

## **AC 2007-548: ANALYSIS OF THE RETENTION OF STUDENTS AND POSSIBLE RECRUITMENT INTO TECHNOLOGY IN A COMMON FIRST-YEAR COURSE FOR ENGINEERING AND ENGINEERING TECHNOLOGY STUDENTS**

### **Irene Ferrara, Pennsylvania State University-Altoona**

Irene Ferrara, Pennsylvania State University Irene Ferrara is the Coordinator for the Electro-Mechanical Engineering Technology program for the Altoona College of the Pennsylvania State University. She received her B.S. in Engineering Science from the Pennsylvania State University and her M.S. in Mechanics and Materials Science from Rutgers, The State University of New Jersey. Address: 205 Force Technology Center, Penn State Altoona College, 3000 Ivyside Park, Altoona, PA 16601. Telephone: 814-949-5568, email: [ixf107@psu.edu](mailto:ixf107@psu.edu)

### **Andrew Vavreck, Pennsylvania State University-Altoona**

Andrew Vavreck, Pennsylvania State University Andrew Vavreck is Head of the Division of Business and Engineering at Penn State Altoona, and an Associate Professor of Engineering. In addition to his administrative duties, he teaches dynamics and engineering design, and his research is in smart materials, especially magnetorheological fluids, including fluid and device design and control. He received his B.S. in Engineering Science, his M.S. in Engineering Mechanics and his Ph.D. in Engineering Science and Mechanics, all from Penn State. Address: 214 Hawthorn Building, 3000 Ivyside Park, Altoona, PA 16601. Telephone: 814-949-5529, FAX: 814-949-5838, email: [vavreck@psu.edu](mailto:vavreck@psu.edu)

# **Analysis of the Retention of Students and Possible Recruitment into Technology in a Common First Year Course for Engineering and Engineering Technology Students**

## **Abstract**

Estimates from the University Park campus of the Pennsylvania State University indicate that the percentage of freshmen accepted into the College of Engineering at that campus who complete a degree program in Engineering is approximately 33%. The percentage of students accepted in the College of Engineering who complete a degree program in another College is approximately 33%. The final third of these students is not accounted for; they are effectively lost to the university. A similar analysis for College of Engineering students who begin their degree programs at Penn State Altoona will be presented in this paper.

During the last academic year, Engineering Technology enrollments decreased at the Altoona campus. One proven method for increasing enrollments is to recruit Technology students from the theoretical majors in the College of Engineering.

Efforts to provide information to Engineering students regarding the full range of options available to them in the Penn State system, as well as the distinction between Engineering and Engineering Technology, began in earnest in spring of 2006. Even with minimal effort, it appears that students are receptive to considering major options. As each semester progresses, additional efforts are being made to provide students with the information and guidance they need to make informed decisions regarding their choice of major. To date, the majority of efforts have been linked to ED&G 100, an Introduction to Engineering Design course. Recent modifications to the course have been made with both recruitment of Engineering Technology students and retention of all students in both Engineering and Engineering Technology in mind. This paper will outline the activities conducted to date, as well as those planned for future semesters.

Though increasing enrollments is a goal, it is more of a side benefit than a primary aim. The primary goal is to make sure that students have a clear understanding of the options available to them so they can make informed decisions about which type of program is the best fit; which will allow them the highest level of enjoyment in their courses, academic program, and eventually, in their professional careers. It is our belief that Engineering and Engineering Technology are equal options; each suited to a different type of student. It really depends upon the particular student and his/her areas of interest and future goals which constitutes the better choice.

## **Background**

Penn State Altoona is one of nineteen satellite campuses in the Pennsylvania State University system, which maintains its administrative and research hub at the University Park campus. The Altoona campus is located approximately 45 miles southwest of University Park, and is the geographically closest of the satellite campuses in the Penn State system. With 150 acres and

more than 20 buildings, Penn State Altoona offers approximately 4000 students the opportunity to complete 20 baccalaureate and eight associate degree programs ranging from Arts and Humanities to Engineering. In Engineering Technology, two associate degree programs are offered, in Mechanical Engineering Technology and Electrical Engineering Technology. In addition, one baccalaureate degree program in Electro-Mechanical Engineering Technology is available at the campus. Approximately thirty students graduate each year with a BSEMET degree (Bachelor of Science in Electro-Mechanical Engineering Technology.) In the eleven years since the inception of the BSEMET program, approximately 300 students have earned the degree.

