Designing a Freshman Program to Support Student Success

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Abstract
The WVU College of Engineering and Mineral Resources has implemented several programmatic changes to the freshman year experience in an effort to support students in their attempt to attain the College's high academic standards and to improve retention of students from the freshman to the sophomore year. This paper describes several of these program modifications, presents an analysis of the data indicating the results of these changes, and makes recommendations for further study.

The changes made to the freshman program include the creation of two engineering tracks, a traditional track for those prepared to enter Calculus 1 in the first semester of their freshman year and a second engineering track designed for those students not prepared to enter Calculus 1 in their first semester, the development of a freshman orientation class, the requirement of participation in weekly study lab sessions, the implementation of a five-day Calculus 1 course comprised of three lectures and two recitations, and the enforcement of the requirement to attain a C or better in calculus before entering a specific engineering discipline major. The orientation class teaches freshman academic success skills and includes weekly communication with students' parents.

Data trends in the last two years indicate that these changes had a significant effect on the retention of engineering students from their freshman year to the sophomore year and improved the freshman class GPA. Analysis of academic performance data has also indicated additional areas for continued improvement in placing and advising students, as well as in supporting and tracking student success.

Introduction
Attracting and retaining qualified students is essential to surviving and thriving in current enrollment-driven environments. The WVU College of Engineering and Mineral Resources has implemented several programmatic changes to the freshman year experience in an effort to support students in their attempt to attain the College's high academic standards and to improve retention of students from the freshman to the sophomore year.

Benchmarking/Baseline Data
In the academic year 2000/01, of the 447 incoming freshmen, the median SAT-Math score was 590 and the median ACT-Math score was 26. At that time, West Virginia had not yet implemented its PROMISE Scholarship program; there was no freshman orientation course and no College-sponsored academic support. Freshman retention, defined as the percentage of freshmen who transferred to a discipline major or to sophomore status at the end of the second semester, was 66.7%; the average GPA of freshmen engineering students was 2.48; and 48

freshmen (10.7%) ended the year with a GPA of 3.5 or better. Since performance in fundamental math and science courses is also a measure of success in an engineering program, student data was compiled and evaluated in three fundamental math and science courses required of all engineering majors: Calculus 1 (MATH 155), Fundamentals of Chemistry (CHEM 115), and General Physics (PHYS 111). In academic year 2000/01, the engineering GPA in Fundamentals of Chemistry was 1.82, with 55.1% of the students earning a grade of C or better; the engineering GPA in Calculus 1 was 1.52, with 38.3% earning a grade of C or better; and the engineering GPA in General Physics was 2.28, with 63.6% earning a grade of C or better.

Programmatic Support Changes

To improve the academic success of freshman engineering students, several student support structures were implemented over a three year period. Changes made to the freshman program include the:

- Development of Engineering 199, a 1-credit hour engineering-specific orientation course for all engineering freshmen, which provides early exposure to the value of an engineering degree, tracks student progress throughout the first semester, and involves parents through weekly emailed newsletters.
- Requirement of participation in weekly study lab sessions.
- Implementation of two engineering tracks: Engineering, a traditional track for those students ready to take Calculus 1 (or a higher math course) in the first semester of their freshman year, and General Engineering, a track designed for those students needing to take algebra and trigonometry, or pre-calculus mathematics, during the first semester.
- Enforcement of the requirement to attain a C or better in Calculus 1 before taking General Physics and implementation of the requirement to attain a C or better in Calculus 1 before entering a specific engineering discipline major.
- Revision of the freshman engineering curriculum to focus on problem-solving and an increased management of the multiple sections of the first year engineering courses to ensure a more uniform experience for all students.
- Implementation of a five-day Calculus 1 course comprised of three lectures and two recitations per week.
- Continual tracking of student academic success and provision of academic advising and mentoring throughout the freshmen year.

Beginning in the 2002/03 academic year, WVU College of Engineering and Mineral Resources initiated a mandatory 1-credit hour engineering orientation course, ENGR 199, which met the university requirement for an orientation course. All incoming engineering students took the engineering orientation course instead of the general university orientation course. In this course, students were taught college and career "success skills" such as study skills, prioritization, and time management; were given early exposure to the value of an engineering degree; were introduced to all the engineering discipline majors; were taught how to write a resume and participated in a career fair and exposed to internship opportunities; and were required to give periodic progress reports on their grades in all their other courses. In addition, weekly assignments intended to provoke consideration of their future career options were given and attendance expectations were clearly defined. The instructor of the orientation course took an active role in supporting student achievement and met with each student reporting poor grades

to help the student refocus his or her priorities on academic success and create a recovery plan to improve his or her grades.

During the 2003/04 academic year, the University and the College increased focus on retention and several additional changes were made with the intent to improve freshmen retention. The two most important changes were modifications to the engineering orientation course and the development of two engineering tracks for entering students.

The orientation class was modified to include a study lab requirement and to request all students to sign privacy releases to enable academic advisors and faculty to speak to a parent who may call with questions regarding his or her student's academic progress or options. Proctored 2-hour study labs were offered five days each week, Sunday through Thursday, from 7:00 – 9:00 PM, and provided a place in which students could work on their homework in math, chemistry, physics or computer science and gain the assistance of upper-class engineering students, as needed. Each ENGR 199 student was required to attend at least one of these study labs each week. Attendance was taken each evening and student participation was tracked and used to determine a portion of the E199 orientation course final grade.

