Innovative outreach programs to attract and retain women in undergraduate engineering programs

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ABSTRACT: Statistics Canada figures for 1998 show that women comprise two-thirds of graduates with degrees in fine arts, humanities and social sciences, yet only 12% of graduates in the science and technology fields are women. For the engineering profession alone, the figures are even more daunting - only 5% of registered Professional Engineers in Canada in 1998 were women. We can no longer afford to exclude the vast pool of talent represented by women, therefore effective recruitment and retention programs are necessary to encourage more women to consider a career in the field of engineering. This paper describes several projects undertaken at Ryerson Polytechnic University to increase the participation of women in engineering. These projects include the ‘Discover Engineering’ Summer Camp, in-class high school workshop program, one day engineering career conference, on-line mentoring program, student ‘drop-in’ hours and an incoming student welcoming reception. The paper discusses the impact of these initiatives, as measured by follow-up surveys and other evaluation tools.

INTRODUCTION

At the beginning of the new millennium the impact that technology has on our daily lives and our environment is enormous. What engineers do affects us all. The current knowledge-based economy not only desperately needs science and engineering graduates, it needs graduates who understand the societal and environmental impact of their activities. At the time when the economic well being of the whole world depends to a great extent on the effective employment of engineers, it is a sobering thought that engineering enrollments are, in general, declining. Figure 1 and Figure 2 show statistics [1,2] for undergraduate engineering enrollment in Ontario, the most populous province of Canada. There has been a 15% drop in enrollments since 1991. This trend is mirrored across Canada and in the USA.

Figure 1, showing data broken down by gender, reveals an interesting snapshot of the state of engineering profession in Canada (Ontario data is representative of national statistics). While reasons for declining interest in engineering as a career are a focus of intense discussion within the profession and academia and are based on larger societal issues, it is clear that more women than ever are interested in pursuing engineering.

WOMEN IN ENGINEERING IN CANADA

The engineering profession has not been as successful in attracting women as other previously male-dominated fields such as law or medicine. While the climate for women in engineering has been slowly changing over the years, lack of encouragement, peer pressure and other factors still act as barriers preventing more women from pursuing a career in this non-traditional field. For example, in the province of Ontario only 3,030 women (4.9%) were registered as Professional Engineers (PEng.) in 1998, with a similar national average. This reflects a reality of low enrollments of women in
engineering programs in past years, as well as the reality of many women still leaving the profession as a result of negative experiences including hostile climate, harassment, or lack of promotion opportunities (‘glass ceiling’ effect).

The engineering profession in Canada has done a lot of soul-searching in the wake of the massacre on December 6, 1989, when 14 young women at Ecole Polytechnique in Montreal were killed simply because they were studying to become engineers. Some visible results were: an establishment of the Canadian Committee on Women in Engineering, the Canadian Engineering Memorial Foundation, and the endowment of five Regional Chairs for Women in Science and Engineering, jointly sponsored by academia and industry, to actively promote programs to attract and retain women in engineering programs at Canadian universities.

Since 1992, the Canadian Committee on Women in Engineering has released many recommendations to change the climate for women in engineering programs at universities and in the profession itself [3]. A need to do so is clear on the basis of allowing equal opportunity to all members of our society. However, the statistics in Figure 1 and Figure 2 show that on a purely economic basis as well, we can no longer afford to exclude the vast pool of talent represented by women who are determined to enter the field of engineering.

BACKGROUND: RYERSON INITIATIVES

In 1989 the participation of women in undergraduate engineering programs at Ryerson Polytechnic University in Toronto was less than half the provincial average, with percentages as low as 3 to 5% in Mechanical, Aerospace and Electrical engineering. The Women In Engineering (WIE) Committee was established that year with an explicit goal to increase the number of women in Ryerson engineering programs. Its first initiative, the ‘Discover Engineering’ Summer Camp [4], started in 1991. The camp aims to educate young women in high school about the challenges and rewards of engineering, and to motivate them to choose engineering as a career option. The camp has been an overwhelming success, over the years, reflecting an attempt to provide the participants with an exposure to a wide range of engineering pursuits. Camp sessions are scheduled in three-hour time slots to allow the participants to explore and ask questions. The material presented is relatively challenging but not overwhelming.

In 1999, engineering-oriented activities included: tower-building exercise, assembling an LED circuit, designing a binary decoder, making, programming and testing of Lego robots in a Robolab project, creating different combinations of esters, and then producing a jelly-like substance (“slime”) from guar gum and boric acid reagents, and a field trip for an overview of cellular technology at CANTEL. Past sessions also included building balsa wood plane models, tests in a wind tunnel, creating holograms, building and stress-testing pasta bridges, designing parachutes for an egg-drop contest, and various field trips [4,5].

