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# Attracting Women to Engineering through Service Based Learning

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## Introduction

The National Academy of Engineering (NAE) points to enhancing student interest in engineering, science and technology entrepreneurship; and increased professional skills in design, communication and teamwork as some of the 'Grand Challenges of Engineering' (NAE, 2009). In response, the Department of Civil Engineering & Construction Management (CECM) at Georgia Southern University aims to systematically integrate experiential and community service learning opportunities throughout the departmental curriculum in order to further the NAE vision of access to enhanced visibility and professional skills of its students. The objective of this revolutionary department transformation is to attract and retain traditionally underrepresented groups to engineering, particularly women, and in effect, increase departmental diversity.

To achieve the goal of more women engineers, the CECM department will take advantage of, and better align itself with the existing experiential learning nature of its sister programs on campus and beyond. This will include common coursework at the freshman level in the first year experience (FYE) courses, at the sophomore level in the surveying courses, at the junior level in the construction economics and finance courses, and at the senior level in the capstone senior project course. Further, the proposed experiential, community service learning activities with Habitat for Humanity of Bulloch County will transcend the four years with integrated assignments in each of these courses, including 100 hours of required community service prior to graduation.

This paper describes the approach currently being undertaken by Georgia Southern University, and provides a model for similar programs who would benefit from a holistic service-based approach for female recruitment and retention. While data regarding the effects of this approach on female recruitment was not available at this time, as the department is in the middle of the transition toward service learning, the department notes an increased interest from female undergraduates in the service based learning approach.

## Background

There is growing scholarly evidence that discusses the numerous benefits that arise from project based experiential based service learning within engineering curricula. The most compelling among these demonstrate that service learning can increase recruiting among underrepresented groups and increase department diversity (Duffy et al, 2009 & Vanasupa et al, 2007). In fact, a study by Coyle et al (2005) showed that service learning courses attracted twice the percentage of women engineering students in comparison to the overall engineering student population. Similar studies by Duffy et al (2008), and Barrington et al (2007), found that in capstone courses with service learning projects there is an increased female population compared to traditional capstone courses. Attracting and retaining women is the key to increasing the population of the engineering students and retaining them to the end of their educational journey, and toward the ultimate goal of professional licensure.

Service leaning has been proven to be an invaluable tool to recruit and retain engineering students, a study conducted by Astin et al (2000) found that in a study of 22,000 students, integrating service learning had significant positive effects on 11 outcome measurements including critical thinking skills, values, leadership and self-efficacy. Eyles & Giles (1999) studied 20 universities and the effect of a service-learning based curriculum on over 1500 students. The results indicated an increased positive impact in the categories of diversity tolerance, personal and interpersonal development and community to college

connections. The resulting service learning principles from that study are the ideologies on which the proposed service based program at Georgia Southern is based. They are: connection (building a relationship with the community, peers and faculty members); continuity (the service initiatives continued for the length of the student's degree program); context (serving the community in which the students live); challenge (a balance of new information without overwhelming the student); and coaching (a community of assistance available).

Experiential service learning has become increasingly popular due to its programmatic success in attracting and retaining students. Service learning based courses are being offered in a variety of programs across the country. There have been over 33 universities that have included some facet of service learning in their curriculum. (Oakes, 2004). The most well-known among these initiatives is EPICS (Engineering Projects in Community Service), an NSF- funded approach developed by Purdue University that has extended to over 15 universities. The service-based approach utilizes service learning courses that students can elect to take at every stage of their educational program. Another well-known program is that of the SLICE (Service-Learning Integrated throughout the College of Engineering), originating at the University of Massachusetts-Lowell, which integrates service learning into its required undergraduate core courses. Both of these programs have had significant success integrating service learning change into their curricula. This proposal, and the framework of the service initiative at Georgia Southern seeks to further evolve these concepts and approaches service learning as a recruitment tool toward a more robust female population in civil engineering and construction management at Georgia Southern University. This approach is change from a systemic perspective, involving K-12 educational initiatives and culminating in the creation of an increased number of graduates on the track toward professional licensure.