Beginning in Fall 2003, the WVU College of Engineering and Mineral Resources admitted students to study under two distinct programs, Engineering, a traditional track for those students ready to take Calculus 1(or a higher math course) in the first semester of their freshman year, and General Engineering, a 3-semester program designed for those students needing to take algebra and trigonometry, or pre-calculus mathematics, during the first semester. The objective of the two path approach is to match each student with a first year curriculum that prepares him or her for study in any of the discipline majors and also is tailored to maximize the learning success of that student. To qualify for the Engineering program, students must have an ACT-Math score of at least 26 with a composite score of at least 19 or an SAT-Math score of at least 600 with a composite SAT score of at least 910. To qualify for the General Engineering program, students must have an ACT-Math score of at least 20, with a composite ACT score of at least 19, or have an SAT-Math score of at least 480, with a total SAT score of at least 910. Students who did not meet the minimal requirements were enrolled in general studies, but were allowed to take the engineering orientation course.

Other changes made to the freshman engineering program that year include: the revision of the two freshman engineering courses to increase the problem-solving focus and to better coordinate the various sections to ensure a more common experience for all first year students; the recruitment of faculty from engineering departments who were enthused and excited about teaching freshmen engineering students; and the addition of the requirement that students must attain a grade of C or better in Calculus 1 before being permitted to declare a discipline specific major.

During fall 2004, the engineering study labs became course specific: Nightly study labs were offered for Calculus 1 & 2; algebra, trigonometry, and pre-calculus math; chemistry; physics; and computer science. Other modifications to the orientation course included weekly email newsletters to the parents and mentoring (academic coaching) for those students most at risk. The 2004 – 2005 academic year marks the first time the study labs will continue for the entire

freshman year and participation will be linked to the grade in the two freshmen engineering courses, as well as in the orientation course.

Based on data collected from previous years, the College focused its efforts on working with the university's Department of Mathematics to improve engineering students' math success rate. The math department created 5-day engineering sections of Calculus 1 which met for lecture three days per week and for recitation, staffed by one math graduate teaching assistant and two engineering undergraduate assistants, two days each week to provide additional problem-solving experience for the students. Enrollment in these classes was limited to engineering students. For those students with a D or F at midterm who chose to withdraw from Calculus 1, a mid-semester math course, focusing on a review of pre-calculus and early calculus skills, was developed to prepare them to be successful in Calculus 1 in their next attempt.

Results

The following indicators were used to assess the success of the changes made to the freshman engineering program (all measures were computed using data from freshmen engineering students in the Engineering and General Engineering tracks)[1]:

- Freshman retention, defined as the percentage of freshmen who transferred to a discipline major or to sophomore status at the end of the second semester.
- Average overall freshman GPA
- The number and percent of freshmen who ended the year with a 3.5 GPA or better.
- Average GPA of freshman engineering students in three specific support classes: Calculus 1, Fundamentals of Chemistry, and General Physics.

Effect of PROMISE Scholarship

One possible confounding influence on the data during this time period is the 2002 introduction of the West Virginia PROMISE Scholarship that provides full college tuition to any state institution of higher education to graduating seniors who complete high school with a 3.0 GPA and a composite ACT score of at least 21 or a combined SAT score of 1000.[2] Data on incoming freshmen were collected and analyzed to determine if the PROMISE scholarship significantly changed the qualifications of incoming engineering students. Enrollment data and SAT-Math and ACT-Math profiles of the freshman class were used to determine possible effects on quantity and quality of students due to the implementation of the PROMISE scholarship.

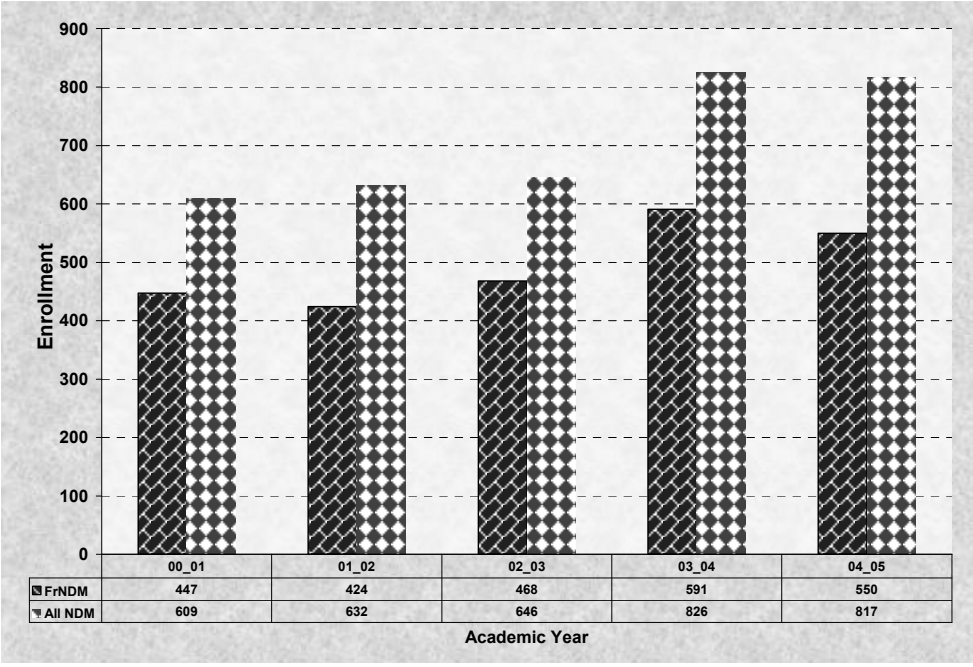
Enrollment

Freshman non-discipline major (NDM) enrollment, which includes Engineering, General Engineering, Pre-Biometrics, and Pre-Computer Science students, has been relatively stable from 2000/01 to 2002/03, averaging 446, ranging from 424 to 468, and varying less that ±5% per year. However, 2003/04 enrollment increased 32% above the 2000/01 level, and 2004/05 enrollment decreased 7% from the 2003/04 level, but was still 23% above the 2000/01 level.

