AC 2009-590: EVALUATION OF RETENTION AND OTHER BENEFITS OF A FIFTEEN-YEAR RESIDENTIAL BRIDGE PROGRAM FOR UNDERREPRESENTED ENGINEERING STUDENTS

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Evaluation of Retention and Other Benefits of a Fifteen-Year Residential Bridge Program for Underrepresented Engineering Students

Abstract

Since 1993, the College of Engineering at the University of Florida has conducted a first-year bridge program for over 600 underrepresented students in engineering. This program, entitled Successful Transition through Enhanced Preparation for Undergraduate Programs (STEPUP), consists of two major components, a six-week summer residential program and an eight-month non-residential program taking place during the students' first academic year.

The residential component of the program was developed to address the majority of the potential first-year issues and challenges that can negatively impact freshmen minority students. Some of these issues are addressed by providing quality role models and a positive exposure to the field of engineering. The rigorous six-week program involves a variety of components over a fourteen-hour day period, including supplemental instruction in chemistry and calculus, personal and professional development instruction, a course in problem-solving and design requiring use of AutoCAD (Autodesk, Inc., San Rafael, CA, USA) and MATLAB (The Math Works, Inc., Natick, MA, USA), and a course that introduces the students to every major offered in the College of Engineering. The non-residential component of the STEPUP program, conducted during the students' first fall and spring terms, involves a strong peer, faculty, and professional mentoring component along with extensive tutoring through required study halls. Other support structures of the program include corporate presentations and team-building activities.

This paper will present qualitative and quantitative results of the program, including improved retention, which is the primary objective of the STEPUP program. Less tangible, but equally important, benefits of STEPUP will also be discussed, especially as they relate to the positive impacts in the development of a peer community that remains intact throughout their undergraduate experience.

Introduction/Background

Diversity: essential for the engineering profession

One of the key challenges in engineering education outlined recently by the National Science Foundation involves retention of engineering students. The greatest attrition of engineering students is experienced during the first year, when students are often engaged in non-engineering classes and thus have no identity as an engineer offered to them. The average national retention experienced by students who begin their major as engineers is 60%, while females and minorities experience an even lower retention. As the United States rapidly approaches a population in which today’s minority will become the majority by 2042, concerns have arisen within the engineering community over the lack of diversity in its workforce. Engineering designs will be targeted to an increasingly multiethnic population, thus calling for a mirroring of ethnicities in the design workforce. Recent reports echo this call to engineering educational institutions to recruit and retain a more diverse engineering student population and have prompted institutional studies to better understand what pedagogical and programmatic features in engineering education are most effective in retention of underrepresented students.
History and vision of the University of Florida STEPUP program

As a means of addressing the concerns of retention of underrepresented students, the College of Engineering at the University of Florida founded a Minority Retention Success program in 1994 using funding from the National Science Foundation’s SUCCEED program. This early version of the program included the elements of instruction in pre-calculus, physics, chemistry, and computer applications, mentoring, tutoring, study halls, and development of team skills, with the primary objective of student preparation for the demands and challenges of college-level courses. Selection of the students was made from among those with a score of 600 or less on the analytical component of the SAT exam, based on historical evidence that these students are most at risk of performing at a lower level in engineering-related coursework than their higher-scoring cohorts. To address a problem of poor attendance in activities in the non-residential program in 1994, the College expanded this Minority Retention Success program to include a residential element in the second summer semester in 1995. This residential element intensified mentoring efforts, increased rapport among the freshmen student cohort, and improved the ability to track and assess each student’s performance. The STEPUP program, Successful Transition through Enhanced Preparation for Undergraduate Programs, was named thus in 1995, officially adopting the combination of residential and non-residential elements that mirrors its current form.

The initial pilot program in 1994 was shaped around several basic assumptions about the target population, and these remain the core values of the STEPUP program today. They are as follows:

1. Every student accepted into the university/college has the potential to successfully pursue an engineering curriculum.
2. Students are motivated to succeed and will do so if provided the proper support system.
3. The focus of the design of the program is to enhance, not remediate. Because of stringent admissions requirements at the University of Florida, each student has successfully established a basic foundation in math (calculus) and the sciences (chemistry, physics) prior to their admission into the university.
4. The primary stakeholders—the university, the college, faculty, the student’s family, the student, and corporate practitioners—will make the necessary investments to ensure the success and sustainability of the program. Investments into STEPUP include, but are not limited to, financial resources, individual/collaborative time contribution, and recognition that each student’s needs are a priority.