Several other initiatives followed. The high school workshop program is designed to raise awareness among all students who have not yet considered engineering as a potential career path, due to a lack of knowledge, interest or confidence. Workshops focus on ‘engineering challenges’ and ‘engineering design’ with an emphasis on human factors, problem solving and teamwork. Teams of women who are engineering students and faculty members at Ryerson present the workshops, serving as role models and working to change stereotypical gender perceptions. A one-day engineering career conference for young women in high school, teachers, parents and guidance counselors is also being planned to disseminate current information about emerging opportunities. Furthermore, in an effort to create a supportive learning environment on campus, a full-time position for the projects coordinator was created. A new on-line mentoring program was launched and ‘drop-in’ hours are available to better assist women engineering students, in addition to an annual incoming student welcoming reception.

DISCOVER ENGINEERING SUMMER CAMP

Background

The ‘Discover Engineering’ program is unique in the Toronto area. Unlike some other science and engineering programs, it is delivered exclusively to women. Although evidence about single-sex education is somewhat conflicting, there is a general perception that girls fare better in math and science in single sex environments. The camp is presented in a weeklong format, which allows more time to introduce the many aspects of engineering. It targets an age group in grades 10 to 12, and engineering professors have primary responsibility for development and delivery of the curriculum.

Posters, information and applications are sent out to more than 500 high schools in the greater Toronto area to the heads of the science departments, the guidance counselors and individual science teachers. Placements are filled on a first-come first-serve basis. Because of the demand, the camp has been expanded twice in the nine years of its existence. The enrollment increased from three sessions of 20 students each in 1991 to the current five sessions of 30 students each. The camp is usually oversubscribed, with 100 students on the waiting list.

Camp Curriculum

A commitment to keeping the camp experience fresh, innovative and involving means that the camp curriculum has changed over the years, reflecting an attempt to provide the participants with an exposure to a wide range of engineering pursuits. Camp sessions are scheduled in three-hour time slots to allow the participants to explore and ask questions. The material presented is relatively challenging but not overwhelming.

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All camp activities emphasize participation and collaboration. The socializing aspect of the camp is very important, as often this is the first opportunity for teenage girls with interest in sciences and engineering to meet a large number of like-minded peers. WAMMO (Women Aware, Motivated and Moving On) career game session provides an entertaining and educational format for including women's issues in the camp agenda. During the “ice-breaker” session participants meet and talk with female engineering students to discuss student life, as well as engineering as a career option.

A panel discussion on the last day of the camp offers an opportunity for the students to meet women engineers representing a wide variety of experiences in the field. The
panelists share details of their own academic history and career paths, describe their current jobs, and highlight aspects of their profession that make it a viable and rewarding career for them.

Camp Surveys

Exit surveys have been conducted among camp participants since 1991 [6]. To measure a long-term success of the camp experience and to track the number of participants who go on to choose engineering as their field of study, follow-up phone surveys were conducted in 1993, 1996 and 1999. The first survey in 1993 surveyed 74 participants of the 1991 or 1992 summer camps. The second, conducted in 1996, surveyed 51 participants of the 1993 summer camp. The 1999 survey was conducted by interviewing 23 participants from each year from 1994 to 1997. The survey results are summarized in Figure 3. On average, 80% of the interviewed camp alumni went on to study at a university. There, over 50% enrolled in engineering programs, and of those, 72% said that the summer camp experience greatly or moderately influenced their decision.

Responses from the evaluation forms indicated that 95% of the interviewed camp alumni were in engineering, followed by a hands-on classroom activity. Two activity modules are currently available for high schools to pick from, Engineering Designs and Engineering Challenges.

Engineering Design activity

Students are divided into teams of three or four, given a problem and asked to design and test their solution. The teams are required to budget, draft a design and build a structure that will contain an egg and protect it from cracking/breaking once dropped from a 20 foot height. They are given 30 ‘Discover Engineering’ dollars and can only purchase items from the ‘Discover Engineering’ store for their structure. This exercise promotes group work and problem-solving skills.

Engineering Challenge activity

Students are divided into groups of five and given straws and marshmallows with which they are to build a structure. Each member of the group is assigned a specific role, i.e. use of only the left hand, cannot talk, use of scissors only, use of marshmallows only, team leader, etc. The object is to build the tallest freestanding structure possible within a specific time limit. This exercise promotes co-operation within the group, teamwork, and problem solving skills.

In order to determine the level of awareness about engineering prior to the workshops, all students are asked to complete questionnaires. At the end of the workshop the students are asked to complete evaluation forms to gain feedback on the effectiveness of the workshop. Results from the questionnaires indicate that more women (53%) than men (38%) are not sure about what an engineer does.

Responses from the evaluation forms indicated that 95% of the students found the workshops to be interesting or very interesting while 73% said that the workshops increased their knowledge of engineering. Before the workshop 42% of the students indicated that they were interested in engineering while after the workshop 58% said that the workshop influenced them enough to investigate engineering as a career option.

RETENTION TOOLS

What engineers do affects all of society and society needs the thoughts and creativity of all of its members in the various disciplines and professions. Gender equity does not simply refer to equal numbers of men and women. It means equal access to opportunity, success and career development, equality in the respect given by peers and employers, an environment where there is no longer harassment (personal or sexual) and a culture where diversity is valued. Retention is a very important issue and much thought must be directed towards networking, mentoring, and creating a supportive and equitable learning climate for everyone. The following describes some of the retention strategies and programs that have been implemented by the WIE project at Ryerson, to encourage a more equitable engineering community.