Enrollment in Engineering or General Engineering from 2000/01 to 2002/03 averaged 428 and ranged from 379 to 438. The percent of Engineering or General Engineering Freshman NDM enrollment has been decreasing slightly over the last four years from 99% in 2000/01 to 92.6% in 2003/04 due to the formation of the programs in Pre-Biometrics and Pre-Computer Science.

Total non-discipline major enrollment has increased from 609 in 2000/01 to 826 in 2003/04 and 817 in 2004/05. This 34% growth is due to the number of Engineering and General Engineering students carrying over as first semester sophomores and the increasing number of non-freshman students continuing as either Pre-Biometrics or Pre-Computer Science majors (who, unlike Engineering and General Engineering students, are not transferred out of the College at the end of their third semester if they have not met the pre-requisites to move into a discipline major).

Figure 1. Total student enrollment and enrollment by subsets of student population.



Freshman NDM SAT-Math and ACT-Math Profiles

The SAT-Math and ACT-Math score profiles of the College's freshman non-discipline majors for the 2000 through 2004 academic years are presented in Figures 2 and 3. These two figures indicate that the SAT-Math and ACT-Math score profiles of the incoming freshmen have not changed markedly over the last four years, even given the beginning of the Promise Scholarships in academic year 2002. However for 2002 and 2003, the upper 10% of the SAT-Math score exceeded about 685, while in 2000 and 2001 it was 665. The ACT-Math profile does not show any improvement in the upper 10%.

While the PROMISE scholarship may have played a role in increasing overall enrollment, it appears that the PROMISE scholarship has had no significant effect on the SAT-Math or ACT-Math profiles of incoming freshmen. It can be expected, therefore, that incoming Promise Scholars will struggle with Mathematics and Chemistry like the non-Promise Scholars; and it is

reasonable to attribute any changes in the student success rate to factors other than the variation in academic preparation and abilities of incoming freshmen.

Figure 2. Cumulative Distribution Plots of SAT Math Scores for Academic Years 2000 through 2004

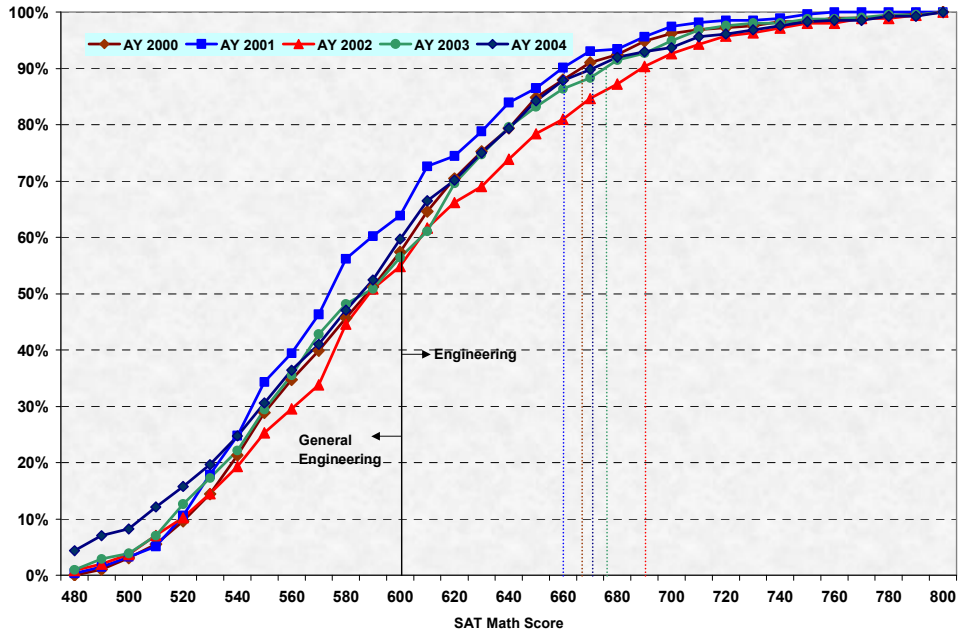
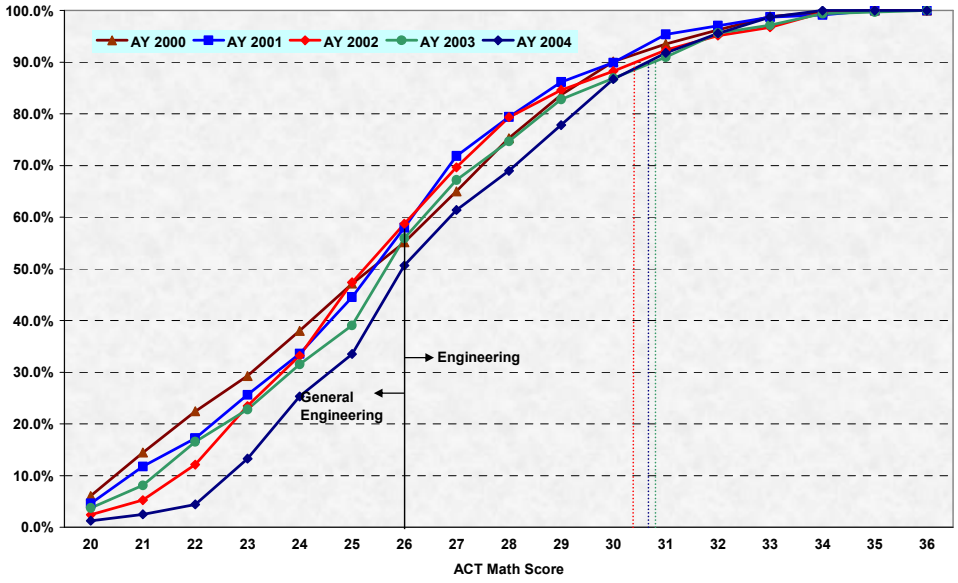