In addition to the many degree programs that can be completed at Penn State Altoona, the campus also offers the first two years of over 180 Penn State majors, including thirteen in the College of Engineering. Engineering students then complete their degree programs at the University Park campus or another Penn State location offering that degree program.

### **Evolution of ED&G 100, Introduction to Engineering Design**

A change in introductory engineering design courses accompanied the curriculum shift from an exclusively “2+2” program in Electro-Mechanical Engineering Technology to one in which students have the option of entering a four-year program as first semester freshmen. Up to this point, students have been required to first earn the associate degree in either Mechanical or Electrical Engineering Technology before enrolling in the BSEMET program. In the past, Engineering Technology freshmen students have taken three one-credit courses, in Mechanical Drawing, Basic Computer Aided Design (CAD), and an Orientation to Engineering Technology, while Engineering students have taken ED&G 100, an Introduction to Engineering Design course. The three one-credit courses for Engineering Technology students and ED&G 100 have traditionally shared many common elements. In spring of 2006, the decision was made to discontinue the offering of the three one-credit courses to Engineering Technology students and offer a new and improved version of ED&G 100 to all Engineering and Engineering Technology majors. Both the topics covered in past offerings of ED&G 100 for Engineering students as well as the topics in the three one-credit courses taken by Engineering Technology students were adjusted to provide for the best blend of topics for both audiences.

Inclusion of common courses for Engineering and Engineering Technology students during the first year, where possible, has long been a goal for the campus and university. There are many advantages to the development of common course experiences: to enhance the mobility of students between the disciplines, to increase interactions between students in the two disciplines to foster better understanding of their commonalities and distinctions, to extend the timeline for students to evaluate career paths without penalizing academic progress, and to improve efficiencies of course offerings in under-enrolled courses.

ED&G 100 still represents a mix of mechanical drawing topics, CAD, and design topics. The mechanical drawing topics are directly linked to the CAD portion, where students complete assignments utilizing both a two-dimensional software package (AutoCAD) as well as a solid modeling software package (SolidWorks). The design component is intended to give students an introduction to a design philosophy that is repeated in subsequent courses, to advance student

understanding of what engineers actually do in industry, and to provide students with team-oriented project work. Team experiences and effectively functioning as a part of a team are addressed as students become involved in the project work.

In spring of 2006, ED&G 100, Introduction to Engineering Design, was offered for the first time as a common course for Engineering and Engineering Technology majors. In addition, with the goal of increased retention due to more concentrated exposure to one faculty member, the course model was changed from one in which three faculty interacted with students for two hours each to one where one faculty member is responsible for delivering the entire course, with six hours scheduled per week. The reason for the change to one instructor for all three sections lies in providing the opportunity for that faculty member to establish a rapport with the twenty students in each section of the course. For the majority of students, ED&G 100 is their first engineering course. All are taking math and science courses, but this is the first contact students have with an actual engineering faculty member. This contact is vital, and must be positive, if we are to provide assistance in exploring major options and potential career opportunities to students. The intent is to provide a fun, project-oriented course, where students can become familiar with the tools used in the profession and the concepts involved in design creation and implementation, with a faculty member who can serve as a mentor and confidant throughout their time at the Altoona campus.

In the one section of ED&G 100 in spring 2006, minimal effort was made to inform students of the Engineering Technology options available at the campus. The BSEMET Program Coordinator visited the class to provide information on the distinction between Engineering and Engineering Technology, and to describe the Engineering Technology programs. As a result of that one presentation, four of 18 students transferred into Engineering Technology.

Planning took place throughout the summer of 2006 to provide better coordination among the eight different faculty members responsible for teaching nine sections of ED&G 100 in fall of 2006. The intent remained to successfully relate the course material while also helping students adjust to the college environment, increase their chances for success in their courses and programs, understand clearly the options available to them and prepare to make informed decisions about their futures. In all, 172 students completed ED&G 100 in fall 2006. Several faculty contacts and student events aimed at enhancing student understanding of all engineering options took place throughout the fall semester.

