Using Social Relevance to Recruit and Retain Minority and Women Engineers

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ABSTRACT: *Showing the social relevance of engineering by engaging students with the community in the effort to define projects that meet real needs is a win-win-win proposition. In this paper we describe our process for community-based projects, and the results we've seen.*

The students win by having the experience of designing and implementing a project for a "real" client. The design constraints arise from real world concerns, rather than the restrictions imposed by a classroom/lab/academic term environment. The students consult with the users throughout the design and implementation of the project, sometimes finding that initial constraints were missing or misunderstood. They learn to work with clients who may not have any technical background; the students must learn to listen well to the client's needs, and to communicate their own ideas clearly, without reliance on technical jargon.

Obviously the community members win by getting access to the free development of a project for which they feel the need. The community members also gain confidence in their own abilities to deal with and express their views on technology.

The third win is most subtle, but perhaps most far reaching. In working with the students the community members learn a little about what engineers do. Little by little, we see an understanding grow within the community that engineering is a creative and people oriented profession. They also see that women and minorities can be engineers. Over the past three years, 75% of the students involved in these projects were female, and 50% were members of an ethnic minority underrepresented in engineering. These students were drawn to the opportunity of doing something valuable for the community; the opportunity was offered to all students, but appealed most to the women and minority students. (Our engineering school student body was approximately 23% female and 15% underrepresented minorities.)

1 INTRODUCTION

We know that engineering suffers from a poor image among the general populace. Most people have no idea what engineers do, though they have derived benefit from the work of engineers. Bill Wulf, President of the National Academies of Engineering, quoted a Gallup poll finding that only 2 percent of the respondents associated engineers with the word "invents;" only 3 percent associated them with "creative;" yet 5 percent associated them with the phrase "train operator."

Most students who choose engineering had the benefit of knowing someone in the profession — a relative or friend of the family. But this kind of connection only perpetuates the lack of diversity in the field. In particular, the public's lack of familiarity with the profession of engineering makes it difficult to recruit and retain women and minorities.

We know that women are as capable as men in the science and mathematics required for engineering, but few of them choose that path in college. At SCU women make up a majority of biology majors; many see this as a path to making positive contributions to the human condition, whether through medical practice or research. They don't see engineering in the same light.

Showing the social relevance of engineering by engaging the students with the community in the effort to define projects that meet real needs is a win-win-win proposition. In this paper we describe our process for community-based projects, and the results we've seen.

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2 INVOLVING THE COMMUNITY IN INNOVATION WORKSHOPS AND PRODUCT DEFINITION

In 1999, Santa Clara University was one of the inaugural sites for the Virtual Development Center sponsored by the Anita Borg Institute for Women and Technology. The Institute was founded with the goals:

- To increase the impact of women on technology, in education, design, development, deployment and policy.
- To increase the positive impact of technology on the lives of all women.
- To help communities, industry, education and governments accelerate and benefit from these increases.

The Virtual Development Center is one of the means of achieving these goals. Using techniques learned from the Institute, we involve the community in innovation workshops, encouraging all participants, regardless of technical background, to brainstorm about how technology could improve their lives. We create a Thinking Environment™ by providing practice in listening skills, and then allow all participants to contribute their own ideas for future technology enhancements to their lives and those of their family and/or community. By the end of the day, we've created a long list of possible projects and identified a few that are most popular among the participants.

One of the less tangible results of the workshop is the increase in self-efficacy with respect to technology that is gained by the community participants who have never considered themselves to be technologically literate. Women who were self-described technophobes found themselves capable of imagining new uses for technology, and understood that their ideas and experience are important to the appropriate development of devices and applications in the future. They also learned quite a bit about the creativity required for engineering.

3 PROJECT DESIGN AND IMPLEMENTATION

The next step in the process is the further development of possible project ideas by the students who attended the workshop. The students specify requirements and develop initial plans for possible designs, then take these ideas back to the community again. The community group serves as client, and helps the students refine the requirements for the project and provides feedback on the initial design options. The project is more narrowly defined so the students can proceed to a complete design. The students meet with the community group several times, for design review and then for prototype evaluation while the implementation is in progress (often resulting in substantial changes to the design). Finally, when the project is complete, it is presented to the user community, along with tutorial assistance in its use.

4   SAMPLE PROJECTS

For the past three years, we have worked with HomeSafe, a transitional community for survivors of domestic violence. This has been a mutually beneficial relationship, with the women of HomeSafe enjoying engaging with the students in the definition of tools to ease their busy lives, and the students benefiting from the experience of designing for real world clients with specific needs and desires for their products as well as the sense that they are contributing to the betterment of society through their efforts. The projects designed for HomeSafe include ANEW, KnowItAll, Virtual Garden, Home Safekeeper, and SmartHome. All of these reflect ideas suggested by the women of HomeSafe at an innovation workshop.

ANEW - Action Now in Employment for Women was a project to enhance the job skills of the women at HomeSafe, as well as to help them in their job searches and resume writing skills. It involved hands on tutorials in common office software, and the development of a website with programs to assist in writing resumes and cover letters, and information to assist in finding online tutorials and appropriate job search engines.