Figure 3. Cumulative Distribution Plots of ACT Math Scores for Academic Years 2000 through 2004



Retention

Freshman retention has been defined as the "percentage of freshman transferred to a discipline major or to sophomore status." Table 1 graphically presents data that specifically tracks the academic actions taken on Engineering and General Engineering freshmen over the last four years and Figure 4 plots retention by academic year for the last four years. In 2000/01 and 2001/02 the retention rate was 66.7% and 64.9% respectively. In 2002/03, the first year of focus on freshman retention, it increased to 71.5%, and retention for 2003/04 was 75.3%.

The percentage of freshmen transferred into a discipline major increased from 44.3% in 2001/02 to 51.7% in 2003/04, showing a positive trend. In the 2003/04 data, (the first year freshman were admitted in two NDM codes) 69.4% of Engineering freshmen were successfully transferred into a discipline major while only 30.1% of General Engineering freshmen were successfully transferred into a discipline major. The discrepancy is to be expected, since Engineering freshman are eligible to take Calculus 1 in their first semester, while most General Engineering freshman must complete algebra and trigonometry, or pre-calculus math courses, and are not able to complete the pre-requisites for entering a major until their third semester.

The percentage of freshman Engineering or General Engineering students returning to their sophomore year as a non-discipline major averaged 22.2% for the three year period from 2000/01 to 2002/03. The percent of 2003/04 freshmen returning to their sophomore year as a non-discipline major was 23.6%, which contributed to the overall increase in retention reported above. (Table 1 & Figure 4)

The significant increase in freshman retention, averaging 5.2% over the past two years, provides evidence to support the claim that the efforts undertaken by the College to increase retention have been successful.

Figure 4. Retention rate of freshman to a discipline major or the sophomore year

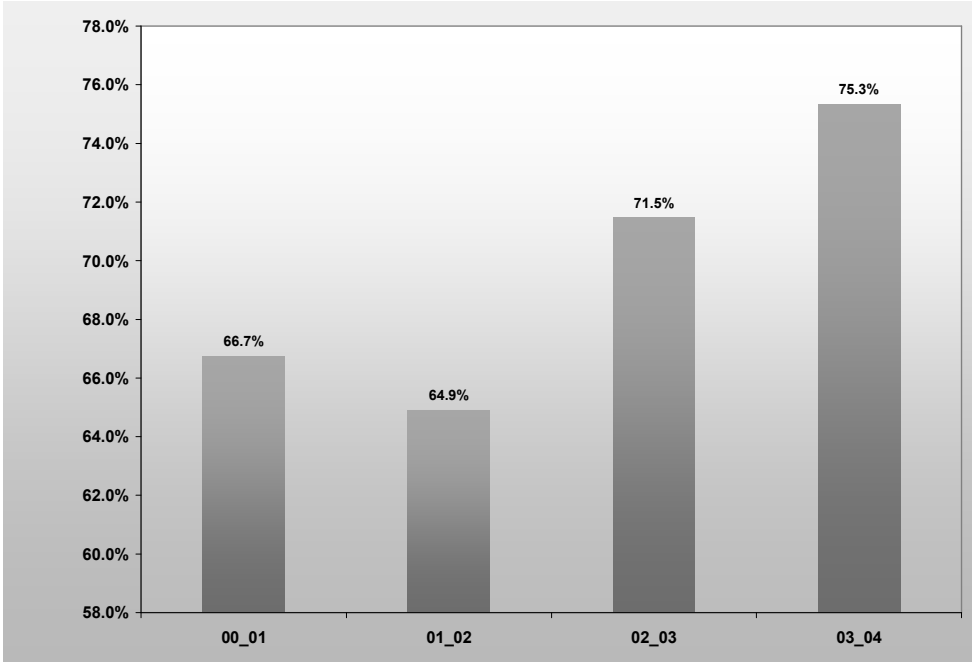


Table 1. Freshman Engineering and General Engineering Non-Discipline Engineering Enrollment and Retention Data

