AC 2011-2332: FACING OUR RETENTION CHALLENGE: A SELF-PORTRAIT

Alan D. Niemi, LeTourneau University

Alan D. Niemi is an Associate Professor and Chair of Engineering Technology at LeTourneau University. He received his B.S. in Electrical Engineering Technology from Lake Superior State University and his M.S.E.E. from Illinois Institute of Technology. He has taught courses in Electrical Engineering and Technology for 24 years. In addition to teaching, Mr. Niemi has spent 7 years in industry designing digital and microcontroller systems.

Robert W. Warke, LeTourneau University

Robert W. Warke is an Associate Professor of Engineering and Engineering Technology at LeTourneau University. He received a B.S. in Welding Engineering from LeTourneau University in 1986 and an M.S. in Metallurgical and Materials Engineering from Illinois Institute of Technology in 1994. He joined the LeTourneau faculty in 2003 following 17 years of experience in industry, consulting, and applied research and development. In addition to his work in student retention, he currently teaches and consults in the areas of materials engineering, welding metallurgy, and structural weldment design and assessment.
Facing our Retention Challenge: a Self-Portrait

Abstract

“Houston, we have a problem.” The national average graduation rate for undergraduate engineering students in the United States is around 55%. The average graduation rate for LeTourneau University’s (LETU) School of Engineering and Engineering Technology (SEET) for the five-year period of this study was 42%, substantially below the national average. In addition to the SEET’s low five-year average, the most recent graduation years show a definite decline, reaching a level of just 33% for the final year of this study.

It was in light of our low and declining graduation rates that this study was conducted in the summer of 2009. In order to determine our (SEET) current standing with respect to graduation and retention rates, we examined internal LETU data and compared it to that of other universities’ engineering programs at large. We also attempted to answer the “Why are they leaving?” question by probing our own data and by surveying those who had left the SEET over the previous three years. Again, we compared our internal findings with those of other universities. An extensive literature study was also conducted in order to determine what other engineering programs are doing across the nation to increase their graduation and retention rates. The most successful of these efforts were identified and are highlighted in this study.

After examining the improvements made by other universities that led to increased retention and graduation rates, and by looking at the current state of our school, we recommended that initial improvements be made in our freshman year. These should focus on an early introduction to the engineering field and the creation of first-year interest groups with significant faculty and peer mentor interactions. The development of a new first-semester course to provide experiences in engineering practice was also recommended.

This report details our findings and supports our recommendations.

Introduction

For the five freshman cohorts (1998–2002) that were considered in this study, the average graduation rate for LETU engineering and engineering technology students was 42%. This was substantially below the roughly 55% US national average graduation rate in recent years for undergraduate engineering students. In addition to the SEET’s low five-year average, our data showed a 5% decline in each of the prior three years, falling to a level of just 33% for the final year of this study. This was especially of concern since many of our students indicate that they believe they are a good fit for LETU and the field of engineering, and yet only one-third of them are actually completing a SEET degree. While we realize that not all students who matriculate in the SEET are actually “cut out” to be engineers, we also believe that we are losing many who should be finishing successfully.

It was in light of these low and declining graduation rates that this study was conducted. To determine our (SEET) present standing with respect to graduation and retention, we examined
internal data as obtained from the LETU Office of Institutional Effectiveness and Retention, and compared it to data from other universities’ engineering programs. In all cases, our graduation and retention rates fell below those of other engineering programs.

We also attempted to answer the “Why are they leaving?” question by probing our SEET data, and by conducting an online survey of those who had left the SEET in the previous three years, both LETU-stayers and -leavers. Again, we compared our internal findings with those of other universities, as obtained from the proceedings of engineering education conferences and other published sources. Through an analysis of the literature pertaining to engineering retention, and by examining pertinent data from within the school, we identified some of the top reasons for the withdrawal of students from SEET degree programs, including:

- They come to dislike what they perceive engineering to be, lose interest and decide that the outcome is not worth the effort.
- They have inadequate study, time management, and/or note-taking skills.
- They are not adequately prepared in math and/or science.
- They are psychologically unprepared to deal with failure and become academically discouraged with their first-semester GPA.
- They encounter serious financial challenges.
- They dislike the social atmosphere at LETU.

