AC 2010-386: GOLDSHIRT TRANSITIONAL PROGRAM: CREATING ENGINEERING CAPACITY AND EXPANDING DIVERSITY THROUGH A PERFORMANCE-ENHANCING YEAR

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GoldShirt Transitional Program: Creating Engineering Capacity and Expanding Diversity through a Performance-Enhancing Year

Abstract

At our nation's universities, too few rural, low-income, underrepresented minority and first-generation students pursue engineering degrees, and most well-prepared women show little interest. Because inadequate pre-college academic preparation is a known critical barrier to university-level engineering admission, one pathway for engineering colleges to increase their undergraduate student population diversity is to commit to boosting the performance of under-prepared high school graduates admitted under transitional status.

The Engineering GoldShirt Program at the University of Colorado at Boulder, supported by National Science Foundation funding, provides a *performance-enhancing year* for under-prepared students directly admitted to the engineering college. The highly-structured approach closely monitors student performance against seven goals. One goal is to increase student interest in, and knowledge of, an engineering career — supported by creating a strong community among GoldShirt students and the larger college population. Another goal is to ensure that students are prepared to academically perform in a traditional engineering program after their transitional GoldShirt year. By achieving all Program goals, we seek to create a national model for significantly boosting recruitment, retention and graduation of under-prepared students in engineering.

The Engineering GoldShirt Program enrolled its first cohort of 16 highly-motivated yet under-prepared students in fall 2009. In the pilot group, 11 represent the first-generation in their families to attend college, 13 are underrepresented minority students, and seven are female. This paper describes the College of Engineering and Applied Science's unique approach to expanding opportunity for students from historically underrepresented groups to succeed in engineering, and shares the lessons learned thus far about recruitment, admissions, curriculum development, course placement, and student support services — all strategies suitable for adoption by other engineering colleges. This includes eye-opening admissions process changes learned through our efforts to more inclusively identify students' potential for success, as well as other expected and unexpected pilot year outcomes.

The GoldShirt strategy described in this paper moves beyond competitive university recruitment efforts focused on the limited pool of best prepared and highly-sought-after US minority high school graduates — students who will likely join the engineering workforce regardless of what college they attend. The GoldShirt strategy aims to *create engineering capacity* from within the next tier of capable high school graduates. Using these multi-faceted approaches to augment the preparation of high-potential, underrepresented students, engineering colleges can more broadly serve the next generation and our nation.

The Preparation Gap

The University of Colorado at Boulder (CU-Boulder) is a public institution with more than 30,000 students, two-thirds of whom are Colorado residents. The College of Engineering and

Applied Science enrolls 3,059 undergraduate and 1,162 graduate students. Among engineering undergraduates, only 8% are underrepresented minorities (URM), 21% are women, and about 15% are first-generation college students. Even though 25% of Colorado high school graduates were underrepresented minorities in 2008, enrollment of such students in our college remained unchanged for a decade, at 7.6% in 1999 and 7.9% in 2009. Enrollment of female undergraduates has also remained flat over this period, at 21%. This enrollment condition is generally true nationwide: even as college campuses are becoming more diverse, engineering college demographics have been stubbornly resistant to reflecting the nation's demographics.

Inadequate pre-college academic preparation is a critical barrier to admission into engineering colleges, with only 4% of US African American and Latino high school graduates having the academic preparation to directly enter a four-year engineering program.[1] In response to our college's unacceptably low diversity numbers and this preparation gap, in 2009 CU-Boulder created the Engineering GoldShirt Program.

Engineering GoldShirt Program Overview

The Engineering GoldShirt Program's goals are to provide expanded opportunity and a *performance-enhancing "GoldShirt" year* for motivated high school graduates who are not *yet* fully prepared to succeed in an undergraduate engineering program, and to thereby increase enrollment and retention of students historically underrepresented in engineering. The Program strives to build community while providing academic scaffolding to enable GoldShirt students to complete engineering degrees and achieve excellence as they do so.

The Engineering GoldShirt Program admits disadvantaged, under-prepared high school graduates who demonstrate potential to be successful engineers, but fall short of meeting standard admissions criteria. GoldShirt students are expected to complete their BS degrees in five years, including the GoldShirt first year. Students are awarded a $2,500 scholarship for each year of successful participation in the Program. The tuition and fee cost for the GoldShirt Program is the same as a typical student in our college but GoldShirt students should expect their time to degree to be five instead of four years (or 4.5 which is the actual average time to degree in our college).