With regard to BSEMET, two specific contacts were arranged during the semester. First, as students met with the Engineering College Representative for an orientation before classes began in September, explanations of the BSEMET program and the distinction between Engineering and Engineering Technology were provided. One student transferred into Engineering Technology as a result of this contact. Second, approximately six weeks into the semester, visits to all ED&G 100 classrooms were scheduled to again explain the BSEMET program, and to encourage students interested in the degree to meet with program advisors. Three additional students moved into Engineering Technology after this contact.

With regard to all other Engineering majors, in December, students were required to attend a College of Engineering Majors Expo where representatives from University Park visited Altoona

to discuss theoretical engineering major options, as well as the cooperative education and internship programs at University Park.

## **Data Review**

Data has been analyzed to indicate whether the efforts made in ED&G 100 during the past two semesters have made an impact. First, data from years past must be analyzed to determine the percentage of students who successfully moved on to University Park in Engineering majors, the number of students who transferred into Engineering Technology programs before any effort was concentrated in this area, and the rate of attrition.

Data was compiled to determine where the students who completed ED&G 100 in each year of interest were two years later. Numbers are reported in Table 1 for students who completed ED&G 100 in five different academic years – Fall 2000/Spring 2001, Fall 2001/Spring 2002, Fall 2002/Spring 2003, Fall 2003/Spring 2004, and Fall 2004/Spring 2005. In each case, the numbers listed indicate the status of the students two years later. So, for example, for students who completed ED&G 100 in Fall 2000/Spring 2001, data has been collected to report their situations in Fall 2002. The number of students enrolled at University Park in College of Engineering majors, students in College of Engineering majors still in Altoona, students enrolled in BSEMET, students enrolled in majors outside the College of Engineering at University Park, students enrolled in non-Engineering baccalaureate degree programs at the Altoona College, students in non-Engineering baccalaureate degree programs at other locations, students in Engineering baccalaureate programs at other Penn State locations, students enrolled in Engineering Technology associate degree programs at the Altoona College, students enrolled in other associate degree programs at the Altoona College, and students with non-degree status, regardless of location are listed. In addition, rates for attrition to represent students no longer in the Penn State system are included.

The data show that for these five academic years, between 42.3% and 58.4% of students in ED&G 100 are at University Park in College of Engineering majors two years later. Between 46.4% and 63.5% of students in ED&G 100 are in baccalaureate College of Engineering majors (excluding Technology) regardless of location two years later. This retention rate is substantially higher than that reported for University Park (33%). The number given for University Park does indicate retention at the conclusion of the degree program, whereas the number reported here for Altoona is only two years after enrollment in ED&G 100 (presumably close to two years after admission.) The reasons students do not complete degree programs are numerous and varied, and can include development of other interests, location preferences, academic challenges, and life events.

The rate of attrition for ED&G 100 students in Altoona, indicating those who leave the Penn State system entirely, is between 8.6% and 14.6%. This number is much lower than that cited by University Park.

**Table 1: Student Status Two Years After ED&G 100 Enrollment**

Year of interest	2000-01 FA/SP	2001-02 FA/SP	2002-03 FA/SP	2003-04 FA/SP	2004-05 FA/SP
Students in College of Engineering at University Park	58 (50.4%)	80 (58.4%)	74 (52.9%)	52 (42.3%)	50 (46.3%)
Students in College of Engineering (UP majors) still in Altoona	2 (1.7%)	7 (5.1%)	4 (2.9%)	5 (4.1%)	2 (1.9%)
Students in Electro-Mechanical Engineering Technology in Altoona	0	1 (0.7%)	0	0	0
Students in non-Engineering majors at University Park	15 (13%)	22 (16.1%)	25 (17.9%)	19 (15.4%)	25 (23.1%)
Students in non-Engineering baccalaureate degree programs in Altoona	10 (8.7%)	4 (2.9%)	5 (3.6%)	8 (6.5%)	6 (5.6%)
Students in non-Engineering baccalaureate degree programs at other Penn State locations	0	1 (0.7%)	2 (1.4%)	7 (5.7%)	4 (3.7%)
Students in Engineering baccalaureate degree programs at other Penn State locations	0	0	2 (1.4%)	0	1 (0.9%)
Students in Engineering Technology associate degree programs in Altoona	10 (8.7%)	4 (2.9%)	7 (5%)	7 (5.7%)	4 (3.7%)
Students in other Associate degree programs in Altoona	1 (0.9%)	1 (0.7%)	1 (0.7%)	0	0
Students with non-degree status, regardless of location	4 (3.5%)	5 (3.6%)	8 (5.7%)	7 (5.7%)	4 (3.7%)
Sub-Total	100 (87%)	125 (91.2%)	128 (91.4%)	105 (85.4%)	96 (88.9%)
Attrition (Students no longer in the Penn State system after two years)	15 (13%)	12 (8.8%)	12 (8.6%)	18 (14.6%)	12 (11.1%)
Total	115	137	140	123	108

