Global J. of Engng. Educ., Vol.4, No.3
Published in Australia

Innovative Outreach Programmes to Attract and Retain Women in Undergraduate Engineering Programmes*

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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. The vast pool of talent represented by women can no longer be excluded, therefore effective recruitment and retention programmes 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 in Toronto, Canada, to increase the participation of women in engineering. These projects include the *Discover Engineering* Summer Camp, in-class high school workshop programme, one-day engineering career conference, on-line mentoring programme, 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 people's daily lives and the environment is enormous. What engineers do affects everyone. 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 enrolments are, in general, declining [1]. Figures 1 and 2 show statistics for undergraduate engineering enrolment in Ontario, the most populous province of Canada [2][3]. There has been a 15% drop in enrolments since 1991.

This trend is mirrored across Canada and in the USA. Figure 2, 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

A need to encourage women to consider engineering as a career option is clear on the basis of allowing

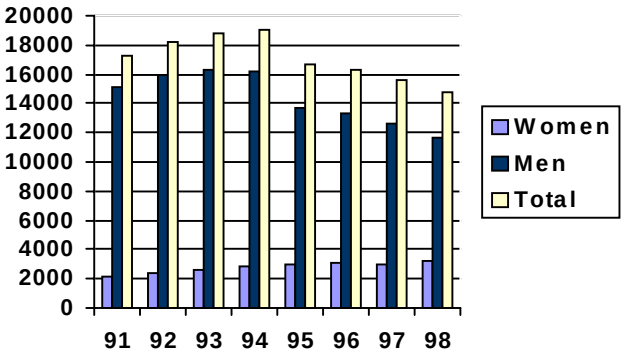

Figure 1: Enrolment of engineering students in Ontario.

*A revised and expanded version of a paper presented at the *2nd Global Congress on Engineering Education*, held at Hochschule Wismar, Wismar, Germany, from 2 to 7 July 2000.

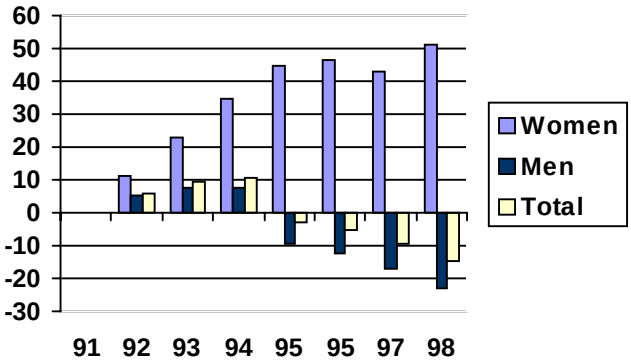

Figure 2: Percentage change in enrolment of engineering students in Ontario as compared with 1991 figures.

equal opportunity to all members of our society. However, the statistics in Figures 1 and 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.

However, the reality is that the engineering profession in Canada 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 in 1998 only 3,030 out of 61,340 registered Professional Engineers (PEng) were women (4.9%). The national average was similar. The national average of women who hold academic appointments in 33 Canadian engineering schools in 1998 was only slightly higher at 7.7% [3]. For comparison, there are 6,855 women among the 26,190 of all academic appointments in Canada (26.3%). These numbers reflect low absolute enrolments of women in engineering programmes over the past years. As well, many women are still leaving the profession as a result of negative experiences including hostile climate, harassment, or lack of promotion opportunities (*glass ceiling* effect).

Aftermath of the Montreal Massacre

On 6 December 1989, 14 young women at Ecole Polytechnique in Montreal were killed simply because they were studying to become engineers. On that day, a 25-year-old man walked into the engineering school at the University of Montreal, Quebec, and opened fire on every woman he encountered. To quote from the *Toronto Star* article by Lynda Hurst, a journalist who covered the event, he shouted:

> *"I want the women. I hate feminists. You're all a bunch of feminists"; he strode the halls of the Ecole Polytechnique, going into several classrooms where he ordered the men out, then into the cafeteria. He shot 27 people, 14 women fatally … Then he turned his semi-automatic rifle on himself. The entire rampage had taken 20 minutes, but it would have far-reaching, eye-opening consequences for all Canadians…* [4].