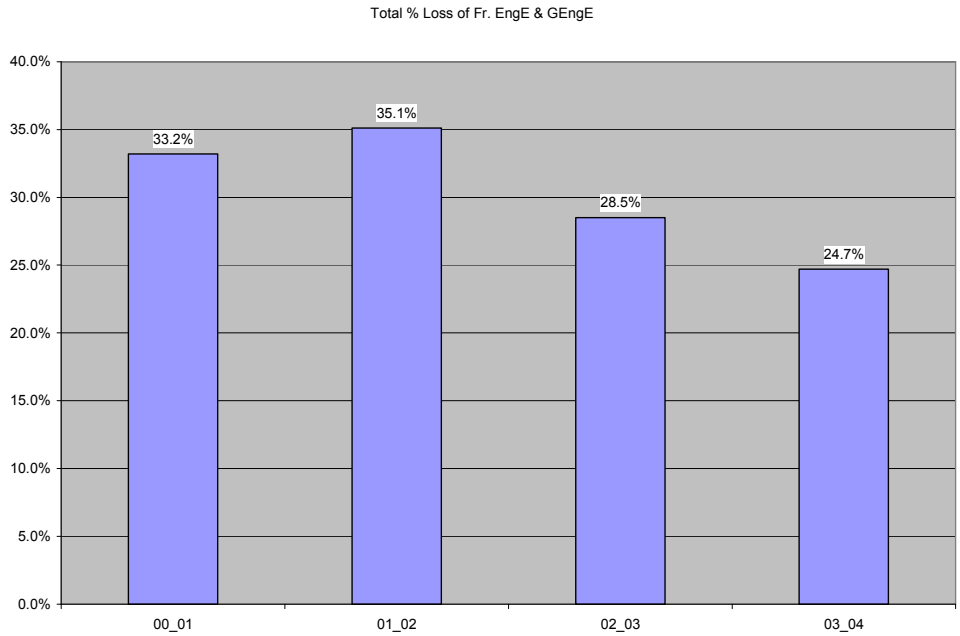
Non-Discipline Engineering	*Academic Year* 00_01	01_02	02_03	03_04
Enrollment				
FrNDME	447	424	468	591
Freshman EngE	445	393	431	301
Freshman GEngE				246
Freshman Pre-BIOM	2	13	10	13
Freshman Pre-CS	0	18	27	31
Freshman EngE & GEngE Subtotal	**445**	**393**	**431**	**547**
Transfer to Discipline Majors				
Freshman EngE To Discipline Major	195	174	209	209
Freshman GEngE To Discipline Major				74
Fr EngE and GEngE to Discipline Majors Subtotal	**195**	**174**	**209**	**283**
Retaining to Sophomore Year				
Freshman EngE to Sophomore Year	95	67	92	33
Freshman GEngE to Sophomore Year	0	0	0	96
Freshman EngE & GEngE to Sophomore Year	**95**	**67**	**92**	**129**
Percentages				
% of FrNDME that is EngE or GEngE	99.6%	92.7%	92.1%	92.6%
% Freshman EngE to Discipline Major	43.8%	44.3%	48.5%	69.4%
% Freshman GEngE to Discipline Major				30.1%
%Fr EngE & GEngE to Discipline Majors	**43.8%**	**44.3%**	**48.5%**	**51.7%**
% Freshman EngE Returning as Sophomores	22.9%	20.6%	23.0%	11.0%
% Freshman GEngE Returning as Sophomores				39.0%
% Freshman EngE & GEngE Returning as Sophomores	**22.9%**	**20.6%**	**23.0%**	**23.6%**
Retention (% to Discipline Majors + % to Sophomore Year)	**66.7%**	**64.9%**	**71.5%**	**75.3%**

As retention increases, a corresponding decrease in student "loss" due to transferring out, suspension and not returning for the sophomore year is expected. Table 2 and Figure 5 illustrate the expected drop in student loss during the 2002/03 and 2003/04 academic years. The average loss for 2000/01 and 2001/02 was about 34.2%, while the average loss for 2002/03 and 2003/04 was 26.6%.

Table 2. Freshman Engineering and General Engineering Non-Discipline Engineering Loss Data

Non-Discipline Engineering	*Academic Year* 00_01	01_02	02_03	03_04
Enrollment				
Freshman EngE & GEngE Enrollment	445	393	431	547
Transfer out of CEMR				
TrO Freshman EngE	88	81	64	38
TrO Freshman GEngE				46
Fr EngE and GEngE Transfer-out Subtotal	88	81	64	84
Did Not Return				
DNR-Freshmen EngE	42	51	50	19
DNR-Freshman GEngE				25
Fr EngE & GEngE DNR Subtotal	42	51	50	44
Suspended Students				
Suspended Freshman EngE	18	6	9	2
Suspended Freshman GEngE				5
Fr EngE & GEngE Suspended Subtotal	18	6	9	7
Percentages				
%Fr EngE & GEngE Transferred-out	19.8%	20.6%	14.8%	15.4%
%Fr EngE & GEngE Did Not Return	9.4%	13.0%	11.6%	8.0%
%Fr EngE & GEngE Suspended	4.0%	1.5%	2.1%	1.3%
Total % Loss of Fr EngE & GEngE	**33.20%**	**35.10%**	**28.50%**	**24.70%**