An extensive literature review was conducted to determine what other engineering programs across the nation are currently doing to increase their retention and graduation rates. Most articles focused on freshman retention and the many efforts that have been undertaken to improve first-year retention numbers. Unfortunately, in many cases it is still too early to determine conclusively whether or not these have been successful. Therefore, this study focuses on efforts where substantial (two or more years of) increased retention have been documented. Successful efforts include:

- First-year interest groups where students are clustered in common class sections.
- Peer mentoring and/or supplemental instruction.
- A first-semester, project-based, career-enlightening engineering introduction course.

After examining the improvements made by other universities that have led them to increased retention and graduation rates, it was recommended that several improvements be made within the SEET, including:

- The creation of first-year interest groups.
- Changing the fundamentals of engineering course’s position in the curriculum to the very first semester, possibly changing its content, or even creating a different course with the focus of introducing freshmen to engineering practice.
- Offering (and in some cases requiring) a summer pre-engineering and math remediation experience.

Details of our findings are provided in the sections that follow. After providing a brief vocabulary lesson to define the various terms used in retention work, and after laying down foundational constraints, the actual study is presented. We begin by providing a look at the
current graduation rate within the SEET and compare this to national trends. We then examine the reasons that students leave engineering, both nationally and within the SEET. This is followed by an identification of methods that are being successfully employed elsewhere to improve retention. Finally, recommendations are provided for improving our graduation rate by implementing several practices that have been successfully deployed by other engineering schools.

**Background Constraints and Terminology**

Before examining retention, it is worthwhile to briefly define the terminology that will be used throughout this report. Definitions given here are consistent with those used in the 2006 ASEE conference paper “The Role of Academic Performance in Engineering Attrition”.

- **Cohort**: A group of students who entered the School of Engineering and Engineering Technology (SEET) during the same academic year.
- **FTIAC**: Students who entered LETU on a “First Time In Any College” basis. These may have previously acquired college credit from dual enrollment or advanced placement courses, but they did not transfer from another university.
- **Graduation Rate**: The percentage of students who entered the SEET as FTIACs and then graduated with a SEET degree (not necessarily in the major in which they entered) within six (6) years.
- **Leavers**: The students who entered the SEET as FTIACs and then subsequently left the SEET, either by leaving the university or by matriculating in another LETU school.
- **X-Year Retention**: The percentage of students who entered the SEET as FTIACs and were still matriculating in the SEET (not necessarily in the major in which they entered) after completing x years.
- **Stayers**: The students who entered the SEET as FTIACs and then graduated within the SEET (not necessarily in the major in which they entered) and within six (6) years.

LETU internal data have been analyzed with the following constraints:

- The SEET is composed of both engineering and engineering technology.
- Five cohorts are considered, from 1998 through 2002.
- Six-year graduation includes graduation within the school in years four, five, and six.
- Only FTIAC students are considered; as in most studies, transfer students are not included.
Where We Are and How We Compare

Where They Are

Graduation
A literature review was conducted to determine the graduation rates of undergraduate engineering programs at public universities. The numbers vary from one source to another, but a national average of about 55% is in reasonable agreement with all sources identified.2,3,4,5 This is in line with a significant longitudinal study released in 2008 showing a 57% graduation rate, spanning nine institutions and 13 cohorts, including 70,000 engineering students at public universities in the southeastern United States.6

Retention
The one-year retention rate among engineering students is nationally about 65%.7 The average national two-year retention rate can be estimated to be 55% since most universities reporting their numbers show about a 10% drop from the sophomore to the junior year.

