

An Evaluation of the Engineering Entrepreneurs Program at North Carolina State University

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The Engineering Entrepreneurs Program is an experimental course offered in the Department of Electrical and Computer Engineering at North Carolina State University. This course is partly funded by the National Science Foundation (NSF) through its SUCCEED coalition. As part of the Early Design Megaproject, it is an attempt to bring engineering design to students early in their academic careers. The primary purpose of this evaluation is to determine how well the Entrepreneurs Program is meeting its objectives and other SUCCEED deliverables.

The approach to engineering education undertaken by the Entrepreneurs Program is relatively unusual in that it includes students at all academic levels participating on design teams. A few others have had success with a similar approach. Li¹ describes team oriented design projects at the University of Wisconsin-Platteville which not only includes students at all academic levels, but is also interdisciplinary in nature by including students from both the Electrical Engineering and Chemistry departments. His course integrates product design, manufacturing and marketing and includes interaction with local industry. Mason² also describes his success with incorporating freshmen into the second semester of year-long senior design projects in Aerospace and Mechanical Engineering at Virginia Tech.

This paper will include a course description, evaluation objectives, methodology, evaluation findings, and areas for program improvement.

Course Description

The philosophy of the Entrepreneurs Program is that real-world engineering consists of teams attempting to develop successful products which are preceded by many failures from which members of the team learn and improve. This is in contrast to most of the standard undergraduate engineering curriculum where success hinges on passing tests where there are defined "right" and "wrong" answers. In the Entrepreneurs Program at NCSU, groups of students form companies to try and make a product -- much like what would be done in a high-tech start-up company.

Within each group, the students organize themselves to handle the various aspects of running a high-tech business: research, development, production, marketing, etc.. They develop a project plan for the semester and work to achieve their stated goals. They present their ideas, progress, and products to the other students three times during the semester. At the end of the semester they are judged, not by tests, but by how well they achieved their objectives, how viable their product is, and the value of their contribution throughout the entire project.



Students are organized into teams (5- 10 is the ideal size) with one to four (2 is ideal) senior leaders, who are **fulfilling** their capstone design requirements. Other members of the team are taking the course for one hour credit and may be at any point in their academic careers. Students are encouraged to take the class for multiple semesters, which allows for continuity of the projects and the availability of design experiences at all levels of the students' careers. Each team has a faculty advisor who serves as a mentor and facilitator for the team and may also have an industry sponsor. Recent companies have included **Pacesetter**, which developed a training system for track athletes which uses markings on the track and light system to inform distance runners of their progress against a desired time, and **Body Systems Innovations**, which developed a prototype pacing mechanism for swimmers to count their strokes and inform them of their lap times while they are still swimming.

In addition to the work on the **team**, there is a weekly seminar series of speakers who focus on issues relevant to a start-up, high-tech enterprise (e.g. venture capitalists, **successful** and failed entrepreneurs, bankers, attorneys). The purpose of the seminar series is to give students an understanding of all of the elements and challenges **involved** in starting a new company.

Evaluation Objectives

The focus of the evaluation is on the six objectives for the course outlined below:

1. To retain student interest in engineering by involving them in **meaningful** design experiences early in their academic careers.
2. To improve the quality of the engineering design experience by involvement in multi-semester design activities.
3. To improve retention of underclassmen (freshmen and sophomores) by providing senior leaders as role models.
4. To improve teamwork skills by involving students in team-oriented projects, similar to what they will encounter in the workplace.
5. To improve leadership skills by assigning seniors management responsibilities for the project and team personnel.
6. To prepare students for the 21st century workplace by exposing them to the dynamics of **small**, entrepreneurial companies.

Evaluation Methodology

The evaluation methodology consisted of telephone interviews with former senior leaders and other senior design students, an electronic mail survey of current and former Entrepreneurship participants, the **end-of-course** evaluation for the Spring 1994, Fall 1994 and Spring 1995 semesters; and comparison of Entrepreneurs students with other engineering students and university students as a whole by use of University **information**.