Objectives

Today, the call to engineering education institutions in the United States to increase and maintain diversity in the engineering workforce is unwavering and cannot be ignored. As the STEPUP program nears completion of its fourteenth year with a residential component and fifteenth year of existence, it serves as a direct response to this call for increased diversity among engineering disciplines. The primary objective of this paper is to present a detailed snapshot of the administration and operation of the STEPUP program, a description of the sources of funding for
this program, initial persistence results from the past twelve years, and areas of flexibility for future enhancement.

**Detailed elements of the current STEPUP program**

*Staffing resources*

The success of the STEPUP program is critically dependent on the roles played by staff and students. To ensure successful execution, two staff members, who are professional advisors under the leadership of the Associate Dean for Student Affairs, serve the role of full-time coordinators over the duration of the program. Under their direction, a team of undergraduate student mentors, alumni of previous STEPUP classes, are selected to help with various activities. During the summer, these students are actively engaged in direct mentoring of students and performing resident assistants’ tasks in the residence hall. The lead mentor, besides having the responsibility of guiding and serving as a role model for other mentors, teaches the pre-calculus course to the STEPUP students. During the fall and spring semesters, these student leaders mentor and tutor on an as-needed basis.

Other professional advisors in the College of Engineering Student Affairs are also involved at different levels, performing various roles, including teaching problem-solving and student success workshops. A graduate-level engineering student serves as the grader for the design and problem-solving class, and two engineering faculty teach AutoCAD (Autodesk, Inc., San Rafael, CA, USA) and MATLAB (The Math Works, Inc., Natick, MA, USA) courses as well as run the project design portion of the STEPUP summer experience. The teaching assistants for the MATLAB course have traditionally been graduate engineering students, whereas upper-class undergraduate engineering students have provided support for the AutoCAD course.

*Recruiting, application, and selection process*

The University of Florida’s College of Engineering Student Affairs receives a database of all students admitted into engineering from the Office of Admissions approximately a week after freshmen admissions decisions have been made in mid-February. Soon thereafter, Student Affairs sends potential STEPUP students an invitation, including applications and testimonial statements. The STEPUP coordinators and student mentors follow up this mailing with a phone call to these targeted students. Admissions into the STEPUP program is based on the strength of a student’s background in high school coursework, grades in science and math (noted from transcripts), teacher recommendation letters, and a required essay describing their desire to enter into the field of engineering.

Once a student receives acceptance into the STEPUP program, s/he must sign a contract and release form and is provided information on housing, the STEPUP orientation weekend, meals, industry tours, and the structure of both the residential summer and non-residential fall and spring program. STEPUP students are designated as “Summer B” admits (a six-week term) and attend Preview, a university orientation program required of all students, during which they register for fall classes. A fee of $750 is charged to each student to partially cover the expenses...
of the program; however, the bulk of the funds to support STEPUP are derived from donor gifts to the College of Engineering.

**Summer residential program**

During the summer residential session, the participants live together, work together, and share meals together. The College of Engineering covers the cost of housing, meals, instructors, mentors, social gatherings, and a chartered bus to travel to the weekly industry tours. The students’ first weekend of orientation begins the STEPUP experience with sessions for parents and students and an opening dinner. The sessions serve as a welcome and introduction to the format/structure of the year-long program, and they also serve to answer any initial questions from parents and students. The primary goal of the orientation weekend experience is to instill a level of comfort in both the parents and students, as the parents entrust the College of Engineering to the care of their children.

Table 1 shows the schedule of a typical Monday-Thursday for the STEPUP students. Activities on Monday through Thursday are centered on academic course work and enhancing academic performance. Academic preparation include courses in Pre-calculus or Calculus I (depending on their placement for the fall term), Pre-chemistry or Chemistry I (depending on their placement for the fall term), computer programming using AutoCAD and MATLAB, student development courses (entitled “Student Success” and focused on college success skills), and an engineering problem-solving course. Students earn one hour of credit by enrolling in a course, “Introduction to Engineering,” that provides an overview of each undergraduate major in the College, and they participate in a project, involving design of a rubber band-powered car with robotics and culminating in an end-of-summer poster presentation and competition. Program courses are facilitated by a team composed of faculty members, engineering graduate students, department administrators and program mentors, who were also graduates of the program, as described previously.