Of particular interest is the number of students who entered as Engineering majors and transferred into Engineering Technology. In the academic years between fall 2000 and spring 2005, between 3.6 and 8.7% of students in ED&G 100 were in Engineering Technology associate and baccalaureate majors in Altoona two years later. The total number of students in the five year time period to move into Engineering Technology majors was 33. Between 4 and 10 students transferred into Engineering Technology in each of the academic years, with the average being 6.6. While this number does not seem large in comparison to the total number of students registered for ED&G 100 in each academic year, it is substantial when taken in the context of the 32 total students who can be accommodated in each BSEMET graduating class. In fact, these students could represent roughly 20% of the Engineering Technology population in any given year. Recalling that during these academic years, no real effort was being made to offer Engineering Technology as an option to these students, the question of how this more active “recruitment” will affect our Engineering Technology programs is a timely one.

For the 33 students who transferred into Engineering Technology during the five academic year period studied, an additional analysis was completed to determine how many semesters these students completed in Engineering before transferring into Engineering Technology. The results of this analysis can be seen in Table 2:

**Table 2: Number of Semesters Before Transfer From Engineering to Engineering Technology**

Number of Semesters before transfer to Engineering Technology	Number of students	Percentage of total
0	3	9.1%
1	5	15.2%
2	9	27.3%
3	4	12.1%
4	7	21.2%
5	4	12.1%
6+	1	3.0%

The table above indicates that eight students transferred into Engineering Technology after one semester or less, but this occurred over five academic years. The transfers over the past two semesters do seem to be significant in comparison to this statistic, in that transfers have increased by a factor of five. Effectively, the number of students who transferred after one semester or less in the past academic year equals the entire number who transferred in the five year period that was analyzed.

### **Current Data**

In spring of 2006, four of eighteen students registered for ED&G 100 transferred into Engineering Technology majors. Two students were in their first semester of study, and two were second semester students. In fall of 2006, four additional ED&G 100 students transferred into Engineering Technology. All four of these students were first-semester freshmen.

The breakdown of majors for the eighteen students registered for ED&G 100 in spring 2006 can be seen in Table 3. (At Penn State, students spend their first three semesters in the College of Engineering, before applying for admission to a specific major.) Fourteen were Engineering majors, three were in DUS, and one had non-degree status. DUS refers to the Division of Undergraduate Studies, an enrollment program for students who want to explore the University's academic opportunities before deciding on a field of study and for students in transition from one college or major to another.

**Table 3: Majors for Spring 2006 ED&G 100 Students**

Major	Number of Students
Engineering	14
DUS*	3
Non-degree	1

\*DUS – Division of Undergraduate Studies – students are undecided at this point

The breakdown of majors for the 172 students in the nine different sections of ED&G 100 in fall 2006 at the beginning of the semester can be seen in Table 4.

**Table 4: Majors for Fall 2006 ED&G 100 students**

Major	Number of Students
Engineering	115
DUS*	28
Non-degree	3
Electrical Engineering Technology	11
Mechanical Engineering Technology	9
Mining Engineering	1
Civil Engineering	1
Mechanical Engineering	1
Agriculture	1
Provisional Status	2

\*DUS – Division of Undergraduate Studies – students are undecided at this point

In the calendar year represented by spring and fall 2006 semester, 190 total students registered for ED&G 100. Twenty were already Engineering Technology majors, leaving 170 total in Engineering or DUS. Of those 170, eight have transferred into Engineering Technology, representing 4.7% of the total. Keeping in mind that additional students are likely to transfer after successive semesters, the impact could be substantial. If we only consider the numbers for the fall semester, where 152 total non-Technology majors were registered for ED&G 100, and consider the four students to be 25% of the total who will eventually move into Technology (equal to the percentage in Table 2 who have transferred by the end of the first semester), then over the next two years, we could potentially see 12 additional students from this group move into Technology.