Various elements of the Engineering GoldShirt Program are designed to build community, ignite excitement about engineering, and prepare students to succeed in engineering. GoldShirt students participate in a two-week Summer Bridge program to orient them to the challenges of college, building community among the students, and developing leadership skills through a wide range of activities. During their initial GoldShirt year, students learn in small, cohort-based classes or co-seminars in mathematics, introductory physics, writing and critical thinking. GoldShirt students are placed into appropriate mathematics classes based on an in-depth placement exam and high school transcript review, with the intent to ensure they are prepared to enter or have begun the engineering calculus sequence at the close of their GoldShirt year. The GoldShirt year curriculum includes two critical thinking and writing classes taught in small sections, with reading and writing assignments focused on topics related to *Engineering and Society*. An introductory engineering design course integrates GoldShirt students with other college students for a semester-long hands-on design/build experience.

Students who achieve predefined metrics in the GoldShirt year continue on with the standard curriculum for their engineering major, along with ongoing required participation in community-building and service-learning activities throughout their subsequent four years.

The GoldShirt Program is led by a program director, who also serves as instructor for its *Preparatory Physics* course, and weekly *Leadership and Self-Management* seminar. The Program is supported by a faculty advisor, an evaluation and assessment coordinator, and the staff of the college's Broadening Opportunity through Leadership and Diversity (BOLD) Center — an academic excellence community that provides a positive environment for peer learning and academic support. The Program also receives significant support from other on-campus services and programs. The GoldShirt team meets biweekly to coordinate activities and review progress.

Targeted Recruitment for College-Wide Diversity

Our engineering college has struggled for years to expand enrollment of underrepresented engineering students, with limited success. The representation of rural, low-income, underrepresented minority and first-generation students is far lower in our college than their representation among college-age students in our state. Seeking alternative pathways that focus on *creating engineering interest and capacity* among underrepresented youth, in November 2008 the college's many recruitment and access activities were reorganized and centralized in the BOLD Center — a new diversity-focused, college-wide unit — making integration of minority student preparation and recruitment part of the day-to-day business of the BOLD leadership team. Despite a late start on the fall 2009 admission cycle, and in tandem with our GoldShirt initiative, our college directly enrolled a record number of minority (65) and women (178) first-year students in fall 2009. As a percentage of our total first-year population, this was 24.6% women, and 9.3% students of color, the latter entirely inadequate, but up from 7.1% in 2008.

To meet our aggressive capacity-building goals, we must cultivate and nurture many more partnerships with schools and school districts that serve significant numbers of minority and low-income students, in order for their teachers, counselors and families to feel comfortable recommending that students attend our predominantly-white, higher-SES institution. This is a formidable challenge, and underscores our understanding that *creating a climate of inclusive excellence is a people-driven, high-touch enterprise.*

To begin to establish more creative pathways for increased inclusive excellence, during 2009-10 we are executing a *Focus 12* plan in which we have identified 12 high schools within our region with which to form meaningful partnerships **—** six this year and six next. While tailoring approaches to meet the needs of each school's population and priorities, these partnerships include daylong, on-campus field trips during which students experience hands-on engineering design projects, visit engineering research labs, and engage in fun campus-wide, GPS-based scavenger hunts. For one set of nine high Latino-serving elementary, middle and high schools located 25 miles — but a world away — from Boulder, the principals asked us to host students' *families* on our campus so they can share their daughters' and sons' engineering projects showcased alongside the undergraduate design projects as part of our college-wide Engineering Design Expo; we're excited about this suggestion and will implement it during 2010.

Potential GoldShirt Impact on College-Wide Diversity — Assuming student demographics similar to those in our 2009 pilot cohort, coupled with planned 2010 doubling of the Program to 32 students, the GoldShirt Program has the likelihood of increasing by 40% our number of first-year URM engineering students, based on our five-year URM student enrollment history. And, if we increase GoldShirt first-year enrollment to 45 students in Year 4 (not currently in our funding model), we would see a 56% increase in URM student enrollment over our historic results. These dramatic increases do not take into account expected improved retention among our GoldShirt students, which would result in even higher graduation rates of minority engineers. Imagine the result if each of our nation's 350 engineering colleges implemented a GoldShirt performance-enhancing year program!