There was no doubt that the man, a failed applicant to the Ecole, had specifically targeted women. A year later police released the contents of a suicide note in which he listed 19 prominent Quebec women he had originally planned to kill. Unable to execute the original plan, he targeted female engineering students, whom he blamed for his failure at the engineering school.

The killer wanted to silence the women, but what he did was the opposite. Quoting from *Toronto Star* again,

> *…his act would re-engage those women who'd grown complacent in the '80s with what, on the surface, was seeming a relatively smooth transition to social equality. It would motivate many men to take a long, hard look at their own behaviour. It would kick-start the gun-control movement. And it would expedite the participation of women in the engineering profession…*[4].

The engineering profession in Canada has done a lot of soul-searching in the wake of the Montreal massacre. The Canadian Committee on Women in Engineering was established. Five Regional Chairs for Women in Science and Engineering were endowed, jointly sponsored by academia and industry, to actively promote programmes to attract and retain women in engineering programmes at Canadian universities. Dr Monique Frieze, currently NSERC/Nortel joint Chair for Women in Science and Engineering in Ontario, was the first professor to hold such a position in Canada, at the University of Brunswick, New Brunswick, in 1989 [3].

According to a 1999 interview, Professor Frieze is pleased that the average enrolment Canada-wide is up to 19%, but would be happier still when it hits the critical mass of 30% [4]. *We have to get universities to understand that life sciences mixed with engineering programmes are what interest women*, she is quoted as saying, *When I speak, I tell women that female values will one day be included in their work.*

To a certain degree, this may be already happening at the University of Guelph, a small Ontario school, where

43% of its 550 engineering students are women. Interestingly, Guelph does not offer civil, mechanical or computer engineering programmes which traditionally have low female enrolments, concentrating instead on biomedical, chemical and environmental engineering.

The Canadian Engineering Memorial Foundation

In 1999, the Canadian Council of Professional Engineers (CCPE) recognised the uniqueness of Guelph's engineering faculty by bestowing on the school the first CCPE December 6 Memorial Foundation award for universities where engineering departments offer *women-friendly* environments. In 2000, Ryerson Polytechnic University won this award in 2000 and was cited as the *most improved*. Women in Engineering Committee at Ryerson projects, described in this paper, were undoubtedly a contributing factor. The award is one of several initiatives of the Canadian Engineering Memorial Foundation.

The Foundation was a result of efforts of many Canadian women, including a distinguished engineer and the first female president of the Professional Engineers Ontario, Claudette MacKay-Lasonde, who spearheaded a successful drive to create it. Administered by the CCPE, the Foundation also provides scholarships for graduate and undergraduate women engineering students across Canada, based on academic achievement and demonstrated leadership, community involvement and extracurricular activities.

Since 1992, the Canadian Committee on Women in Engineering has released many recommendations to change the climate for women in engineering programmes at universities and in the profession itself, many of which have been successfully implemented [5]. The Montreal massacre galvanised the society at large, and the professional and academic establishment. Numbers of women in the profession and in engineering schools, growing steadily since 1970s, have begun to increase at a faster rate, more than doubling since 1989.

BACKGROUND: RYERSON INITIATIVES

In 1989, the participation of women in undergraduate engineering programmes 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 programmes.

Its first initiative started in 1991: the *Discover Engineering* Summer Camp [6]. 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, including a yearly 150-student enrolment and wait list for the following year. Over the years, the camp has received positive coverage in media (newspapers, TV), which contributed to an increased awareness of WIE activities in the greater Toronto area. Camp information is also available on-line [7].

Several other initiatives followed. The high school workshop programme 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 counsellors was set up 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 project coordinator was created. A new on-line mentoring programme 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

Elements of a Successful Initiative

There are a number of factors that have been quoted as diverting young girls away from choosing engineering as a career:

Streaming, or the "Leaky Pipe Syndrome": Girls are diverted from math and science courses early in their high school careers. It has been argued that this is associated with issues of competition, isolation, lack of female role models, and not of lack of academic ability [5]. Systemic obstacles include cultural influences and gender stereotyping at home and in school, peer pressure and images in the media [8].