## Institutional Information

### Undergraduate, Graduate and Faculty Populations

Currently, enrollment in the department is 541, with Civil Engineering at 279 students enrolled, and Construction Management with an enrollment of 262. Table 1 shows the freshman, sophomore, junior and senior fall populations as of November 2014.

**Table 1: CECM population as of November 2014**

| Fall 2014 | | | | |
|---|---|---|---|---|
| **Program** | Freshman | Sophmore | Junior | Senior |
| **Civil Engineering** | 94 | 56 | 53 | 76 |
| **Construction Management** | 56 | 73 | 68 | 65 |

On average, in 2012 and 2013 there was an average 12% female students across both programs.

**Strategy for Transformation**
After identifing the need to attract more women to engineering, the department underwent several faculty driven internal reviews to determine what areas could be improved that would create a department with a culture that welcomed and recruited women and groomed for professional practice . The results of this evaluation identified several key areas in which the department intends to improve and employ a service based approach to attract women to the civil engineering. Among these were:

1. **Greater demand for experiential learning:**

Based on feedback from both female students and employers, there is growing demand for experiential learning opportunities within the CECM program. Although the CM program has already implemented a required internship, it is expected that co-op opportunities for both CE and CM students will become more prevalent as a result of the Industry Advisory board's participation in the program. Based on the available literature, service learning directly impacts recruitment of female students.

2. **Increased levels of interaction with community projects:**

Based on faculty feedback, it was determined that female students would benefit from enhanced interaction with the local community. This community engagement is expected to foster social awareness and meaningful practical experience. Additionally, the faculty recommended the involvement of female leaders in the community in these service projects would greatly impact female retention.

## Case Study Approach

The vision of Georgia Southern University's service learning initative is to create an environment that would foster diversity, and groups of students with advanced academic knowledge and meaningful practical experience, who are also generously committed to improving their local communities. Based on the feedback gained during the investigative period, the goals for the program are:

**GOAL A: Increase department diversity.**
The primary objective is to attract and retain traditionally underrepresented groups to engineering, especially women, and in effect, increase departmental diversity. In order to achieve this, the CECM department plans to expose a wide range of groups to the civil engineering profession before they enter Georgia Southern University by developing relationships with local high schools and community colleges. Additionally, the department will continue to host the "Camp Invention" summer camp, for grades 1-6, and continue to provide faculty and students as mentors and judges for the Associated General Contractors (AGC) Skills competition. Also critical to the achievement of the intended objective is to increase the support of, and participation in, the "BRIDGE" program at Georgia Southern University. Another measure taken will be to encourage faculty to participate in community activities involving underrepresented groups. Additionally, the department plans to provide a nurturing environment for incoming freshmen through retention initiatives like the 'Living Learning Community'. Progress will be measured by tracking enrollment, retention and diversity statistics, and identifying the most prevalent recruitment avenues through the administration of a freshman survey.

**GOAL B: Prepare female students to function as high-performing, well-rounded and practical professional engineers**.

At the core of the second goal of the program is increasing opportunities for experiential learning. The strategies to accomplish this objective are to partner with Habitat for Humanity of Bulloch Country and the Downtown Statesboro Development Authority (DSDA) to provide students with opportunities to gain hands-on experience on community projects. Additionally, the department plans to restructure the CECM curriculum to include experiential, community service learning components, and a required 100 hours of community service, to be completed during their 2nd and 3rd year of study. Additionally, toward this goal, the department plans to create opportunities for students to participate in a community service-based study abroad program. The progress of this goal will be measured through employer survey and continuous curriculum assessment.

A second objective of this goal is to increase industry input on curriculum and outcomes through creating a professional mentorship program that will assist students in preparing for professional practice. To accomplish this, the department plans to survey members of the Professional Advisory Committee (PAC) regarding curriculum and outcomes, as well as relevant industry partners and alumni. Progress will be based on continuous dissemination of results and feedback from PAC members.