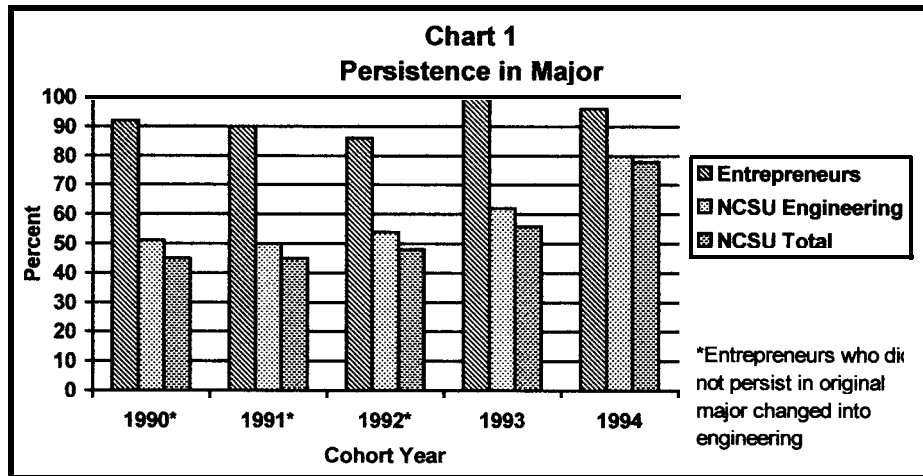
Findings

In the six semesters that the Entrepreneurs Program has been offered, 159 students have participated. Of these, 113 have taken the class once and 46 have taken it more than once. Of the students for whom information was available, nearly **90%** were men and **85%** were white. This contrasts with the University as a



whole which is 60% male and 82% white and with the College of Engineering where 22% of the students are female and 82% are white.

Retention at the University and in Engineering is excellent for Entrepreneurs participants. For all but the entering class of 1994, 100% of the entering freshmen remained at the University and those who began as engineers, remained in engineering. Some students even transferred into engineering from other non-engineering majors after participating in the program. A few of the students surveyed, including one of the three women responding, indicated that participation in the Entrepreneurs program was one reason that they remained in engineering. Chart 1 shows the persistence in major for Entrepreneurship students in contrast to other engineers at NCSU and the University as a whole. The data were as of October, 1995 for each class. Therefore, the second year is represented for the 1994 entering cohort while the sixth year is represented for the 1990 cohort.



The quality of the design experience seems to be very good, although seniors leaders do not seem to have a substantially better design experience than other senior design students. Virtually all students who had taken other design and laboratory courses at NCSU found this experience superior to those. The multi-semester nature of the course does seem to have some appeal with most students surveyed saying that they would take the course again if their schedule permits. Nearly 30% of the participants have taken the course for multiple semesters.

While retention in the University is excellent, the role of the senior leaders in encouraging younger students to remain in engineering is mixed. Some students say that their senior leader was instrumental in encouraging them to remain in their major. This was true of two of the three women surveyed - an important factor for SUCCEED objectives. However, others felt that their senior leader was decidedly not influential in their decision to remain engineers. In fact, only 66% of freshmen and sophomores agree or strongly agree that they learned a lot from their senior leaders.

Students generally feel that their teamwork skills have improved as a result of the program with senior leaders, especially, feeling that their skiUs have improved while freshmen and sophomores are less likely to agree and more likely to disagree. In interviews and surveys, however, students realize the importance of working as a team and see how they could apply teamwork skills in their jobs.

Senior leaders overwhelmingly feel that their leadership skills improved through their experience and some students chose Entrepreneurship for their design requirement because of the leadership opportunity. Students who were not senior leaders were less positive about their leadership ability with a substantial minority (19%) not agreeing that their senior leader was effective. These results are certainly indicative of the different skills and abilities that seniors bring into the class and some variation in the skill levels is to be expected and should not be viewed as a negative reflection on the program's effectiveness.

Students seem to be well prepared for the work that they do **after** graduation or in co-op programs. Most students do not go onto work for small entrepreneurial companies for their first jobs, but **find** application for the skills that they learned or honed in Entrepreneurship in their workgroups within larger companies. Students do indicate that they learned a lot about running a business from the seminar speakers and they enjoy the business aspect of their work on their projects.

Strengths and Weaknesses

The strengths of the Entrepreneurship Program **far** outweigh the weaknesses. The program is a good idea and well received by virtually all of the participants. With one possible exception (see Li¹), it is also a unique approach to engineering education. Entrepreneurship has done an outstanding job in the area of student retention. Students are made to think for themselves, a refreshing change from cookbook labs and "one right answer."

Students appear to get out of the class what they put into it. Underclassmen in particular have a wide range of experiences ranging **from** totally integrated into the team and working on an important component to completely **left** out. This is undoubtedly due to a number of factors including their own commitment to the work of the team and the leadership ability of their senior leaders.

Possible weaknesses include team formation and continuity. Teams formed of groups of **friends** (or fraternity brothers) appear to be more **successful** than others. In addition, continuity of teams from semester to semester could be enhanced.

Areas for Program Improvement

There are six areas which would yield program improvement. They are:

1. Institute a team building session early in the semester as the teams form. This will help integrate underclass students into the teams better.
2. Institute leadership training for the senior leaders.
3. Include an obligation to integrate all team members into the senior leaders' contracts.
4. Integrate this course completely into the curriculum. Currently, the course depends entirely on word of mouth and the efforts of the professor for enrollment. Inclusion of the course in the Undergraduate Bulletin and availability of credit toward the major would help the integration effort.
5. Provide for a "Senior Leader-Elect." This will help ensure continuity of the teams from semester to semester.
6. Recruit more women into the program. It seems very effective at encouraging them to remain engineers and would help meet that SUCCEED deliverable.



References

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