Predictors
In addition to benchmarking the graduation and retention rates of other schools, we thought it worthwhile to consider the predictors by which they identify at-risk students in their engineering programs. Across the literature there was some disagreement as to which student characteristics are best able to predict future engineering retention. One study, which included nine universities over a 15-year period, revealed that the average GPA of leavers was 2.3, as compared to an average stayer GPA of 3.0.8 This agreed with other cited studies showing FTIAC first-semester GPA as a significant predictor of graduation rate. Another analysis of the same nine-university data found high school GPA and math SAT scores to be the two most reliable predictors of engineering graduation.9 (On a side note, it was noted that verbal SAT scores correlated negatively with engineering graduation at a majority of the schools studied!) In a later study, the same data were re-examined in terms of student performance to determine which freshman- and sophomore-level core courses most greatly affected engineering retention.10 Of the twenty courses considered, only six revealed any significant impact, the most influential being chemistry lab, followed by chemistry lecture, followed by Calculus I and II. At New Jersey Institute of Technology a thorough statistical analysis of survey responses, SAT verbal, SAT math, placement scores, and cumulative GPA was performed in an attempt to identify which factors could be best used to predict retention.11 It was determined that cumulative GPA was the best predictor, with math placement also being significant. But interestingly, in a study performed at East Carolina University it was determined that the best predictor of first year college GPA was actually high school GPA and not standardized test scores.12

Where We Are

With assistance from the LETU Office of Institutional Effectiveness and Retention, a sizable quantity of SEET data were obtained and analyzed. Most of these data were derived from FTIAC cohorts 1998 through 2002, which were selected to enable a complete assessment of six-year graduation rates for the five most recent cohorts. In addition, cohort years 2003 through 2007 were examined for one- and two-year retention rates.
Graduation
Graduation rates for the five cohorts studied are shown in Figure 1. A nearly continuous decline in graduation rates within the SEET is clearly evident, while a less significant decline in the overall university graduation rate is also apparent. The average SEET graduation rate for these five years was 42.3%, while that of the whole university was 51.1%. The final (2002) SEET cohort fell to just 33%.

![Figure 1. Graduation Rates of 98–02 Cohorts](image)

Retention
One- and two-year retention rates from 1998 through 2007 are shown in Figure 2. The one-year retention rate graph reveals no overall improvement. It should be noted that the 2007 cohort shows about the same retention as the 2002 cohort (the final year of the graduation rate study in which the graduation rate was 33%). The two-year retention rate is also relatively flat from 1998 through 2005 at about 50%. The 2006 cohort however, shows a significant increase to 68%. It will be interesting to see if this is reflected in future graduation rates.

![Figure 2. SEET 1- and 2-Year Retention Rates](image)
Cohort Characteristics
The five cohorts (1998–2002) were further analyzed to determine whether a decrease in college preparedness was indicated by entrance exam scores and high school GPA during the time period under investigation. These values are recorded in Table 3, and do not suggest any such decrease. It is especially noteworthy that the average math SAT and ACT scores (on which new-student math placement is based) for the five cohorts did not decrease over the five years analyzed. In other words, the observed decrease in graduation rate was not accompanied by an apparent decrease in math preparedness.

Table 3. Average Entry Scores for 98-02 Cohorts

<table>
<thead>
<tr>
<th>Cohort</th>
<th>SAT Total</th>
<th>SAT Math</th>
<th>ACT Total</th>
<th>ACT Math</th>
<th>H.S. GPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>98FA</td>
<td>(not available)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>99FA</td>
<td>1123</td>
<td>585</td>
<td>26</td>
<td>28</td>
<td>3.5</td>
</tr>
<tr>
<td>00FA</td>
<td>1209</td>
<td>622</td>
<td>26</td>
<td>27</td>
<td>3.6</td>
</tr>
<tr>
<td>01FA</td>
<td>1211</td>
<td>616</td>
<td>26</td>
<td>26</td>
<td>3.6</td>
</tr>
<tr>
<td>02FA</td>
<td>1214</td>
<td>633</td>
<td>27</td>
<td>27</td>
<td>3.6</td>
</tr>
<tr>
<td>Average</td>
<td>1209</td>
<td>623</td>
<td>26</td>
<td>27</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Predictors
Additional data were analyzed to determine whether ACT and SAT scores (both math and general), high school GPA, and first and third semester cumulative college GPA could be used as predictive indicators of SEET graduation. The data analyzed only suggested correlation between graduation rate and two of the possible predictors. The results can be summarized as follows:

- In Figure 3, higher math SAT scores suggest an increase in graduation rate.
- In Figure 4, it can be seen that students with a first semester GPA at LETU of 2.5 or above are much more likely to graduate, than those with a lower GPA.