Admissions as Our Intellectual Partner

CU-Boulder's Office of Admission serves as a close and essential intellectual partner in the College of Engineering's quest for inclusive excellence reform. They share in our mission and passion for change, and partner with us in real-time reforms, especially when those reforms are supported by quantitative analysis of past results.

Past Successes Drive Future Approaches — To be more data-driven in our 2009 inclusive excellence admissions approach, we analyzed the *entering* standardized test scores, GPAs and class ranks of all 180 underrepresented minority engineering students who had *graduated* from our college during the prior five years, breaking those data down further by gender. This gave us a clear picture of the entering profile of successful minority students in our educational setting. To our chagrin, we found that since those graduates had entered our college, we had drastically increased our standardized test score admission requirements such that those successful URM engineering graduates were not likely to be admitted by our current profile. Oops! Clearly we had unwittingly migrated to an admissions profile that was unnecessarily restrictive for URM students to achieve engineering excellence, with the unintended consequence of denying such URM student candidates the *opportunity* to pursue an engineering future. With support from the engineering deans, and in partnership with our director of admissions, we immediately changed our fall 2009 cohort admissions practices to admit students within our known successful profile, sometimes offsetting lower test scores for URM students by other factors in their application — luckily supported by two new required application essays that helped us learn more about the students for a holistic application evaluation. Table 1 shows the high school academic performance of GoldShirt students (by gender), compared to regularly admitted first-year 2009 engineering students.

Table 1. High school performance comparison, GoldShirt vs. regular admit students.

Performance Indicators	Female GoldShirt Students	Male GoldShirt Students		Regularly Admitted Fall 2009 First-Year Students
Count (16 total GoldShirt students)	7	9		702
Average unweighted high school GPA (4.0 scale)	3.71	3.56		3.82
Average class rank	83%	81%		87%
Average ACT composite score	22.6	23.7		28.9
Average ACT math score	23.1	23.6		30.0

Must I Really *Decide on Engineering at 17?* **—** Our second significant 2009 admissions reform was inspired by the research of Ohland et al.[2] who, looking at the migration of students into STEM degree programs, found that engineering — in which only about 7% of graduates begin their educational quest in other majors — stands in sharp contrast to the sciences and computer science, in which 30-40% of graduates begin their undergraduate experience in other majors. Learning this, we revised our practice for admission to engineering for students who did not choose engineering directly after high school. Now, if a student *would have been admissible to engineering* within the past 18 months, but chose a different life path (working, studying any other discipline, traveling, etc.) and has not experienced academic failure while on a college path in any other major, we admit them directly to engineering if they express late-blooming interest. This makes transfer into engineering easier for students who have chosen to study at a community college or who were on our campus in another discipline and have not completed our daunting many-semester transfer requirements for calculus, chemistry and physics.

These seemingly small adjustments in our admission practices and policies are having a strong positive impact on creating multiple pathways for admission to engineering — all without putting our college at significant risk of reducing retention rates. And, while it is early, we are finding women inordinately represented among students who migrate to engineering via this pathway.

Finding GoldShirt Students **—** The GoldShirt strategy aims beyond the current US university recruitment "competition" to enroll from the limited pool of the best prepared (and highly-sought-after) minority, first-generation and female high school graduates — young adults who are destined to join the engineering workforce regardless of which engineering college they attend. Instead, our desire is to establish a replicable pathway for a diverse and excellence-focused engineering student body by engaging students who do not *yet* qualify for direct admission to engineering. By helping the next tier of capable high school graduates across the preparation gap, our college will be *creating new engineering capacity* — a service to our state and to our nation.

In our quest to find highly-motivated, underrepresented students who are not directly admitted to our engineering college, the GoldShirt Program is resource intensive and the selection process is rigorous. For our 2009 pilot cohort, we found that the primary reason GoldShirt students were not directly admitted was because of quite low standardized test scores. When reviewing an

applicant's file, if a strong reason exists to believe a student who is not admitted to engineering could be successful in engineering through participation in a *performance-enhancing GoldShirt year,* the admissions counselor forwards the application to our BOLD team. After the college's review, the applicant — and his or her parents — may be invited to a multi-family on-campus GoldShirt interview session.

