineering education still is to provide an education and training in engineering principles and design. It is constantly changing to meet the changing needs of students. These changes are prompted by industry demands, advances in technology, and availability of powerful and affordable tools and equipment. Involvement of undergraduate engineering students of different levels in research projects with different levels of guidance from faculty or engineers from industry has been found to have positive outcomes.

At the University of Wisconsin-Platteville, several initiatives have been undertaken to expose undergraduate engineering students to engineering design. Apart from the conventional upper level engineering design courses and senior capstone design courses, the most recent initiative has been the introduction of design at the freshman level in the Introduction to Engineering course required for all incoming freshmen. Another undergraduate research program - Pioneer Undergraduate Research Fellowship (PURF) initiated about a half dozen years ago at the University of Wisconsin-Platteville has been instrumental in providing first hand research experience to undergraduate students. What follows is an account of this program which has produced a good number of graduate students or research and development engineers for industry, and a brief description of the freshman design experience.

The PURF Program

The purpose of the Pioneer Undergraduate Research Fellowship Program is to encourage undergraduate students to participate in research or other creative projects under the direction of a faculty member. It is hoped that this opportunity will stimulate an interest in pursuing graduate work in the area of the students' research or creative activity. Five fellowships are awarded annually. Undergraduate students with at least Junior standing with a minimum core GPA requirement are eligible to compete. Students have to be enrolled during the academic year and group projects are not allowed. Applications are processed and awards are announced during the months March-April every year. Recipients are expected to develop a report or paper on the results of their activities. Each fellow is required to present the results of his/her efforts at a luncheon during the spring of the following year. Recipients are encouraged to present their work at national or regional meetings.

A list of interesting projects funded by PURF over the past couple of years are as follows:

- A study of fan performance using two different methods of air flow control.
- Reduction of friction in an artificial knee replacement.
- Design of a locating device for a relief grinding operation.
- Chaotic attractor evolution of a dripping faucet.
- Finite element stress analysis of structural elements.
- Extraction shampooer brush design for maximum cleaning efficiency.
- Redesign of latch in pickup truck tops for improved security.

The students involved in the program not only get opportunities to work on design or research, but with an increased amount of flexibility and independence. In addition, the direct one on one contact with the supervising faculty and the open-ended nature of the problems involved provides the students with a real taste of engineering. Although the fellows may have taken a couple of courses with design components in them they typically do not have any experience with capstone design prior to this work. The idea is to expose the student to design and research experiences early in the curriculum.

Introduction to Engineering - A new course

To maximize the exposure to the design experience a new course targeting freshmen was included in the curriculum at UW-Platteville three years ago. Working on open-ended problems and one group design project constitute a major portion of the course requirement. Since incoming freshmen have varying levels of math and science competencies, it is difficult to make them go through any sophisticated level of engineering design. Instead, the process of engineering design and teamwork is emphasized in these projects. It is expected that they will cover the following: address customer needs, manage time efficiently, explore product development, communicate effectively, and develop a sense of the total business equation.

Students are divided into small groups (3-5) by the second week of the semester. The steps involved in the process of engineering design is presented in class. The students are provided a list of product design or product development ideas to choose from. The projects suggested by the instructors are loosely defined and intentionally left vague in detail. They are usually similar to real-life problems. The students are to structure the problem through background research and create a clear goal statement and set of task specifications before attempting to develop a solution. Some students prefer to work on an idea of their own with the instructor’s approval.

By the fourth week, they are ready to inform the instructor and the rest of the class exactly which project they will work on and who the group leader or contact person would be. By the sixth week, they are required to submit an abstract to the instructor. Every two/three weeks, the instructor meets with every group to check on the progress and discuss problems encountered. The students can also contact the instructor any time through e-mail if anything requires immediate attention. Steps involved in writing a report and final presentation are outlined in class. Finally, during the last week of the semester, each group submits a written report, a small

proto-type of the design project, and makes an oral presentation before the entire class.

A list of interesting projects performed by student groups in this course over the past couple of years are as follows:

- Design of a miniature golf course
- Redesign of a dormitory loft system
- Recycling rain-water for greenhouse application
- Wheel-chair that goes over a curb
- Brake mechanism for a table saw
- Portable water filter
- Efficient can crusher
- Battery powered bike

In addition to the semester long project, open-ended problems are discussed in class where the instructor guides the student teams through a design exercise exploring the different stages of engineering design, viz., identification of the problem, analysis, transformation, idea development, modeling, information gathering, experimentation, synthesis, evaluation and testing , etc. An example of such a design exercise used recently is as follows:

“The construction of a child care center is underway. Most of the structural work has been completed. At this time, the center is approached by the Psychology and Childhood Education departments at a nearby university expressing interest in using the facilities for research on child behavior and interaction. The center is willing to cooperate since there is a potential for obtaining funds if this is identified as a research site. The problem is - no structural provisions were made in the building plans to facilitate observation of the children without intrusion or their knowledge of the presence of the observers. The center approaches your design team to help with a feasible solution to this problem. You are reminded that the children will not behave in their spontaneous manner if they are aware of the presence of strangers. Also, you are dealing with the issue of human subjects for research - therefore, some legal factors may have to be considered. The center will serve 60 children 2-6 years of age in four rooms, one of which is for toddlers only and has no carpeting”.

Discussion and Conclusion

The PURF program provides an opportunity for a selected number of undergraduate students an understanding of what is involved in an independent research project. As indicated above the activities include, choosing a project on their own, formulating a proposal and feasibility, carrying out literature search, analyses and presenting final results and conclusions. At every stage of the project, the faculty advisor plays a very active role, perhaps more than in a typical research situation. Students commented that they received one-to-one attention from their mentors over longer periods of time and thus developed skills which they otherwise would not have developed in larger groups. By involving undergraduates in such activities, many positive results are obtained. The immersive nature of the projects force students to face real issues in

research and design. The students' educational experience is enhanced, the research takes place in a campus which primarily focuses on undergraduate education, the faculty and students develop a strong relationship and progress along a path of learning.

The activity-oriented nature of the course - Introduction to Engineering is intended to encourage students to arrive at a deeper and more personal understanding of the nature of design than if the concepts were merely presented to them as theories or examples. The general feeling among instructors is that students would learn more from doing than from just discussing, hearing, or seeing. We expect that the effect of being encouraged to continually think about their own processes would cause students to come to view the global concepts of design in a different light. We want students to arrive at their own unique conclusions with the hope that they would come to appreciate that many different design styles could all be successful, and aid them in discovering their own styles.

Student feedback through written evaluations and interviews regarding the projects and open-ended problems in Introduction to Engineering plays a major role in evaluating the success of the course and in idea generation for future improvements. Although the projects are basically a rewarding experience, students are also challenged to the point of frustration. Many groups experienced moderate levels of both satisfaction and frustration during the project but are more positive after the completion. Last three times the course was offered the majority of students generally enjoyed the course and praised it.

The instructors from all engineering disciplines are invited to teach a section of the course. These instructors bring their individual expertise and ideas from their respective fields. Time involvement on the part of the faculty is significant; however, personal satisfaction is tremendous when students excel in their academic work and discover the engineering areas they like.

Biography

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