Figure 3. Graduation Rate vs SAT Math for 98–02 Cohorts
Additional Analysis

Further analysis of the data was performed in order to gain more insight into the five cohorts under consideration. While the analysis is not included in this report, several significant observations were made.

- The average first semester GPA for the five cohorts increased slightly from 2.9 to 3.1 over the five years analyzed. In other words, there was not a decline in GPA, while there was a decline in graduation rate. The standard deviation did not change.
- The average third semester GPA for the five cohorts increased slightly from 2.9 to 3.2 over the five years analyzed. In other words there was not a decline in GPA, while there was a decline in graduation rate. The standard deviation did not change.
- Further analysis again confirmed that students with a first- or third-semester GPA of 2.5 or less were much less likely to graduate than those with GPAs above that value. There was also a noticeable correlation between first-semester GPA and graduation rate.
- As follow-up to the preceding, further analyses were performed on high school GPA as a possible predictor of first-semester (LETU) GPA as shown in Figure 5. Linear regressions indicated positive correlation trends, but coefficients of determination ($R^2$) were relatively poor in both cases. Notable, though perhaps not surprising, was an average GPA drop of about 0.7 from high school to first semester, and (as noted above) the importance of first-semester GPA to retention and graduation. However, perhaps more troubling than the number of those who did well in high school but poorly in their first semester at LETU—and became SEET-leavers—was the number of first-semester LETU high performers who eventually left, as well.

![Figure 4. Graduation Rate vs 1st Semester GPA for 98–02 Cohorts](image-url)
In summary, our average graduation rate of 42% is significantly below the national average of 55%. Also, our one- and two-year retention rates do not appear to be any better in recent years (with the exception of 2006) than they were for the initial five cohorts; therefore, without intervention, we expect the present graduation rate to continue.
Why Are They Leaving Engineering?

What Others Are Saying

The reasons why students leave engineering are numerous. A study conducted at the University of Pittsburgh over a six-year period found that about 69% of the students who left engineering either came to dislike studying it or lost interest in the profession (as they perceived it) during their freshman year. Academic problems accounted for 25%, whereas only 2% indicated personal or financial reasons for leaving. The study correlated this to the findings of Seymore and Hewitt, who in their longitudinal study indicated that the structure of engineering education and the culture of the discipline are much more likely to cause attrition than the student’s actual academic ability. In contrast to this work, a longitudinal study conducted at the nine SUCCEED universities over a 15-year time period clearly indicated that the average GPA of freshman leavers was about 2.2, as compared to the 3.0 average GPA of stayers. One could speculate, however, that the lower GPAs were a result of a loss of interest in engineering during their freshman year. A study done at Howard University investigated the connection between academic performance and loss of scholarship support, leading to a change in major. They concluded that many students often abandon engineering when their GPA threatens their academic scholarships. They then switch majors to something less risky, even though they would have preferred engineering. In one significant longitudinal study released in 2008, it was found that the percentage of stayers in engineering was actually higher than that of any other major group at the University. The study, which involved nine universities, concluded that engineering’s main problem is not too many leavers, but that it gains far fewer internal transfers than other majors. In this context, transfers were students who changed from one major to another within the university.