Our multi-faceted interview session brought together 26 student candidates, most with one or two parents/guardians, for a half-day schedule that includes an introduction to engineering and the GoldShirt Program, followed by an ice-breaker. While the parents meet for a financial aid overview and discussion, the students participate in individual interviews (one student with two faculty/staff) and a campus tour. Brought back together, students work on team exercises so evaluators can observe how well each student performs in a team setting; during this time, the parents take a campus tour. Next, students are reunited with their parents for a lunch reception with current engineering students, faculty and staff.

This intensive individualized interview and group activity process allows the BOLD team to get to know the students and see how they interacted with peers. To our surprise, most students had a story to tell about a family-centered trial they experienced during high school that had a severe impact on their academic performance — frequently resulting in a one-year academic derailment. There is also value in the candidates and their families being introduced to the other potential students as a foundation for community-building.

Figure 1. CU-Boulder's 2009 Engineering GoldShirt Program students (and instructor).

After the interviews, the BOLD faculty and staff team make a collaborative decision regarding admission of each student. For the fall 2009 pilot cohort, our goal was to enroll 15 students. We interviewed 26 candidates and offered GoldShirt admission to 22; of those, 17 accepted our offer. (One student subsequently withdrew from the Program a couple weeks into school to

return to her hometown to study education.) Of the 17 students who accepted admission in the Program, 11 are first-generation college-bound, 13 are underrepresented minorities, eight are women and six are English language learners. More importantly, they are an inclusive group of motivated women and men with real histories, including a young Latina mother, a cancer survivor and a Native American rancher (see Figure 1).

Admissions Surprises — A few surprises were encountered in our pilot GoldShirt admissions process. As we performed the more comprehensive application reviews, we directly admitted many students who would not have typically been admitted. This was especially true among female students with lower standardized math test scores; upon further review, high class ranks, high academic performance throughout high school and strong high school course selection justified their direct admission to engineering. Thus, we found that we had to "dig deeper" into the pool of female applicants to find GoldShirt candidates. Interestingly, after reviewing the GoldShirt students' first semester engineering performance, we believe that we can dig *even deeper* for the second cohort, looking at ACT math scores down to the 21 range.

We also found that while the female GoldShirt students came in with lower math test scores, they placed at higher levels in university math courses and performed in them at a very high level. Thus, for this small cohort, the women's lower standardized test scores in math were not predictive of their first semester performance. Clearly we must track — and more deeply explore — this as we expand the GoldShirt Program.

Figure 2. Summer Bridge experiences lay the groundwork for a successful GoldShirt first year.

GoldShirt Summer Bridge Experience

To jump-start their academic careers, GoldShirt students participated in a two-week residential Summer Bridge experience. The goals were twofold: 1) to prepare students both academically and mentally for the fall term, and 2) to build a strong, interdependent scholarly community. To achieve these goals, the summer experience included courses in engineering design, math, computing, and humanities, coupled with team-building activities and student life seminars (see Figure 2). Summer Bridge outcomes included:

- *Fall course placement:* Through study sessions and multiple assessments, students were placed into five different fall math courses (see Table 4). All 16 are on track to take calculus after their GoldShirt year; and 11 will complete Calculus I during their GoldShirt year.
- *Orientation to college life:* For most of the students, the two-week Summer Bridge was their first university experience. They learned valuable skills in time management, studying, and living with others. And, becoming familiar with campus and its resources reduced anxiety about starting college.
- *Technical skills:* The students gained experience using engineering software (Excel, Matlab, SolidWorks, CorelDraw), and were introduced to the iterative, hands-on design process.
- *Creating shared core values:* Together, students defined a set of core values to which they hold themselves accountable.
- *Interdependent learning:* During the second week, students spontaneously formed math study groups when given free time. The resident advisors report that this behavior was also common during evening study hours.
- *Close friendships:* By Day 2, students claimed to know each other inside and out. By Day 4, they referred to each other as family, and by Day 12 were eager to share what they liked best about each other. This astounding cohort-building outcome exceeded our expectations.