**GOAL C: Increase involvement with community**

The primary objective of this goal is to deepen engagement between female students and the community through service and outreach. In order to accomplish this, the CECM curriculum will be restructured to include experiential community service components, and a required 100 hours of experiential community service, recruit female leaders in the community as liaisons and mentors. Additionally, the 'Senior Project' course will be redesigned to allow students to manage teams of students on Habitat for Humanity projects. Progress will be measured by tracking student engagement, faculty retention and participation.

## Program Goals and Outcomes

**Program Assessment Process**

Ultimately, CECM faculty members would have primary responsibilities for all program goals and outcomes of the model. The goals and outcomes were initially agreed upon by the CECM faculty, and were reviewed by both the administration and Professional Advisory Committee. The continuous improvement plan is ultimately driven by measures and analysis of goals and outcomes.

**Program Assessment Tools**

Multiple tools for the assessment of the program goals and outcomes will be used as well as a documented plan that uses the data obtained to implement changes that will further improve the program goals and outcomes. The documented plan consists of program-level continuous improvement, as well as course-level continuous improvement. A five-step process has been implemented and consists of 1) program assessment planning, 2) data collection, 3) data analysis, 4) program review, and 5) program improvement actions. During this process, the program objectives and outcomes are evaluated and revised to maintain currency and technical relevance.

The preliminary tool that will be used for assessment of experiential learning and community service is Symplicity™ Campaign Management which enables the management, development and tracking of experiential learning campaigns. This powerful software, already in use at Georgia Southern, has the ability to track students' experiential community service learning hours and analyze data toward program improvement. The basic assessment tools that are used are as follows:

- PAC Recommendations (Indirect Assessment)
- Alumni Survey (Indirect Assessment)
- Employer Survey (Indirect Assessment)
- Graduating Seniors (Indirect Assessment)
- Sample Student Work (Direct Assessment)
- Faculty course level improvement plan (Direct Assessment)

Based on the results of the assessment tools, continuous improvement actions at the course level and program level are identified and used to revise the program assessment and evaluation plan. Since the PAC provides insight and direction for ensuring that the program objectives and outcomes are current and appropriately meet industry expectations, they are an integral part of the Program Assessment Planning.

**Program Outcomes**

The outcomes of the initiative are:
1) An increase in female recruitment and retention, through the rebranding of the Civil Engineering department as community service-learning based.
2) Through the experiential community service learning experience, female students will leave the program better prepared for professional practice, and will be more driven toward a path of professional licensure.
3) All students will leave the program with an increased level of social consciousness, community connectivity, and commitment to becoming contributing members of society through their role as future engineers.

## Implementation

**Program Description**

Georgia Southern's educational model that incorporates community service and experiential learning at every level of the educational journey toward increased recruitment and retention of female students, through comprehensive curriculum reform, co-op and community service learning opportunities, and peer support through cooperative interaction between departmental programs.

The model involves the development of a pipeline of recruitment and retention techniques that create a channel of female students through K-12 outreach initiatives and exposes students to project based experiential learning early in their academic career. Once a female student has enrolled in the CECM program at Georgia Southern, they will have immediate access to a strong system of support through the CECM Living and Learning Community and First Year Experience programs as they are further introduced to the practice of experiential, community service learning. Retention is key during the freshman year, and the initiative's intensive approach is expected to increase retention statistics, ensuring that students are fully engaged in the model during their sophomore and junior years through 100 hours of required community service. In their senior year, all students participate in the FE Prep Course, designed to prepare students for the FE exam. Also as part of their senior year, students become community service learning leaders in the capstone course, and participate in ongoing mentorship initiatives provided by the PAC.

**K-12 Recruitment**

To increase the recruitment of female students and develop an 'engineering pipeline', aggressive recruiting initiatives will be undertaken beginning at the K-12 level. These initiatives will involve faculty engagement at local summer programs, bringing hands-on community service based micro activities to local day camps and involving students in simple experiential learning projects, and promoting diversity and the role of females in the engineering industry. The focus of these initiatives will be to educate potential female students on the vast opportunities in the field of engineering and promote diversity in the

Civil Engineering department at Georgia Southern. These visits will be focused on bringing together engineering concepts through creative and experiential projects and experiments. Each program, targeting various age groups will provide an opportunity for students to be exposed to the experiential nature of civil engineering, and for the department to establish and maintain contact from an early age.