<table>
<thead>
<tr>
<th>Day</th>
<th>Activity</th>
</tr>
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<tbody>
<tr>
<td>7:00-7:55 a.m.</td>
<td>Group Breakfast</td>
</tr>
<tr>
<td>8:00-9:15 a.m.</td>
<td>Calculus or Chemistry</td>
</tr>
<tr>
<td>9:30-10:45 a.m.</td>
<td>Calculus or Chemistry</td>
</tr>
<tr>
<td>11:00 a.m.-12:15 p.m.</td>
<td>Student Development Courses or Lunch</td>
</tr>
<tr>
<td>12:30-1:45 p.m.</td>
<td>Student Development Courses or Lunch</td>
</tr>
<tr>
<td>2:00-3:15 p.m.</td>
<td>AutoCAD or MATLAB</td>
</tr>
<tr>
<td>3:30-6:00 p.m.</td>
<td>Project Design Class/Introduction to Engineering</td>
</tr>
<tr>
<td>6:15-7:00 p.m.</td>
<td>Group Dinner</td>
</tr>
<tr>
<td>7:15-9:00 p.m.</td>
<td>Study Hall</td>
</tr>
</tbody>
</table>

The remaining portion of the program centers on peer mentoring, team-building exercises, and networking with engineering professionals and College of Engineering faculty. Professional networking activities involve weekly tours of engineering and manufacturing facilities and speaker presentations by engineers from government and corporate organizations, such as
NASA, The Walt Disney Company, Lockheed Martin, Inc., and Anheuser-Busch, Inc., etc. A faculty speaker series exposes students to department-related research endeavors and tips regarding academic preparation. On the weekends, program mentors are responsible for planning fun activities (e.g., team sports activities, campus scavenger hunts, movie nights, interactive games, etc.) that promote community-building through teamwork. The program also includes two home visitation weekends during which students are allowed to leave the program to visit their families.

A closing celebratory luncheon ends the 6-week summer component. Attended by both the students and their family, this event is a celebration of accomplishment of the students and an opportunity for the parents to observe the rapid maturing and preparedness of their children as they fully begin their engineering study.

Fall and spring non-residential programs

During their first fall semester, the STEPUP students enroll in the calculus and chemistry course equivalents of those taken during the summer residential component of the program. Additional courses may include general education classes, First Year Florida (a freshmen introductory course), courses to complete a minor, and other introductory courses offered by the College. Students are required to attend study hall sessions at a minimum of 4 hours per week and a minimum of two Student Success Workshops offered by Student Affairs staff on topics ranging from time management, resume development, test-taking skills, etc. Regular group meetings with the coordinators, mentors, and peer participants are scheduled at the beginning of each semester and over the course of the semester as needed. Program participants are also prepared to participate in a large career fair in the fall (well-attended by potential employers and hosted by the University of Florida Career Resource Center, http://www.crc.ufl.edu) as a means of identifying potential internship opportunities for the summer after their first academic year. Preparation for the career fair involves developing their resume, refreshing their skills in introducing themselves to potential employers, and guiding them through a job interview.

Students who have completed the summer program with a cumulative GPA of a 3.0 or higher are provided the opportunity to participate in the STEPUP Corporate Mentor Program that commences in the fall term. These students are matched with practicing engineers as a means of providing additional professional guidance and advisement. Currently, engineers from the Kraft Foods Company are participating in the Corporate Mentor Program, which offers monthly teleconferences, on-site mentor/mentee meetings, and additional corporate presence throughout the entire first year of the program. Students who have completed the summer program with a cumulative GPA below 3.0 are required to attend mandatory bi-monthly advising sessions with a program coordinator during the fall and/or spring semester. These advising sessions afford the program coordinators an opportunity to further intervene and assist the student in making a successful transition into the mainstream college/university.

During the students’ first spring semester, program requirements are the same as those in the fall (study hall, Student Success Workshops, and attendance at a University of Florida career fair). As students progress further into the semester, they are encouraged to schedule visits with their
engineering departmental advisors to learn more about their specific major of interest and to seek admission into the department if applicable.

After STEPUP

Upon completion of the STEPUP year-long experience, the graduates are always welcome back to contribute their wisdom to the incoming class. As previously described, some STEPUP alumni return as mentors; however, the perception of most of the alumni is that they all are mentors for current students in some way. Feedback from students who have graduated from the first-year STEPUP program repeatedly reports that their perception of being a STEPUP student never ceases. This initial community of entering students experiences a broadened network of STEPUP graduates, many of whom are upper division students and many others who are working throughout the world in the profession of engineering. During their STEPUP year, students are encouraged to become involved in engineering societies, such as the National Society for Black Engineers, the Society for Hispanic Professional Engineers, and the Society of Women Engineers, all with very active student chapters at the University of Florida. Many of the officers of these organizations are STEPUP alumni because of the tradition of leadership begun during their first-year experience, and these students participate in the tradition of attending national conferences sponsored by these organizations in order to further network with peers and potential employers.