Perception of Difficulty: Engineering is thought to be extremely difficult. Combined with the prevailing myth that girls are poor at mathematics, girls tend to choose something perceived as more achievable.

Exposure: Girls do not have as many engineer role models as for other careers, such as business, medicine or law. There are few women science high school teachers; few women are represented in science textbooks and among university engineering faculty.

Lack of Knowledge about Engineering: Engineering is perceived as a technical, often solitary pursuit, in which one works with machines rather than people. Career options in engineering are not well known by most adults, let alone teenagers, and are not well represented in high school curricula or through career guidance counselling. This affects girls disproportionately, as they typically have less access to information about engineering outside the school environment.

Hobbies: Encouraged by parents and peers, boys engage in mechanically oriented hobbies, which prepare them better for the practical aspects of engineering.

Social Status of the Profession: In North America, the profession of engineering derives from the skilled trades of Britain, and therefore may be associated with the working class. This is in contrast to the European tradition of engineering, where it has always been regarded as a profession allied to the sciences. Notice the difference between the derivation of the English word *engineer* (associated with engines) and the French word *ingenieur* (associated with ingenuity or invention). Thus, engineering has a tradition of higher social status in the New World countries such as Venezuela, deriving their traditions from continental Europe, as opposed to British-influenced Canada. Parents who are considering professional careers for their daughters implicitly understand this.

The *Discover Engineering* camp programme deals directly with the above issues that deflect women away from science careers [9], as described below:

Role Models: Students meet a wide variety of women engineering students, engineering professors and practicing engineers.

Confidence Building: Many of the camp activities are hands-on and result in something the student can take home, so that the student will experience the involvement of a mini-engineering project and see herself as competent. Having a project to show at home also creates support from parents and relatives.

Career Options: At the end of the week, the student has seen and heard about a wide variety of career options, both in subject material (civil, electrical, mechanical and so on) and in career focus (researcher, applications engineer, manager, inventor.)

Societal Role of Engineering: The camp programme emphasises that engineering makes an important contribution to society, and that interaction with other people is an important aspect of engineering.

Design and Management of the Project

The *Discover Engineering* programme is unique in the Toronto area. Unlike some other science and engineering programmes, 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 counsellors 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 enrolment 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.

The total project budget is about $60,000 per annum, requiring substantial support from the university and from our engineering industry and Federal Government. Sponsors support the project with donations in kind, financial support, and by identifying speakers for the panel discussions. In return, they are recognised in various displays of their company logos and provided with reports and certificates identifying their support.

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. As resources become available, new sessions are being developed and added. Annual exit surveys help decide which components of the curriculum need modifications. Core sessions consistently attract high levels of interest.

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. During the week at the camp, students participate in hands-on activities in a stimulating learning environment that allows young women to achieve success in small engineering projects in a variety of engineering fields.

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 [6][7].

All camp activities emphasise participation and collaboration. The socialising 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 panellists 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

It is crucial that the success of a programme aimed at attracting girls into science and engineering is evaluated. The follow-up is cited in literature as the most important characteristic of an exemplary programme, regardless of programme design or setting [10][11]. Since its inception in 1991 in order to evaluate the success of the *Discover Engineering* project, participants have been asked to complete exit surveys concerning the camp experience, their attitudes about engineering and their career decisions [12]. These data can be used to measure the success of the camp experience and to track the number of participants who go on to choose engineering as their university major.

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, for a total of 92. The survey results are summarised in Figure 3.

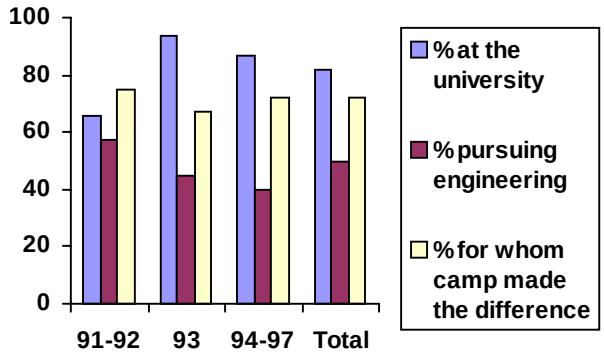

Figure 3: Telephone survey results.