Why They Leave LETU / SEET

An online survey was devised to collect data and student feedback toward an assessment of the underlying reasons for withdrawal. Of the 93 leavers from the Fall 2006, 2007 and 2008 cohorts, 31 had withdrawn from SEET degree programs but remained matriculated at LETU, while 62 had withdrawn entirely from LETU. Ten (10) of the former, designated “SEET Leavers” (SL), and twenty (20) of the latter, designated “University Leavers” (UL), were successfully recruited to take the survey. It bears noting that the SL:UL ratio within the surveyed sample was approximately equal to that of the entire leaver population.

Also, 27 (90%) of the respondents were male, 25 (83.3%) had been first-time students upon entering LETU, 27 (90%) had majored in engineering (as opposed to engineering technology), and 27 (90%) had lived on campus. All but one of the respondents had withdrawn after completing only one or two semesters (17 and 12, respectively). Figure 6 provides a breakdown of where these 30 respondents went upon leaving LETU and/or SEET.
Upon leaving LETU and/or SEET, I did the following:

- Changed my major and transferred to a different university or college: 12
- Changed my major but stayed at LETU: 9
- Kept the same major but transferred to a different university or college: 6
- Stopped attending any university or college: 2
- Changed my major, stayed at LETU for a while, then transferred to a different university or college: 1

**Figure 6.** Summary of responses to the “where they went” question.

Depending on how each respondent answered the “where they went” question, he or she was then directed to an SL- or UL-specific question. In either case, the objective was to identify at least the primary influence, and preferably the secondary and tertiary influences, as well, on each respondent’s decision to withdraw. In Figures 7 and 8, “frequency” was determined by the number of respondents who ranked a given influence as 1st, 2nd, or 3rd, while “weight” refers to the multiplier value assigned to the ordinals: 3 for each 1st, 2 for each 2nd, and 1 for each 3rd. As the product of frequency and weight, “influence points” thus provided a simple basis for comparison among the various influences.

It was notable that the strongest academic influence reported by both SL and UL respondents was a loss of interest in or motivation to study engineering or engineering technology (Figures 7 and 8). However, just as noteworthy was SL respondents’ collective ranking of social and financial factors, rather than academic, as their two strongest influences overall (Figure 8).

A follow-up question, which was the same for SL and UL respondents, sought to identify underlying factors in cases where respondents had ranked “had difficulty with coursework” among their top three influences. Rather than the forced ranking approach of the preceding “why they left” questions, this question listed nine possible contributing factors and asked respondents to indicate the degree to which each of them played a role in their own situations. Respondents did so by assigning to each factor a significance value, with the choices being “not at all” (value 0), “minimally” (value 1), “somewhat” (value 2), “significantly” (value 3), and “very significantly” (value 4). Figure 9 shows the average significance assigned to each factor by the thirteen respondents who answered this question.
Rank the top one (1) to three (3) of the following influences on your decision to change your major from engineering or engineering technology to something else.

1. Lost interest in / motivation to study engineering or engineering technology: 5 x 3
2. Had difficulty with coursework (academic performance): 2 x 3, 2 x 2, 3 x 1
3. Uncertain of future career options: 3 x 2
4. Initially majored in engineering or eng. tech. due to parental pressure and later decided it just wasn’t for me: 1 x 3, 1 x 2, 2 x 1

Influence Points (respondents × weight)

**Figure 7.** Summary of Ten (10) SL responses to the “why they left” question.

---

Rank the top one (1) to three (3) of the following influences on your decision to leave LETU/SEET.

1. Disliked social atmosphere / community at LETU: 3 x 3, 4 x 2
2. Encountered financial challenges: 4 x 3, 2 x 2, 2 x 1
3. Lost interest in / motivation to study engineering or engineering technology: 3 x 3, 2 x 2, 3 x 1
4. Seeking more opportunities at another institution: 3 x 3, 2 x 2, 3 x 1
5. LETU’s lifestyle requirements (rules, norms, expectations): 1 x 3, 3 x 2, 2 x 1
6. Had difficulty with coursework (academic performance): 1 x 3, 2 x 2, 3 x 1
7. Uncertain of future career options: 1 x 3, 1 x 2, 2 x 1
8. Excessive home-to-LETU travel distance: 2 x 2
9. Initially entered LETU due to parental pressure and didn’t want to stay: 1 x 2, 3 x 1
10. Extreme homesickness: 1 x 3
11. Disciplinary action: 0
12. Personal or family health issues: 0

Influence Points (respondents × weight)

**Figure 8.** Summary of Twenty (20) UL responses to the “why they left” question.
If difficulty with coursework was one of your top three influences, please indicate the degree to which each of the following factors played a role.