Figure 5. Loss rate of freshman Engineering and General Engineering Students



Academic Performance of Non-Discipline Majors

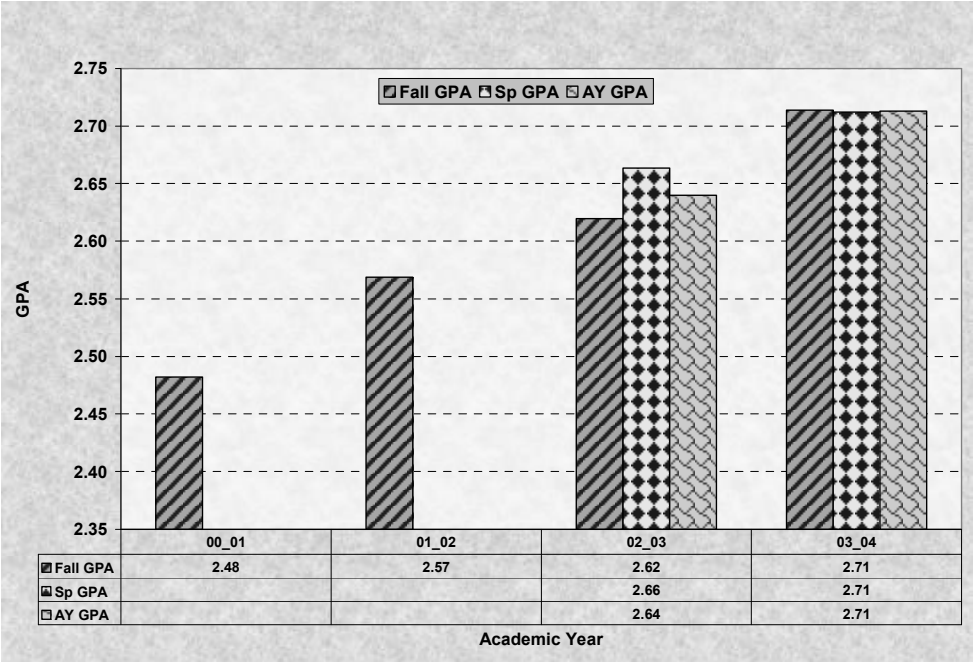
Freshman non-discipline major performance over the last four academic years has been evaluated by the overall GPA performance by semester and academic year, as well as by grade achievement and percentage of C or better grades in Calculus 1 (MATH 155), Foundations of Chemistry (CHEM 115), and General Physics (PHYS 111).

Freshman GPA Performance by Semester and Academic Year, in all Classes

Average GPA in specific courses and the average GPA for each semester and Academic Year (AY) were measures sued to evaluate freshman academic performance.

The GPA data for semester and academic year are given in Figures 6 and 7. Figure 6 plots semester and AY GPA from the 2000/2001 AY through the 2003/2004 AY. Since students had unequal course loads, the average GPA was calculated using a weighted average of total quality points divided by the total credit hours.

Figure 6. Freshman Non-discipline Major GPA Performance by Semester and Academic year from 2000 through 2003

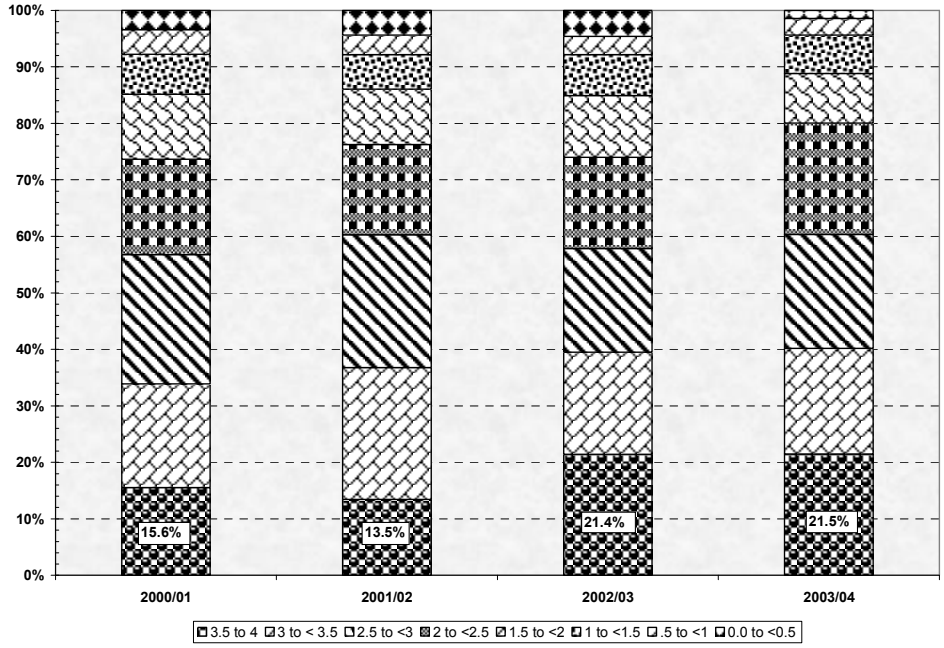


The Fall GPA data show a strong improvement in Freshman GPA over the last four academic years rising from 2.48 in 2000/2001 to 2.71 in 2003/2004. While the data necessary to determine the Spring GPA in AY 2000/2001 and 2001/2002 is not available, the Spring GPA and the AY GPA for 2002/03 and 2003/04 have shown improvement as well over the last two academic years.

The stacked bar graph in Figure 7 shows the distributions of freshman GPA for the fall semester from academic years 2000/01 through 2003/04. This graph demonstrates the marked increase in

the percent of students achieving an overall freshman GPA of 3.50 or higher. In 2000/01 and 2001/02, the two years before the Promise scholarship, the percent of freshmen having a GPA of 3.50 or higher was 15.6% (68 students) and 13.6% (55 students) respectively. In 2002/03 and 2003/04, with the Promise scholarship, the percent of freshmen having a GPA of 3.50 or higher was 21.4% (98 students) and 21.5% (123 students) respectively.

Figure 7. Stacked bar chart of GPA distributions of engineering and general engineering freshman students for AY 2000/02 – 2003/04.