GoldShirt Curriculum

The first-year GoldShirt curriculum is designed to prepare students academically in mathematics and science before they enter engineering calculus, physics and chemistry courses. The curriculum is designed to meet each student where his/her needs are, as determined from their high school transcript and the math placement exam at the end of Summer Bridge. The GoldShirt first-year curriculum consists of the courses listed in Table 2.

Table 2. Engineering GoldShirt Program first-year curriculum.

GoldShirt Year — Fall Semester	GoldShirt Year — Spring Semester
Mathematics **(4-5 credits)** • Algebra, trigonometry or calculus • Determined by math placement exam • Concurrent *Academic Excellence Workshops*	***Mathematics*** **(4-5 credits)** • Next level math class • Concurrent *Academic Excellence Workshops*
Preparatory Physics **(3 credits)** • Small section course	***Introduction to Chemistry*** **(3 credits)** • Open to all students
First-Year Engineering Projects **(3 credits)** • Hands-on, team-based design course • Integrated with first-year engineering students throughout the college	***Free elective*** **(3 credits)** • GoldShirt student choice • Encouraged to select outside of engineering
Engineering for Society (**3 credits)** • Writing and critical thinking course • Small section GoldShirt-only course	***The Meaning of Information Technology*** **(3 credits)** • Writing and critical thinking course • Small section course open to all students
Leadership and Self-Management I **(1 credit)** • Small section GoldShirt-only course	***Leadership and Self-Management II*** **(1 credit)** • Small section GoldShirt-only course

Several of these courses count toward engineering degree requirements (*Calculus*, *First-Year Engineering Projects*, *Engineering for Society*, *The Meaning of Information Technology*, and

Leadership and Self-Management), so GoldShirt students complete their first year with 9–18 credits toward their engineering degrees.

Math Placement and Courses — Table 3 provides an overview of the highest mathematics courses that GoldShirt students completed in high school, segregated by gender. Looking at their transcripts, this suggested that 12 of the students were prepared for college calculus, but this was not supported by their Summer Bridge math placement exam results, in which only six placed into some level of calculus (see Table 4).

Table 3. GoldShirt students' highest high school math course, by gender.

	Count (16 total)	**Most Advanced High School Math Course (# students)**
Female Students	7	AP Calculus (4), Pre-Calculus (1), Discrete Math (1), AP Calculus and AP Statistics (1)
Male Students	9	AP Calculus (2), Calculus 2 (1), IB Math Studies II (1), Pre-Calculus (3), AP Statistics (1), College Trigonometry (1)

Table 4. GoldShirt student Summer Bridge math placement results.

Intro to College Algebra (Math 1005)	**Calculus-Bound College Algebra (Math 1011)**	**Calculus 1A/1B (two semester Calculus 1)**	**Calculus 1 (one semester)**	**Calculus 2 (one semester)**
4 placed 2 male 2 female	***6 placed*** 4 male 2 female	***3 placed*** 3 male 0 female	***2 placed (3 enrolled)*** 0 male 2 female	****1 placed*** 0 male 1 female
*One student placed into Calculus 2, but chose to enroll into Calculus 1 to better master the concepts.				

Thus, we learned that even though students had completed upper-level math classes in high school (e.g., calculus, pre-calculus, etc.), they did not demonstrate readiness for the college-level math class next in sequence. It may be that this lack of readiness reflects that many of the students graduated from high schools that under-prepare them for the expectations of college mathematics. The students were, understandably, upset that they did not place into the course they had anticipated. Several expressed frustration with their performance and asked to retake the assessment. These students were invited to study and practice for the exam, return to the university with their study materials and take the test again in early August. None ultimately chose to retest. Some students who placed into college algebra initially said they thought the course was too easy, but as the semester progressed, their uneasiness dissipated as they realized that they were "familiar" with the material but had not "mastered" the concepts.

Preparatory GoldShirt Physics — This GoldShirt course aims to provide a strong foundational understanding of physics concepts through a combination of lectures, experiments, online simulations, and a hands-on project. The concepts taught in the course include kinematics, Newton's laws, work, and energy — all concepts for which the Colorado high school educational science standards require students be able to demonstrate mastery. In high school, 13 of the 16 GoldShirt students had completed either regular Physics or AP Physics.