![Graph showing factors and their significance levels.]

**Figure 9.** Summary of combined SL and UL responses to the “factors underlying difficulty with coursework” question.

The survey concluded with two open-ended requests for input, both of which provided space for free-text responses of unlimited length:

- “In my own words, this is why I left LETU and/or SEET:”
- “I would offer the following suggestions for improvement:”

The individual responses to these prompts were found to be generally consistent with our quantitative results, in which “disliked social atmosphere/community at LETU” was ranked just as highly as “loss of interest/motivation” by UL respondents. Accordingly, some noteworthy trends in the students’ commentaries included the following:

- The dominant cultures of both LETU and its surrounding communities were viewed unfavorably by some students, particularly to those whose backgrounds were socially less conservative or technology-oriented, to those seeking a broader range of recreation and entertainment options, and to several who were displeased by our male:female ratio.
- There appears to be a need for courses and/or experiences providing freshmen with a more realistic preview of the breadth of activity across the engineering profession. Many students seemed disillusioned by what they perceived to be a disconnect between their long-term expectations and their first-year classroom experiences.
Common Factors

There appeared to be no fundamental disagreement between the results of our survey-based investigation of SEET-leaver motives and those reported in the literature by other institutions. Loss of interest and motivation is clearly one of the strongest factors across the board. For engineering students, we and others believe that this is preceded by a loss of vision leading to a loss of purpose. When they find themselves academically challenged, many of them for the first time in their lives, and their view of the goal is obscured because their understanding of what it represents is inadequately developed, they lack the purpose necessary to persevere. We believe this ties directly into the poor academic performance which becomes the immediate reason for their withdrawal.

What Can Be Done?

What Others Are Doing

Most of the changes that have been implemented to improve retention at other universities focus on the freshman year. While many efforts have been made, fewer have actually been shown to improve retention. Many are in their early stages, so adequate retention data have not yet been acquired. This section focuses on the major efforts that have been shown to foster significant (two or more years of) improvements in retention. It should be noted that all of these activities begin in the very first semester for the FTIAC engineering student.

First-Year Interest Groups

First-year interest groups (FIGs) have shown significant retention improvements at several universities. FIGs are generally small freshman student groups who share common academic interest, are enrolled in common courses (clusters), participate in a weekly seminar, and are led by a peer and a faculty member. The purpose of the FIG is to create a support network to help first-year freshman make the transition from high school to a university’s engineering program.

FIGs have been implemented at several universities during the past two decades, some of which have extended the concept by creating dorm floors (or even dorms) that are major-specific. A study specific to engineering FIGs was done at the University of Missouri-Colombia that revealed a freshman retention rate of 90% for FIG students compared to 78% for non-FIG students. The study further revealed a graduation rate of 56% for FIG students, compared to 41% for non-FIG. At the University of Texas-Austin, participants in engineering FIGs had a one-year retention rate of 97%. After two years, the retention rate was 89%. While this program specifically targeted retention improvements in minority and female populations, it could be adaptable to other at-risk students. At the University of Hartford, initial results of implementing FIG’s in an engineering technology program have also been positive. Clustering students within math and science courses at the freshman level has had a positive effect on retention at Texas A&M University. Two years of data collection show that one-year retention for clustered students averages 91% compared to 84% for non-clustered students. Two-year retention numbers are 85% for clustered students and 73% for non-clustered.
Engineering Introduction Courses
Several engineering programs have created first-semester introduction to engineering courses that are having a positive impact on retention. The common themes of these engineering introduction courses include exposing students to what the field of engineering is really all about, allowing them to participate in meaningful hands-on type projects, and using peer mentors in the process.