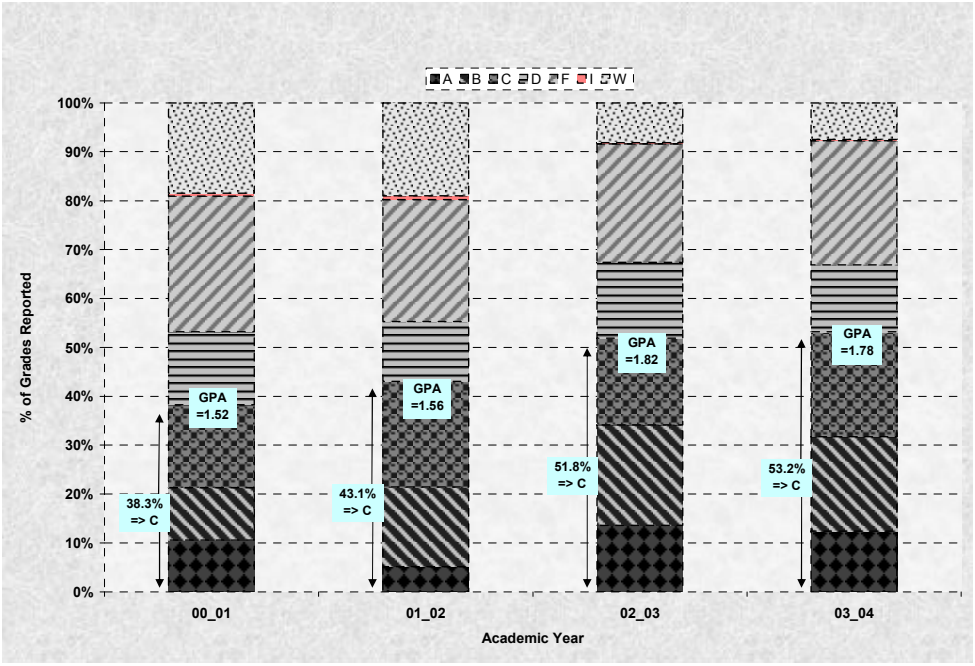
The increase in the percent of students achieving an overall freshman GPA of 3.5 or higher is remarkable. Since incoming characteristics were not significantly different, the continued improvement seen in academic years 2002/03 and 2003/04 may be due to the introduction of the Promise Scholarship, which requires students to maintain a high GPA, and the initiatives implemented in the freshman engineering program to help students improve their GPA.

Performance in Select Classes

The performance of all freshman engineering and general engineering students was evaluated by looking at the GPA and percent of grades of C or better for Calculus 1 (MATH 155), Fundamentals of Chemistry (CHEM 115) and General Physics (PHYS 111). These data show some improvement over the last four years with more substantial improvement in PHYS 111. The data are illustrated in Figures 8 through 10.

Performance in MATH 155 by academic year is presented in Figure 8. The GPA performance of all non-discipline major students in MATH 155 in the 03/04 AY was 1.78 compared to 1.82 in 2002/03, 1.56 in 2001/02 and 1.52 in 2000/01. The percent of C or better grades in MATH 155 in the 2003/04 AY was 53.2% compared to 51.8% in 2002/03, 43.1% in 01/02 and 38.3% in 2000/01.

Figure 8. Stacked Bar Figure of MATH 155 Grades Including AY-GPA and % of Grades => C



Performance in CHEM 115 by academic year is presented in Figure 9. The GPA performance of all freshman engineering and general engineering students in the 2003/04 academic year was 1.98 compared to 1.79 in 2002/03, 1.86 in 01/02 and 1.82 in 2000/01. The percent of C or better grades in CHEM 115 in the 2003/04 AY was 64.7% compared to 54.9% in 2002/03, 55.7% in 2001/02 and 55.1% in 2000/01.

Performance in PHYS 111 by academic year is presented in Figure 10. The GPA performance of all freshman engineering and general engineering students in PHYS 111 in the 2003/04 academic year was 2.22 compared to 1.82 in 2002/03, 1.97 in 2001/02 and 2.28 in 2000/01. The percent of C or better grades in PHYS 111 in the 2003/04 AY was 66.7% compared to 51.8% in 2002/03, 52% in 2001/02 and 63.6% in 2000/01. Enforcing the PHYS 111 prerequisite of a C or better in MATH 155 beginning in the 2003/04 academic year may have contributed to the increase in GPA and percent of C or better grades in 2003/04.

In general, these data suggest that the initiatives implemented by the College to help improve retention have had a significantly positive impact on the overall academic performance of the freshman class as well as improving the academic performance in key freshman courses.

Figure 9. Stacked Bar Figure of CHEM 115 Grades Including AY-GPA and % of Grades C or Better