To verify students' mastery of key concepts before taking college physics, the pre- and post-Force and Motion Conceptual Evaluations (FMCE) were given to 17 of the 23 enrolled students in the course (including 14 of the 16 GoldShirt students). The pre-test was administered in August, and the post-test was in December; the results are provided in the Academic Performance Results section in this paper.

First-Year Engineering Projects — A decade's worth of college data show that First Year students who take this course are more likely to persist in engineering and graduate. Throughout this 15-week elective, students work in small teams to apply their scientific and mathematical skills to interdisciplinary engineering design / build projects. Completed projects are exhibited at an end-of-semester design exposition. All GoldShirt students took the course in classes along with traditional path engineering students. One instructor who had many GoldShirt students enrolled in his section did not realize that he had *any* GoldShirt students in the class.

The Herbst Program of Humanities in Engineering Courses — The Herbst college-wide program enriches and broadens technical education through discussion-based classes and seminars on the great works in literature, art, history, and political and social thought. Herbst courses encourage students to engage in immediately relevant and significant conversations about our world.

Herbst faculty designed a two-course sequence for the GoldShirt Program; both courses count toward college Humanities and Social Sciences course requirements. *Engineering for Society* (3 credits) focuses on historical engineering challenges, and the creativity and skills required to meet those challenges. Students trace technological innovation from the Stone Age to the Atomic Age through readings, writing, research projects and small-group discussions of original source materials. Discussing these sources from the past inevitably leads to reflections on the present, and suggests how to improve engineering practice in the future.

In *The Meaning of Information Technology* (3 credits) course, students examine the commercial, artistic, civic, and social implications of information technologies (IT). Through small-group reading, research, writing projects and discussion, students improve their understanding of their roles in a digitally-interconnected world, and appreciate how ubiquitous IT gadgets work, how social networks impact behavior (cell phone, texting, blogging, FaceBook), and how human behavior impacts IT development. In both classes, students write extensively and iteratively (approximately 40 pages of multi-draft graded writing, as well as blog posts and wiki contributions). They also present their own work (using a variety of presentation methodologies), and learn to engage in the positive give-and-take of academic debate.

Leadership and Self-Management Course — Designed to create group cohesiveness, mutual support, multicultural awareness, and leadership, this course also teaches time management, goal setting, résumé writing and learning styles. In fall, guest speakers presented on the topics of internships, faculty research, brain rules, the malleability of intelligence, and preparing for career fairs.

Academic Excellence Workshops — Conducted concurrently with many mathematics and science courses, these workshops, taught by teaching assistants, guide students in practice problems and further course review.

Academic Performance Results

A grade check was required of all GoldShirt students in mid- to late-October. Instructors reported estimated grades within a range, so low and high estimates of midterm GPA were computed for each student, with the results presented in Table 5.

Table 5. Engineering GoldShirt Program first semester midterm GPA forecasts and final results.

	Low-end Midterm GPA forecasts (out of 4.00)	High-end Midterm GPA forecasts (out of 4.00)	Final Semester GPA (out of 4.00)
Average	3.12	3.22	3.43
Maximum	3.63	3.78	4.00
Minimum	2.49	2.84	2.61
Median	3.14	3.22	3.44

After midterm grades were reported and analyzed, the GoldShirt Program director conferred with students whose report contained one or more Cs. The goal of these conferences was to develop strategies for making academic improvements in courses in which students struggled. Both study strategies and time management were discussed. In some cases, it was discovered that family concerns and issues were affecting students' performances, so strategies for managing these concerns were discussed. In all cases, the data suggest that the interventions made a difference. The results of final first-semester grades for the cohort showed good improvement from the estimated midterm grades. Of the 16 students, 15 had final GPAs above 3.0, with the range from 2.61 to 4.0 (median 3.44 and mean 3.43).

The GoldShirt students thrived in their math courses. The average GoldShirt grade in *Intro to College Algebra* was 90%, in *Calculus-Bound College Algebra* was 86%, and in the *Calculus 1A/1B Course* was 91%. Additionally, the GoldShirt students worked well collaboratively and helped to further motivate other students in *Calculus-Bound College Algebra*. The entire *Calculus 1A/1B Course* is collaborative, including exams; GoldShirt students excelled at the group exams. As part of the *Calculus 1A/1B Course*, they were introduced to the concepts and applications of limits and derivatives in calculus. Their dialogue about the material was insightful, critical, and at a level we look for in calculus students.