At Southern Illinois University–Carbondale, a three-discipline approach has been used in an introduction to engineering course exposing students to various engineering laboratory experiences across the disciplines. It also includes guest speakers from industry, hands-on projects, and the use of peer teaching assistants. Preliminary data indicates that the course was well-received by the students with 88% of them remaining in engineering the next semester. The University of Colorado-Boulder has used a First Year Engineering Projects Course (FYEP) for many years in an effort to improve retention. The course introduces engineering students to the redesign-build-test cycle of product prototype development. The course is required by some engineering programs but not by others within the school, thus providing a reasonable control group with which to analyze retention differences. Retention was considered over eight cohort years revealing a first-year retention rate of 86% for those taking the FYEP course, compared to 78% for those not taking the course. Retention to the senior year was 64% for FYEP students, compared to 54% for the rest. Although the graduation rate seems higher than the average, they do have selective admittance into their engineering program. Baylor University has implemented a freshman engineering course focused on laboratory experiences and two design-build-test projects. The first offerings of this course have shown first-year retention increasing from 67% to 86%. The course authors have concluded that students must "do engineering" to get a meaningful picture of the engineering career field. Another initiative implemented at Baylor is offered as a supplement to first semester engineering courses and packaged in a format called Success4Students. This program, dealing with such things as time management and study skills, is implemented as a three-hour video seminar with 12 weeks of internet follow-up. Preliminary results show a second-semester retention increase from 67% to 83% and an average GPA increase from 2.6 to 3.1. The University of Denver has integrated design courses throughout the four-year curriculum which allow students to practice analysis, design and evaluation of multidisciplinary projects. Since the introduction of these project-oriented courses, the one-year retention rate has increased from about 53% to 83%.

Peer Mentoring/Supplemental Instruction
An Engineering Workshop Program (EWP) has been implemented at Northwestern University for several years. In the EWP students meet weekly in groups of about six students to work problems associated with specific engineering analysis type courses. These groups are led by peer instructors who have previously completed the courses and are mentored by the faculty instructor of the course. These teaching assistants receive academic credit for their efforts. Those students who take part in the EWP are shown to have about a 10% higher retention rate than those that don't participate. At the University of the Pacific, the freshman introduction to engineering course is being supplemented by the involvement of engineering student peers. These peers serve as mentors to groups of 6 to 8 freshman who are clustered by major, and gender and ethnicity when possible. These mentors hold “office hours” and lead their groups in studying, field trips, and involvement in professional engineering societies. A Freshman
Academy using peer mentors has been established in the engineering school at the University of Southern California. The role of these upper division engineering mentors is to “coach” the freshman engineering students through their first academic year. As part of a multi-faceted approach to increasing retention, University of Pittsburgh has employed student mentors in its freshman engineering seminar. The seminar content is now delivered by freshman team mentors who have been successful in creating supportive peer groups and ongoing learning communities.

**Math Interventions**

Several preliminary efforts have also been made in the area of the math preparation and intervention. While these efforts have not yet revealed an improvement in program retention, they do indicate increased success in Math and are worth noting:

- A five-week summer math module, to serve as a “boot camp” for incoming engineering freshman.
- A mid-semester math recovery module enabling students who are clearly not succeeding in Calculus I to take a precalculus refresher course for the second half of the semester, to better prepare them to repeat Calculus I the following semester.
- An innovative precalculus course based on the “dimensions of learning framework,” developed within the school of engineering to better retain those students who are not calculus-ready.

**What LETU SEET Freshmen Need**

- Training and mentoring in study skills and time management. (See Figure 9.)
- Effective math remediation, in some cases prior to matriculation, to better ensure their success in the clearly pivotal Calculus I course. (See Figure 9.)
- Real-world engineering “foretaste” experiences that inspire their persistence through the rigors of their preparatory math and science coursework. (See Figures 7 and 8.)
- A greater sense of community and camaraderie with their peers, through teamwork, mutual service and shared achievements. We believe helping each other overcome challenges on the path to a common goal could be for SEET freshmen an even stronger binding force than those of social interaction or shared living space. (See Figure 8.)