In-coming student phone-calling program

This initiative was established in 1995 by the WIE project, with the objective to telephone all women high school students, who have been sent letters of acceptance to Ryerson
Recently, the WIE project launched a pilot, e-mail based mentoring program to foster more meaningful student-program. The program has now evolved into an online program where students can connect with working women engineers in various fields. Making contact with many women engineers can provide students with a clearer idea of what an engineering career might entail; and to encourage them to continue in engineering in their studies and post-graduation.

Students in their senior years of engineering undergraduate studies were invited to apply to MENTOR-LINK, and those selected were matched with a woman engineer working in their field of interest. Mentors were invited to participate, based on their previous participation in women in engineering projects at Ryerson, such as speaking at the ‘Discover Engineering’ summer camp. Mentors received an information package with guidelines on mentoring undergraduate students and both students and mentors receive biweekly e-mails from the Project Co-ordinator, to offer discussion ideas and gauge any progress. Mentors are encouraged to share their experiences with one another over e-mail, and students are encouraged to the same.

Though the program is structured around dialogue only, mentors have the option of arranging a work-site visit for their student, similar to the job shadow program. The program runs for four months, facilitated by the WIE project office, after which the mentor and student may choose to maintain their mentorship independently and at the discretion of the mentor.

The evaluation process will begin in April 2000, with questionnaires for both students and mentors in order to obtain their feedback and recommendations. To date, the project has proved to be ‘low-maintenance’, given the convenience and flexibility that e-mail offers, delivering several benefits to both students and mentors. Students are encouraged and inspired by successful women engineers, and mentors are overwhelmed at how important the mentorship makes them feel, as well as how they can make a meaningful difference in a young person’s life by sharing their career-related experiences and building confidence within the student.

Annual in-coming student welcoming event

At the beginning of each academic year, all entering first-year women engineering students are invited to attend an evening of social activities to welcome them into their new program of study. Each entering student is sent an invitation in the mail, and student volunteers who make the in-coming student phone calls remind students about the event over the phone. Senior women engineering students are also invited to attend so that they may share their undergraduate experiences in their respective programs and network with in-coming students. Women engineers attend the event as guest speakers. The Dean of Engineering, Departmental Chairs and various Faculty members are also invited. This project is particularly valuable given that it introduces students to a support network at an early stage in their academic career.

Drop-in hours

The Co-ordinator of the WIE project hosts regular drop-in hours in order to field any questions or concerns from women engineering students. The Co-ordinator provides counselling and referrals (personal, career, academic) when appropriate to students in need. Having a consistent, identifiable service available to students is essential in ensuring a supportive learning climate for women in engineering.

Volunteer opportunities and skill building opportunities

Several volunteer opportunities exist for women engineering students to get involved with the WIE project. Recent initiative combines volunteer work with specific skill building opportunities. The new high school workshop program offers...
students an opportunity to become trained workshop presenters in order to gain teaching experience, as well as enhance their public speaking and communication skills. Students feel empowered as they learn the value of being a positive role model for younger students.

CONCLUSIONS

The participation of women in engineering in Canada has increased every year since 1974 (the year first statistics were recorded), when only 2.9% of full time engineering students were women, and reached 20.7% in 1998 [2]. In the province of Ontario in 1998 there were 3,164 (or 21.4%) female engineering students. Their number has increased by more than 50% since 1991, as shown in Figure 2 and in Figure 4. Enrollment of female engineering students at Ryerson rose at an even more rapid rate, and more than doubled between 1992 and 1998, from 7.9% to 16.1%, as shown in Figure 4. Current enrollment figures at Ryerson, while still below provincial and national average, show now signs of catching up.

The increased enrollment figures in undergraduate engineering programs are also beginning to translate into an increased number of women engineers. Among Engineers in Training in Ontario (EIT is a professional designation for those with less than 4 years of experience), over 400, or 20%, are women (see Figure 5), compared to only 4.9% of registered Professional Engineers who are women (1998 data).

Figure 4: Enrollment (in %) of female engineering students at Ryerson vs. Ontario

Figure 5: Registrations (in %) with Professional Engineers Ontario (PEO) in 1998

There are many contributing factors: an increased awareness among the society at large of career opportunities for women, globalization, changing perceptions of engineering, increasing emphasis on communications and people skills, changes in the profession itself in the wake of the Montreal massacre ten years ago, and the economy, to name just a few.

National and regional recruitment efforts are certainly contributing as well. While it is too early to evaluate the more recent Ryerson initiatives, hundreds of young women in Ontario who decided to pursue engineering as a result of their direct and indirect exposure to ‘Discover Engineering’ are certainly beginning to make an impact. Although many ‘Discover Engineering’ graduates enter other universities to pursue engineering, the increased visibility of WIE projects at Ryerson and efforts to create a gender-positive environment, also has had an undeniable effect on enrollments at Ryerson.

REFERENCES