The Corporate Mentoring Program continues throughout the students’ undergraduate experience. The current corporate participant in this program, Kraft Foods Company, increases the level of mentoring as the student progresses towards degree, with the intent of hiring these students into “co-op” positions and/or permanent positions upon graduation. Students are strongly encouraged to pursue an internship after graduation from the STEPUP program, especially during the summer between their first and second years. The University of Florida’s College of Engineering has strong connections to the INROADS program (http://www.inroads.org/inroads/inroadsHome.jsp), designed to provide internship opportunities for underrepresented engineering students in sponsoring corporations. This connection, combined with the Corporate Mentoring Program and the University of Florida’s career fair events in the fall and spring, provide ample opportunities for the students to gain internships during summer terms.

The University of Florida also administers active Alliance for Minority Participation (AMP) and McNair Research Scholars programs that offer opportunities for the STEPUP graduates to pursue undergraduate research in a faculty’s laboratory. Both programs provide the students funding to support living and research expenses and require the student to present her/his research at an annual exposition. The AMP program is closely associated with a University of Florida Bridge to the Doctorate program and thus grooms the student towards a graduate-level degree.

Persistence results and discussion

Table 2 provides the total number, ethnicity, and gender makeup of each STEPUP class since 1996 when tracking of these students began. A total of 662 students, predominantly African American and Hispanic American, have participated in this program since 1996. With the exception of three years, 1996, 1999, and 2002, the program also included Caucasian students,
the most participating in 1998 when sixteen Caucasian females participated in a pilot to determine the effectiveness of the program in female student retention. The percentages of females in the STEPUP classes have, on average, been higher than the average percentage of females in the overall engineering student population; however, with the exception of 1998, no concerted effort has been made to recruit females to the program.

The average percent retention of each incoming cohort of STEPUP, non-STEPUP, and minority non-STEPUP students after each year of study is shown in Figure 1. Each bar represents an average percent of the relevant 1996-2007 freshman classes retained. The bar showing the percent of the STEPUP students retained after Year 1, for example, is an average of the 1996-2007 freshman classes (total of 632 beginners), whereas the bar showing the percent of STEPUP students retained after Year 6 represents the 1996-2002 freshman classes (total of 416 beginners). Students graduating before Year 6 are still considered part of the retained cohort in subsequent years.

Consistent with national trends, most attrition of the non-STEPUP students occurred after the first year of study. Thirty-one percent of all non-STEPUP students and 36 percent of all minority non-STEPUP students left engineering after Year 1, whereas only 17 percent of STEPUP students left. After Year 2, 33 percent of STEPUP students entering as engineering freshmen, 44 percent of all non-STEPUP students, and 44 percent of minority non-STEPUP students had already left engineering. Much of the high attrition of engineering students in the first two years is hypothesized to be a result of their sub-optimal experience in large critical tracking courses, including chemistry, physics, and calculus. However, the lower attrition of the STEPUP students after these sensitive years may indicate the positive impact of introducing

### Table 2: Description of Each STEPUP Class from 1996-2008

<table>
<thead>
<tr>
<th>STEPUP Class</th>
<th>Number</th>
<th>Ethnicity</th>
<th>Percent Female</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>AA</td>
<td>H</td>
</tr>
<tr>
<td>1996</td>
<td>48</td>
<td>29</td>
<td>18</td>
</tr>
<tr>
<td>1997</td>
<td>64</td>
<td>37</td>
<td>25</td>
</tr>
<tr>
<td>1998</td>
<td>71</td>
<td>28</td>
<td>22</td>
</tr>
<tr>
<td>1999</td>
<td>49</td>
<td>32</td>
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<tr>
<td>2000</td>
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<td>2001</td>
<td>58</td>
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<tr>
<td>2002</td>
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<tr>
<td>2003</td>
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<td>15</td>
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<tr>
<td>2004</td>
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<tr>
<td>2005</td>
<td>37</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>2006</td>
<td>47</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td>2007</td>
<td>50</td>
<td>26</td>
<td>22</td>
</tr>
<tr>
<td>2008</td>
<td>30</td>
<td>15</td>
<td>14</td>
</tr>
</tbody>
</table>

*Sixteen Caucasian females and seventeen African American females participated in the 1998 STEPUP program.*
engineering early in their curriculum and providing them an instant support community so that they are able to adopt an identity of “engineer” early in their university experience.

By Year 6, attrition of the STEPUP students was still lower than the all non-STEPUP and minority non-STEPUP cohorts, 47 percent, 44 percent, and 41 percent, respectively; however, a steady loss of STEPUP students throughout Years 1-5 decreased the difference dramatically. The steady decline of the percent of STEPUP and minority non-STEPUP students retained after Year 3, when engineering students enter their home engineering departments, may indicate the need for continued support and mentoring even after the critical first two years.