*Camp Invention (Grades 1-6)*

The first of these initiatives, Camp Invention, a nationally recognized program for children entering grades 1 through 6, will be hosted by the Civil Engineering and Construction Management department at Georgia Southern University in the summer of 2015. The Camp Invention is a non-profit educational outreach program from the National Inventors Hall of Fame Foundation. It promotes a passion for learning science with exciting hands-on activities. Each student participates in five innovative modules presented by department faculty and local teachers, focused on hands-on experiments in the areas of physics, engineering, and creative problem-solving. Hands-on, inquiry-based learning is emphasized in integrated curricula that align with national and state standards. In fact, Camp Invention has been proven to have a positive impact on children's attitudes toward creativity, active learning and exploration (Saxon, et. al, 2003).

*BUILD Program (Summer after High School Senior Year)*

One of the crucial parts of the K-12 Recruitment initiative of an innovative program called Southern Pathways Building Undergraduate Involvement and Leadership Development (BUILD). Faculty intends to engage female students aggressively in the engineering field at this event. It is a summer leadership program offered to Georgia Southern University incoming freshmen. It is coordinated by the Office of Student Leadership and Civic Engagement (SLCE). This program encourages freshmen to develop leadership skills and form relationships with the University community through social outings such as, Habitat for Humanity, Kingdom Builders, etc. The program consists of three broadly defined components: 1) daily service opportunities with community partners such as Habitat for Humanity, the Boys & Girls Club, a local food bank & soup kitchen, the Bulloch County Board of Education, and the Downtown Statesboro Development Authority, to name a few; 2) a leadership development curriculum focused on transitioning from leadership in high school to leadership in college and the community; and 3) a small group cohort experience that emphasizes reflective and experiential learning through small group team building, but also includes social activities. The BUILD program began in the summer of 2006 and has continued uninterrupted to the present.

The success of the BUILD program has fueled the initiative. BUILD cohorts consistently have higher average first term GPAs, high school GPA averages, and average SAT scores compared to the University averages (The first-year retention rates for BUILD cohorts increased from 89% for the (2006 cohort) to a high of 95% (2012 cohort). This compared to the University rates which increased from 79% for the (2006 cohort) to a high of 81% for the (2012 cohort), with a high of 81% also occurring for the Fall 2007 and Fall 2008 cohorts).

Additionally, the six-year graduation rates for BUILD cohorts decreased from 69% (2006 cohort) to 68% (2007 cohort), while the University rates remained basically the same at 50% for the Fall 2006 and Fall 2007 cohorts. The BUILD program has been proven to increase the diversity of the student population. In fact, the majority of the BUILD cohorts were mostly female students (Fall 2006 and Fall 2008-2013). The percentage of females increased from 56% in Fall 2006 to 59% in Fall 2013, with highs of 69% for the Fall 2010 and Fall 2011 semesters.

**Freshman Year**

Following the enrollment of a first year female student in the Civil Engineering & Construction Management program, Georgia Southern's First-Year Experience (FYE) and Living Learning

Community will facilitate the first-year students' acclimation to the university community and to the principles of experiential community service learning. These faculty-led initiatives foster engagement and help female students develop academic and life skills essential for success as college students and global citizens.

The incoming first year female students have the opportunity to apply to be part of this immersive community located in Southern Pines Residence Hall on the Georgia Southern campus. Participants take common classes; have access to academic and career development programming and the opportunity to interact with female faculty outside the classroom. Women and students from culturally diverse backgrounds are strongly encouraged to apply. Living Learning Communities are comprised of students who live together in a residence hall and have a common academic program or take one or more classes together as a community. The College of Engineering and Information Technology (CEIT) has formally partnered with University Housing to create and manage the community.
All students will be required to take FYE 1220 is a two-hour seminar that serves as an academic, theme-based introduction to college-level inquiry and extends the orientation process into a student's first semester at Georgia Southern. The course in an opportunity to research topics the student enjoys as well as to meet other students and a faculty member with similar interests. The Civil Engineering and Construction Management department facilitates a first year seminar to introduce female students to the department and the platform. This class will showcase the community service learning initiatives of the CECM department and introduce them to mentors from the Industry Advisory Board. The course will also feature an introduction to the program.