All students passed the *Preparatory Physics* course which means they are all ready to take college physics. The physics pre- and post-FMCE shows that students gained significant improvement in understanding in all concept clusters measured by the assessment. Overall, the class as a whole gained 24% from pre- to post-exam.

All members of the first GoldShirt cohort completed their first semester in good academic standing and five made the Dean's list (GPA 3.6 or above). Three of the five on the Dean's list are women. And, all six students who took calculus succeeded, with an average grade of 3.26 (B+). In reviewing the students' predicted first-year GPAs based on their high school performances, all GoldShirt students exceeded their predicted GPAs in their first semester, with the difference ranging from +0.04 to +1.43 on a 4.0 scale.

Student Feedback Results

Student feedback was gathered as part of the assessment plan for the GoldShirt Program through the administration of four surveys along a specified timeline: pre-Program, post-Summer Bridge, mid-semester, and mid-year. The surveys included questions from the Academic Pathways of People Learning Engineering Survey (APPLES)[3] as well as questions created to specifically assess the GoldShirt Program. Survey questions included qualitative, open-ended questions and quantitative questions with a Likert-type response format.

While a summative assessment of the Program is premature at this time, preliminary results are described in this paper, targeting the following GoldShirt Program goals:

Goal 1: Increase engineering student interest and knowledge of an engineering career.
Goal 2: Build a sense of community among GoldShirt students and the larger college population.
Goal 3: Prepare students to succeed in a traditional engineering program the following year.

Regarding Goal 1, knowledge of engineering as a career was measured on the pre-Program survey and mid-year survey. Student responses to the pre-Program survey question: "How clear was your understanding of engineering as a career before you enrolled at CU?" indicated that 29% of GoldShirt students were clear or very clear on their knowledge of engineering as a career. Mid-year survey responses to the question: "How clear is your understanding of engineering as a career now?" indicated that 100% of students were clear or very clear regarding their knowledge — a remarkable +245% gain in knowledge of engineering as a career.

Student interest was also measured at the pre-Program, post-Summer Bridge, and mid-year survey with the question: "Do you intend to complete a major in engineering?" Results from all three assessment points found that 100% of students answered either probably or definitely yes, indicating a strong commitment to graduating in engineering, which has been maintained throughout the first semester. Given these results, Goal 1 objectives have been successfully met.

For Goal 2, a sense of community was measured against GoldShirt students' experiences working in teams. Students were assessed on their team experiences on the pre-Program, post-Summer Bridge, and mid-year survey with the question: "To what extent have you found it beneficial to work in teams?" Results from the pre-Program and post-Summer Bridge survey found that 82% of students found team experiences often or always beneficial, while 100% of students found benefit in teamwork on the mid-year survey, a 28% gain. One GoldShirt student commented on his/her Summer Bridge team experience, "At first we came into the Program not knowing anyone, but now we're like a family. By working together, we get to know others' strengths and weaknesses, which holds us so close to each other." Another GoldShirt student referred to his/her first-semester engineering projects course team as "solid and unifying."

An additional indicator of the development of a sense of community within the GoldShirt Program came in response to an open-ended question on the mid-semester survey: "What has been the highlight of the GoldShirt Program for you?" Here, 77% of respondents focused on the community aspect as the Program highlight. One student said the highlight of the Program was,

"Meeting some of the coolest people I know, who are and will always be my family away from home." Another commented, "GoldShirt gives me a chance to be in a small community within CU that helps me adapt to the college life as well as helping me improve my study habits."

While our goal of building community within the Program is judged a success, it has been more of a challenge to integrate GoldShirt students into the larger population in the College of Engineering. On the mid-year survey, student responses to the question: "What might best improve the GoldShirt Program?" resulted in 31% of respondents indicating some difficulties finding equal footing with students outside of the GoldShirt Program. One student suggested "…having a better understanding from the beginning that it is not the same as being directly in the engineering school. It would help so when you realize it when you are around your other friends it doesn't have as big of an impact on your ego." Another commented, "There is a perception by other students that GoldShirt students aren't as smart as other engineering students so dealing with what some people say about us has been a little difficult."