Figure 1: Yearly Percent Retention of STEPUP and Non-STEPUP Students Entering as Freshmen from 1996-2007

![Figure 1: Yearly Percent Retention of STEPUP and Non-STEPUP Students Entering as Freshmen from 1996-2007](image)

Figure 2 provides similar retention data for male and female students over Years 1-6. Of all of the student cohorts compared, female students suffer the lowest retention after Years 1 and 2. Sixty-eight percent of all female students are retained after Year 1, and 53 percent, after Year 2. On the other hand, 75 percent of all male students are retained after Year 1, falling to 58 percent after Year 2. Interestingly, however, after Year 6, the percent of the female and male freshman classes retained were strikingly similar, 42 and 45 percent, respectively.

After Year 1, STEPUP males and females reverse the trend of higher male retention observed in the other cohorts, and both STEPUP cohorts show the highest retention of all presented in Figure
2. After Year 6, 50 percent of STEPUP females graduated with an engineering degree, compared to 46 percent of the male STEPUP students. The lowest retention percentages of all the cohorts shown in Figure 2 were exhibited by the minority non-STEPUP female (40 percent) and male students (42 percent) and by all female students (42 percent).

**Figure 2:** Yearly Percent Retention of STEPUP and non-STEPUP Male and Female Students Entering as Freshmen from 1996-2007

While the higher retention of the STEPUP participants over the past 13 years is clear in the data shown in Figures 1 and 2, the relatively small differences in retention between these students and the other cohorts do not initially provide a convincing argument for the success of the STEPUP program. To further compound this assessment of program success, the average latest GPA values of the STEPUP students from 1996-2007 were slightly lower than that of the general student population and of minority non-STEPUP students. A closer look at the background of these students, however, reveals the strength of the STEPUP program.

The average high school GPA values of incoming freshmen from 1999 through 2008 are shown in Figure 3. While still competitive, the average high school GPA of the STEPUP students entering the University of Florida was lower compared to all non-STEPUP students. As previously described, the original intention of the program was to enhance the preparation of students who scored lower than a 600 on the analytical portion of their SAT in order to increase their odds of succeeding in the intensely analytical engineering curriculum, and, to some degree,
the STEPUP program today still honors this original intention. By virtue of their experience 
prior to entering the university, these STEPUP students possess the greatest risk for failure in the 
university, and the fact that the retention rates for these students are the highest among their 
cohorts is a clear indication of the success of this program.

**Figure 3**: Average High School GPA of 1999-2008 Freshmen Classes

![Figure 3: Average High School GPA of 1999-2008 Freshmen Classes](image)

**Conclusions**

The initial results presented herein provide strong evidence of the success of the STEPUP model 
in negating the risk factors that many underrepresented students carry with them into the 
university. Future work will focus on assessment of the effectiveness of each element of this 
program and a closer tracking of the student’s risk factors, including not only high school GPA 
but also SAT scores, number of and performance in science and math classes, socioeconomic 
status, etc., as a better means of recruiting students into the program.

May and Chubin\(^{13}\) recently reported results of an earlier work by Astin\(^ {14}\) who connected the 
student’s involvement with her/his success towards completion of degree. Five metrics—energy 
devoted to studying, time spent on campus, participation in student organizations, interaction 
with faculty, and interaction with other students—were provided to measure student 
involvement, implying that, the higher the metric, the greater potential for success of the student 
in completion to degree. May and Chubin\(^ {13}\) translated these metrics to the barriers of the
underrepresented student in engineering, suggesting that these students face additional 
challenges to their involvement because of the difficulties in establishing relationships across 
cultures. STEPUP has shown to be successful in establishing such relationships between the 
underrepresented student and their faculty and to other students, and this “human” element, 
combined with enhancement of their discipline and team skills and early introduction to 
engineering, undoubtedly are critical in increasing their persistence in engineering.

Today, because of continued success, the University of Florida STEPUP program has become 
institutionalized into the College of Engineering and has inspired a non-residential program for 
the general engineering population, the Engineering Freshman Transition Program (EFTP), with 
the same goal of increasing retention in mind. Both programs have provided strong evidence in 
support of “capturing” engineering students during their first two years by infusing elements of 
the discipline as early as possible into the undergraduate curriculum and thus minting their 
identity as engineers when they are freshmen. STEPUP extends this concept further by 
providing a strong community of support of underrepresented students throughout their entire 
stay in the university and, as a result, aiding them in learning how to break down barriers of 
culture that undeniably still exist for them.

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