**CORE- 2nd and 3rd year**

*Habitat for Humanity*
As shown in Table 1, the experiential community service component revolves around a partnership with Habitat for Humanity of Bulloch County and the Downtown Statesboro Development Authority for local projects. The proposed pilot project involves a partnership with Habitat for Humanity of Bulloch County, the Downtown Statesboro Development Authority, and the City of Statesboro. All students in the Department will be engaged throughout their educational journey with an ongoing downtown revitalization initiative that welcomes economic diversity through affordable housing.

This initiative began in the Fall of 2014, and will expand to other homes. Habitat for Humanity of Bulloch County is part of a global, well-known nonprofit housing organization that provides homes to low-income families around the world. During their time in the program, students work closely with Habitat for Humanity and the Downtown Statesboro Development Authority on various facets of homes. Depending on their major and credit status, they provide a range of services to Habitat for Humanity including surveying, scheduling, sustainable system design and construction management. Sophomore and Junior level students are supervised by a service learning facilitator, or a student that is enrolled in Senior Project.

During their 2nd or 3rd year, all students have the opportunity to participate in a community service-oriented study abroad program. These fully immersive programs are led by faculty members and involve projects in communities abroad. This program serves to promote international awareness and responsiveness to community issues. In the summer of 2014, a group of CECM students visited South Korea for the inaugural study abroad experience in the department. In 2015, a group of students is scheduled to visit Mexico to participate in a similar activity, and additional trips are currently being planned for Costa Rica and France for the summer of 2016, and will include a cohort of female students with a female faculty advisor

**Senior Year**

The senior year of the model is the year in which female students are groomed for professional practice through leadership in the Capstone Senior Project course. Additionally, the Civil Engineering and Construction Management department partners with Career Services to better prepare students for professionalism and relevant employment opportunities upon graduation. Students enrolled in the Senior Project class will be assigned a leadership role on a Habitat for Humanity community service project.

*PAC Mentorship: Bridge to Professional Practice*

In preparation for a female student's entrance to the professional world, the program's professional advisory committee will play an integral role in preparing students to emerge from their educational program as competent engineers-in-training. During this time, a female mentor from the industry advisory board is assigned to each graduating senior and serves as their guide to professional practice. The role of the advisory board mentor is to enable professional skill building, provide invaluable insight into the industry and to support female students as they embark on their careers.

As described in the 'Background' section, experiential community service learning is a popular and intellectually sound endeavor. Curricula changes linking course outcomes to hands-on service learning projects is in itself an innovative concept, however the proposed initiative goes far beyond curriculum change to involve every stage of the female student experience. Students are groomed to be service-focused leaders before they apply to Georgia Southern through the K-12 outreach including the innovative BUILD program. Once enrolled, they experience an immersive student living and learning community where traditional programmatic barriers between Civil Engineering and Construction Management are broken and those relationship are fostered through joint experiential, community service projects. Students find themselves totally immersed in the revitalization initiative of downtown Statesboro during their experience as an undergraduate

## Conclusion

The implementation of this type of program toward increasing female recruitment and retention in engineering has potentially far-reaching benefits at both the college, university and community levels. The model for creating a 'pipeline' of incoming female engineering students through community outreach and K-12 recruitment is expected to have a significant impact on the diversity of the faculty and staff attracted to the CECM department. This paper provided a broad overview of the departmental plan. Results from this study are expected to be applicable to almost any traditional engineering department across the United States. Additionally, the unprecedented collaboration between the Civil Engineering and Construction Management program to increase the involvement of CE female students in experiential service learning projects, and create a culture of support and engagement, is an exemplary model for any college and/or department.

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