**What the SEET Should Do**

On the basis of our own findings, the documented experiences of other programs, and what we considered to be workable at LETU, we recommended the following near-term actions:

1. Place all incoming freshman SEET students into first-year interest groups (FIGs) consisting of 8-10 freshmen, a peer mentor, a faculty mentor, and an external professional contact (i.e., a locally-practicing engineer). For the freshmen members of each FIG, the faculty mentor and their academic advisor would be one and the same. The faculty mentor would then serve as their academic advisor for the duration of their SEET matriculation, except in some cases of change of major concentration. Each peer mentor should be recruited from the ranks of his or her faculty mentor’s advisee roster, preferably as a sophomore. He or she should be given the option of either being paid as a
student worker or receiving up to three hours of academic credit. The purposes and goals of the FIG program will be to:

- Promote early, regular and frequent interaction between SEET freshmen and their faculty mentors for academic, professional and personal mentoring.
  - Make use of the Success4Students curriculum.
  - Provide at least 30 minutes of face-to-face academic advising for each SEET freshman within the first three weeks of each fall semester.
  - Organize and provide two to three social events for each FIG and its respective faculty and peer mentors.
- Build community and camaraderie among the FIG freshmen and their peer mentors. This should include clustering of freshman students and their FIGs into the same sections of Chemistry I and Calculus I or Precalculus, and especially the new first-semester course recommended below.
- Facilitate homework and study assistance by peer mentors, as well as accountability in the areas of class attendance, homework completion and time management. The Success4Students curriculum should be integral to these activities.
- Through occasional but purposeful interaction with an external professional contact, provide a mechanism for exposure of freshman SEET students to “real world” engineering practice.
- Increase retention of peer mentors by giving them a sense of ownership in and responsibility for SEET programs and students.

2. Introduce a new first-semester course to be required of all incoming SEET freshmen. Its primary aim should be to maximize students’ active participation in the practice of engineering design, fabrication and testing for real-world applications, such as community service projects.
- Ideally this would be a “I and II” two-course sequence, extending over both freshman semesters.
- The FIG program should be integrated into these courses, such that each section consists entirely of whole FIGs. Involve the external professional contact in projects undertaken by student teams throughout the courses.
- Repackage other first-year courses to create space in the SEET core curricula for the new courses.

3. For incoming freshmen considered to be academically at-risk, establish and require successful completion of a pre-freshman summer math intervention “boot camp”. A side benefit of this program would be its ability to help us identify students who are academically underprepared but sufficiently motivated to succeed in SEET programs.

4. Stimulate SEET faculty to form teaching partnerships with math faculty, particularly those instructing Calculus I. Develop and deliver lecture content containing realistic examples of how calculus can be applied to engineering design and analysis.
Conclusions

The average SEET graduation rate of 42% for the five-year period of this study was substantially below the national average of 55%. With the most recent graduation years showing a definite decline, falling to a level of just 33% for the final year of our study, we believed that a corrective course of action was necessary. In light of this, we examined internal LETU data to determine where we currently stood, and conducted a survey of those that had left in order to determine why. Having examined this internal input, and after having studied successful retention efforts at other universities, we recommended that improvements initially be made in our freshman year. These were to focus on an early introduction to the engineering field and the creation of first-year interest groups with significant faculty and peer mentor interactions. The development of a new first-semester course and additional math remediation were also recommended.

Status

The preceding recommendations were accepted by LETU’s School of Engineering and Engineering Technology, resulting in the submission of an NSF STEP grant proposal to assist with their implementation. The proposal was funded, and the pilot year of the project is presently underway. As the project reveals future retention outcomes, we intend to perform statistical analyses that will enable us to quantify the accuracy of predictors and the effectiveness of our various actions in increasing retention.

References