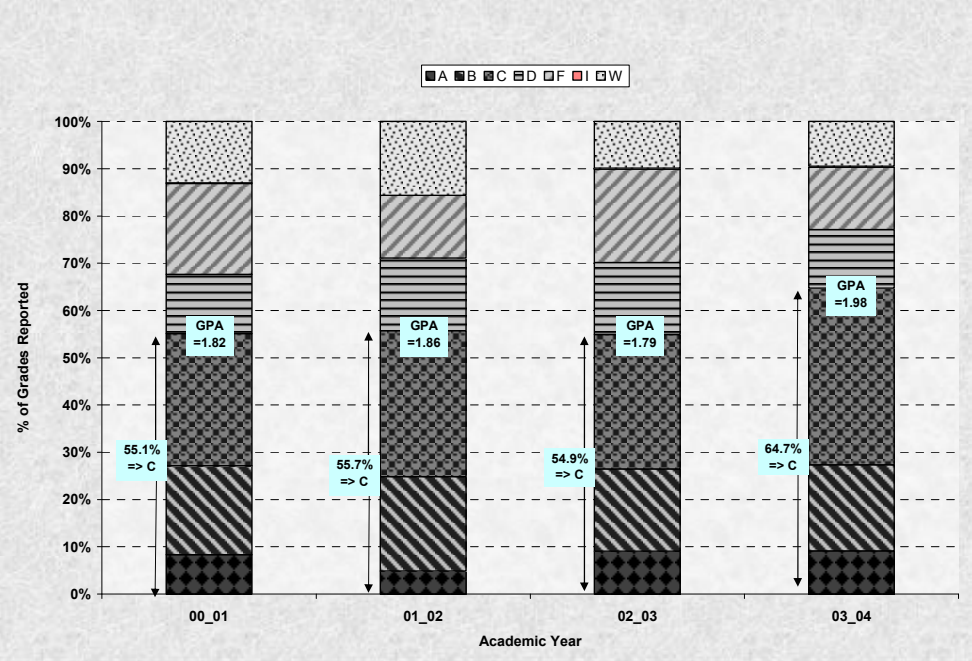
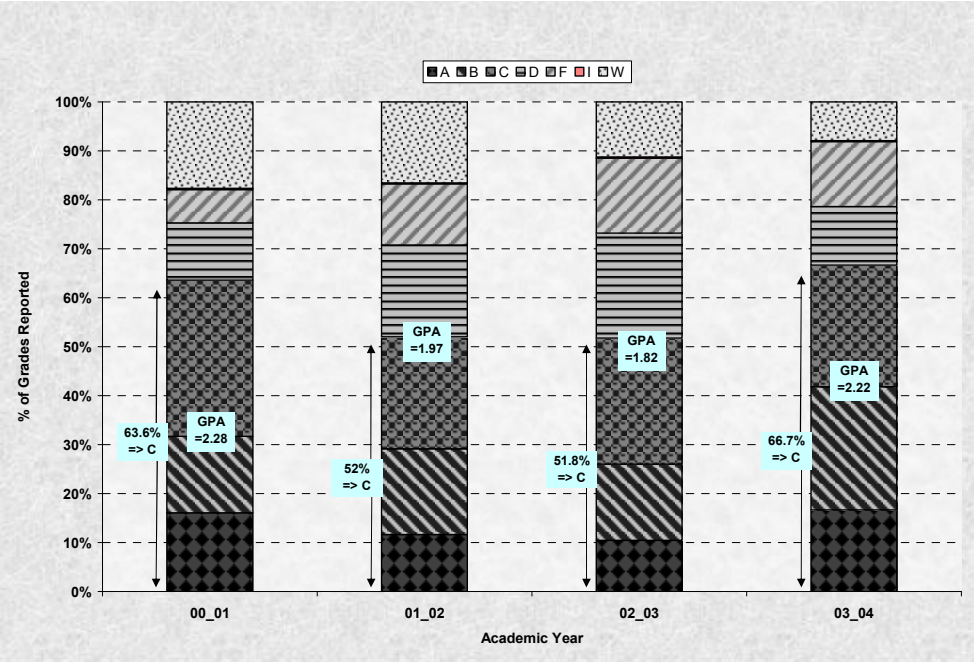


Figure 10. Stacked Bar Figure of PHYS 111 Grades Including AY-GPA and % of Grades of C or Better



CONCLUSION

The retention and student achievement data suggests that the implementation of the elements of an evolving retention plan has resulted in the improvement in freshman non-discipline major retention and academic performance. The key ingredients contributing to this success appear to be the implementation of two engineering tracks to facilitate an appropriate and achievable program of study for each student based on the student's mathematics preparation, development of a 1-credit hour engineering-specific freshman orientation course with mandatory weekly study labs, enforcement of pre-requisite grade standards for key courses, and well-managed freshman engineering courses focused on problem-solving.

Unfortunately, there is no way to dissect the data to indicate which programmatic change had the greatest or any effect on student retention or student success in the first year of their engineering education. While there may be confounding factors influencing the trends observed in the data, it seems to be clear that the combination of all efforts made to increase freshman success in engineering and to improve retention has been effective.

Recommendations for Further Study

Since the improvement in retention and student success is a continual process, data collection and analysis must also continue to determine which modifications are beneficial and which are not. Continued analysis of retention and student success data, as new ideas for the improvement of student retention and academic success are tried, will assist the College in determining which changes lead to significant and sustained improvement. Additional data related to student academic performance can be collected and analyzed to make recommendations to influence recruiting and advising of students. Increased understanding of student achievement patterns will assist the College in establishing appropriate acceptance and enrollment criteria and in determining more accurate course placement criteria. These future recommendations will have significant impacts, not only on programming and course development, but on student recruiting and academic advising as well.

In addition, through the process of implementing the various elements of the College's evolving retention plan, a continuing dialogue was opened with the University's Mathematics Department to explore ways of improving the performance of engineering freshman in Calculus 1. That dialogue is continuing and has expanded to include ways of helping students succeed in other required math courses and has also included the Chemistry and Physics Departments. Working together with engineering support departments to facilitate student achievement, by sharing student achievement data in selected courses and brainstorming, cooperatively, for new ways to help students succeed, will benefit all entities involved by gradually improving all students' opportunities for academic success. Continual assessment of each initiative must drive these efforts.

Bibliography

1. CEMR Academic Almanac, Prepared by the Office of the Associate Dean for Academic Affairs, 2000 – 2004 (Fall 2004).
2. The PROMISE Scholarship Website. 28 December 2004. www.promisescholarships.org.

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