KnowItAll is an educational site for the children of HomeSafe. It covers the curriculum offered at local schools for first through fourth grades in English, Social Studies, and Mathematics. The women at HomeSafe felt they had little time to help their children with homework, and recognized that the children enjoyed using the computers provided in a lab, but wanted the children to spend the time on more educational uses than the typical games they tended to play.

Virtual Garden was designed in response to the expressed desire for a leisurely diversion to the hectic life most of these women lead. The virtual garden allows them to specify the area the live, the size and shape of a garden they would like to design, as well as the colors and shapes of the flowers and other plants they would like to grow. With access to a database of plants and flowers appropriate to a growing region, the user can design and plant the garden, even maintain it through watering, feeding, and weeding, and watch it grow over a user selected time period and rate.

Home Safekeeper is a program to assist with the details of managing the daycare center attended by the children of HomeSafe. It makes the process of checking children in and out, and identifying appropriate guardians simpler and less time consuming.

SmartHome is an energy monitoring system, allowing residents to set specific monthly energy budgets and track usage so they know whether their daily usage is likely to stay within or exceed their usage goals.

5   RESULTS ARE WIN-WIN-WIN

Our students win. Through the continued involvement of the user community, our students learn that requirements are often a moving target. They learn to consider environmental, usability, health and safety, maintainability, economic and ethical issues in their designs. They have to deal with maintaining a cordial working relationship with a client even while insisting that changes can no longer be made beyond a certain point in a project. They must also learn to work well with their teammates, dealing with problems that arise from some members slacking in their duties, others proceeding with ideas not agreed to by all, and delays caused by things beyond their control, such as the error in shipment of parts they need. Instead of being graded on individual efforts they learn about sharing responsibilities for failures as well as successes. They also learn that the job is not done when a product is delivered. They must also deal with educating their customers to its use, and providing a plan for maintenance.

Our community wins. The women of HomeSafe have benefited from the actual production of tools they chose as being most relevant to their lives. More importantly, they have learned that their life experience is important in helping to define appropriate technological advances. They have been empowered to speak out on technological issues, both the desirable and less desirable consequences of various possible developments, and they've expressed a willingness to continue to contribute to such a dialog.

Our society wins. The involvement of the community, both in technological discussions and in interaction with students working on specific projects, educates the community to who engineers are and what they do. As an understanding of the engineering profession and the positive impact it can have on society spreads, we may engage more of our young women and ethnic minorities in the study of engineering. We have already seen that community-based projects attract a disproportionate number of our women and minority students. Over the past three years, 75% of the students involved in these projects were female,

and 50% were members of an ethnic minority underrepresented in engineering. These students were drawn to the opportunity of doing something valuable for the community; the opportunity was offered to all students, but appealed most to the women and minority students. (Our engineering school student body was approximately 23% female and 15% underrepresented minorities in the same time period.) As these students are seen in the community, they provide role models for others to follow.

6   CONCLUSION

We have found that involvement in community-based projects has provided motivation to our students and been instrumental in educating them to the conscience and compassion parts of our university mission. Each student has been grateful for the experience. We have even had students who offered to continue to be involved after graduation. We are repeatedly told of the value of this experience by those who participate, but we have yet to demonstrate whether it can substantially impact the retention of engineering students. Research has shown that students participating in service-learning have a higher comprehension of the course material in addition to developing an awareness of their community and its concerns; we expect this must also increase their retention In the coming year we plan to extend participation in these projects to more undergraduates. While the project course we have offered has been open to more than just seniors in engineering, the vast majority of the students have used the projects to fulfill their requirement for a capstone project in engineering. We have been unable to gauge the possible effect participation in such a program might have on the retention of minority students in engineering, since the students participating have nearly all been seniors, who are unlikely to leave engineering in their final year. We want to involve sophomore and second term freshmen students. We expect that the revelation of the impact they can have will provide context and motivation that will encourage them to continue in their engineering studies.

We also plan to expand our community outreach to two groups besides HomeSafe. We plan to work with GAINS (Girls Achieving In Nontraditional Subjects), a program of the Santa Clara Unified School District. We expect that working with these girls will educate them about engineering and the ways in which it can improve the lives of everyone. We will provide mentors for the girls in the program and expect that a larger percentage of them will choose to study science, engineering, and mathematics as a result of this contact.

Diversity of participation is critical for engineering. Our thinking patterns are shaped by our experience, and thus the greater the diversity of our backgrounds and experience, the greater the diversity of our thinking and the greater the likelihood for new and creative solutions to the problems with which we are faced.

REFERENCES

ASTIN, A. & SAX, L. J. How Undergraduates are Affected by Service Participation. *Journal of College Student Development.* 39 (3): 251–263.

DAVIS, RUTH E. Improving the Diversity of Our Technological Workforce. *explore*. 4, 1 (2000): 17–23.

DAVIS, RUTH E. Motivating Women Engineering Students Through Community-Based Projects. In *Proceedings of the 2003 ASEE Annual Conference and Exposition.* Nashville, TN: ASEE, 2003, (on CD).

SLIVOVSKY, LYNNE A., DEREGO, FRANK R., JR., JAMIESON, LEAH H., & OAKES, WILLIAM C. Developing the Reflection Component in the EPICS Model of Engineering Service Learning. In *Proceedings of the 33rd Annual ASEE/IEEE Frontiers in Education Conference.* Boulder, CO: IEEE, 2003. 0-7803-7961-6/03