## Conclusions and Future Plans

The argument could be made that because of the additional information being provided with regard to Engineering Technology, students will be more likely to transfer earlier in their academic careers. This is certainly possible, even probable, and would be advantageous for three reasons. First, the longer a student stays in Engineering before transfer, the more likely he/she will take courses that will not count toward the Engineering Technology degree program upon transfer. As a result, more time is spent earning the degree. Second, many students who remain in Engineering for longer periods of time before transferring damage their grade point averages substantially before the transfer, largely due to lack of interest and engagement in the curriculum. Third, it becomes more difficult to build schedules for students who spend longer periods of time in Engineering before transfer. Generally, the earlier a student can make a decision to transfer, the better for both the student and the university.

For the 33 students who transferred into Engineering Technology between fall 2000 and spring 2005, six completed associate degrees, one is still working on an associate degree, fourteen completed BSEMETS degrees, and eleven are working toward BSEMETS degrees at this point. Only one student failed to complete a degree program. Therefore, approximately 75% of these students have completed or are working on BSEMETS degrees, and 97% completed degree programs, indicating a high level of success for the transfer student group as a whole.

A companion effort has been made on campus to make sophomore level students aware of the Engineering Technology options available as well. The effort is informal and basically consists of engineering advisors addressing the issue with students during regular advising sessions. In addition, the BSEMETS Program Coordinator visited classrooms during spring of 2006 to make sure students were aware of the Engineering Technology programs, to briefly explain the difference between Engineering and Engineering Technology, and to provide contact information for students interested in assessing their options. Seven additional upper level Engineering students entered the Engineering Technology programs in spring and fall 2006, with varying semester standings.

The retention rate of 33% estimated by the University Park campus for Engineering students is clearly in need of improvement. No doubt some of these students genuinely have an interest in some field totally separate from Engineering, and find a better fit for their own talents and interests after they arrive on campus. But the fact that so many of these students are lost to the system entirely is alarming. These are likely students who could be successful, but for any number of reasons are not able to perform at the necessary academic level, or are not happy doing so. It is our belief that Engineering Technology offers a percentage of these students with a viable option. We have experienced the reaction of students who began their studies in Engineering at University Park, in theoretical courses without laboratory components, often in lecture halls with four hundred other students, who move into Engineering Technology at the Altoona campus and come to life. The individualized attention combined with the applied nature of the program offers them a totally different educational experience. Students develop one-on-one relationships with faculty members, and this added sense of importance has profound effects on their educational progress. The fact that for each theoretically based lecture course, there is also a companion laboratory experience offering students the ability to actively and visually

learn the concepts is thoroughly effective. It is not unusual for a student who was failing in a theoretical program to move into the Technology programs and thrive.

Students registered for ED&G 100 in fall of 2006 were surveyed at the end of the semester to see if their major preference had changed between their arrival in August and the end of the semester in December. By the end of the semester, 33% indicated a change in their original major preference. This can be seen as a positive statistic, in that it indicates that students are interested in exploring major options. They are actively seeking information, and are listening when we attempt to provide it, making it even more imperative that we as faculty continue to try to provide information about all options available to them.

Future plans include the development of a coordinated and multi-faceted marketing strategy for the Engineering Technology programs, which also addresses both recruitment and retention issues at the campus. Initiatives are likely to include visits to schools within our service area, extra help for and/or contact with students who begin to experience difficulty in courses, additional classroom visits, cooperation with our Admissions office in developing a more engaging presence at regularly scheduled events, developing additional opportunities for recruiting, meetings and/or contact with guidance counselors in our service area, mentoring programs for current and prospective students, and outreach programs on the campus targeting students in elementary, middle and high schools.