With respect to Goal 3, students were asked the following question on the pre-survey and the mid-year survey: "How prepared do you think you are to study the following subjects in the CU-College of Engineering and Applied Science?" Table 6 presents the percentages of students who responded "somewhat prepared" or "highly prepared."

Table 6. Student self-ratings of preparation to study engineering subjects.

Course Subject	Pre-Survey	Mid-Year Survey	Change
Physics	65%	75%	+15%
Engineering design	59%	63%	+7%
Calculus	71%	75%	+6%
Technical writing	41%	38%	-7%

Results show preparation gains in three of four subject areas, with the strongest gains in physics. One GoldShirt student commented on the mid-semester survey about his/her physics preparation, "My physics instructor is good. She explains everything until the students understand it." Another commented on his/her engineering design course, "Very well constructed class, allows for hands-on work and the chance to actually apply what we learn in math and physics to what we make." Finally, one student commented on math preparation, "Starting off in an introductory math class has helped me understand all the basic things in math that I used to have questions about." The lowest self-ratings for preparation went to technical writing — a subject with which engineering students typically struggle. Additional assistance or curriculum in this area may be warranted, and/or it may be that students' awareness of writing expectations and challenges increased as a consequence of feedback received in their fall semester courses.

In summary, student feedback on three goals of the GoldShirt Program indicated successes for each goal. Students became more knowledgeable about engineering as a career and maintained a strong commitment to gaining an engineering degree. GoldShirt students bonded strongly as a community, had good team experiences, and often referred to themselves as a "family." Also, the GoldShirt curriculum made students feel more prepared to study traditional engineering subjects. Suggestions for improvement to the GoldShirt Program include efforts to better integrate

GoldShirt students with the larger engineering college student community and continued attention to technical writing skills.

GoldShirt Program Funding

The pilot year of the Engineering GoldShirt Program was financially supported by the National Science Foundation, and alumni and friends of the College of Engineering and Applied Science. Ongoing campus funding and gifts from college alumni and friends will cover much of the cost associated with continuing and expanding the Program in coming years with a significant fundraising component to provide the GoldShirt scholarships.

Conclusion

As with engineering colleges across the country, our college has struggled for years to increase enrollment of underrepresented students, with limited success. The Engineering GoldShirt Program was created to expand access by directly addressing the critical barrier of inadequate preparation. The first GoldShirt cohort of 16 students was enrolled in fall 2009 and student enrollment is expected to double to 32 for 2010. The Program is resource intensive and draws on expertise across the university, including the Office of Admissions, Student Academic Services Center, BOLD Center college staff, and college faculty. The Program also builds on expanded K-12 partnerships with school districts with high enrollments of underrepresented students.

Admission to the GoldShirt Program is based on a comprehensive review of student preparation — looking beyond standardized test scores to gauge motivation and potential for success with additional academic preparation. Beyond identifying an outstanding GoldShirt cohort, the expanded review also benefitted the college by identifying for standard admission many promising students whose high school performances overrode concerns about relatively low standardized test scores. As a result, we now give greater consideration to students whose test scores would disqualify them for standard admission.

Most students in our pilot GoldShirt cohort had taken advanced mathematics courses in high school and on that basis appeared ready to start engineering calculus. However, placement test results indicated only six of the 16 were adequately prepared. The other 10 students were placed into preparatory courses; they have demonstrated strong progress and all are expected to have started or be ready to start the engineering calculus sequence by the end of their first year.

The pilot class of GoldShirt students exceeded expectations for academic performance in their first semester, with a median GPA of 3.4 on a scale of 4.0. Five students made the Dean’s list. Student feedback indicates they have strengthened their interest in engineering as a career, and established strong bonds with each other. Students in the pilot class have established a strong foundation for success and are pioneering a new pathway for academic excellence and diversity. Based on our early experience, undergraduate engineering programs seeking to expand opportunities for motivated but under-prepared students should comprehensively examine their recruiting and admission processes, placement procedures and mechanisms for bolstering preparation for gateway engineering courses, academic advising and support, and efforts to build community and engagement with engineering.

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