On average, 80% of the interviewed camp alumni went on to study at a university. Over 50% of those at the university were enrolled in engineering programmes, and of those, 72% said that the summer camp experience greatly or moderately influenced their decision. Over 60% of the participants surveyed commented that the hands-on aspect of the camp was its most effective component.

The sample size of the survey (217 participants) allows for some extrapolation of these findings. To date, approximately 1000 young women were introduced to engineering through the camp experience. The surveys indicate that about 500 of those young women are already working in engineering, or studying to enter it. Information collected from the surveys suggests that the camp experience helped them significantly to decide whether or not to study engineering, becoming a deciding factor for 360.

These numbers indicate a positive contribution that Women in Engineering at Ryerson Committee has made over the years to its stated goal of recruiting women into engineering.

THE HIGH SCHOOL WORKSHOP PROGRAMME

The High School Workshop programme was initiated in the fall of 1999 as an extension to the Discover Engineering camp programme. The goal of the new initiative is to raise awareness about careers in engineering among all high school students. The programme

develops a communication bridge between the women presently involved in science, technology and engineering and prospective students in secondary schools.

The programme is offered in a co-ed classroom environment and not just to female students. However, the use of female presenters provides strong positive role models for the young women. As well, this helps change stereotypical perceptions of engineers, held by both male and female students in the audience. Presenters are recruited from among faculty, staff and students, and must be able to communicate well with various age groups. They volunteer their time to visit classrooms to inform students about future career opportunities.

Each workshop is approximately 1-2 hours. It includes a brief presentation describing the purpose of the workshop, engineering at Ryerson, and opportunities in the field of 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, ie 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.

Engineering Career Conference

In May 2000, the first one-day engineering conference aimed at young women in high school took place at Ryerson. Three workshops offered high school students a close look at careers in engineering and allowed them to meet with successful women from the profession. The conference, which will take place semi-annually, is designed to provide helpful resources to use in planning career paths and highlight some of the key issues around women in technology and engineering. Conference participants attend panel discussions as well as have a choice of several workshops, offering a fun and interactive introduction to engineering.

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 programmes that have been implemented by the WIE project at Ryerson, to encourage a more equitable engineering community.

Incoming Student Contact Programme

This initiative was established in 1995 by the WIE project with the objective to contact all women high school students who have been sent letters of acceptance to Ryerson engineering programmes. The purpose of the calls and e-mails is to congratulate each student on their acceptance by Ryerson and to answer any questions that the student or her parents may have. Senior year women engineering students in the new student's programme of study make the contacts.

The project aims to make entering women engineering students feel welcome at their new university, to encourage networking between students at different stages of completion of their degree, and to provide any information to the students and parents which may help ease the transition to university. When the student is contacted, volunteers take note of questions that are asked, comments made and any other relevant information that would be useful to the project. They are asked to evaluate the call as positive, neutral or negative (in their opinion).

Students who have made the decision to study at Ryerson seem to appreciate the contact and often ask many questions. The most common question asked is: *Will I be the only woman in my class?* This indicates a justified concern on the part of incoming students and it is encouraging that they are able to ask this question and get a clear answer from students who have already been through the experience. New students are also nervous about their chosen discipline and want to know *is engineering hard?* Honest answers from students in the programme along with useful information about student services such as the math centre, learning seminars and the writing centre are helpful in reassuring them.

Overall this project has had a positive response, helping women engineering students to make the transition to university by connecting with a student already studying at Ryerson. The programme lacks any formal evaluation procedures at this point, and the data that has been collected has yet to be compiled and reported.

Job Shadow Programme

Initiated in 1995, the goal of this project was to place 3rd and 4th year female engineering students at Ryerson with a woman engineer in industry for a half-day job shadowing experience. Matches were made according to discipline and the student's field of interest. Many students (particularly in the non co-op disciplines of engineering) are not gaining experience in engineering through summer/part-time employment.

The aim of this programme was threefold: to give women students a chance to meet with and be mentored by a working woman engineer; to give them a clearer idea of what an engineering career might entail; and to encourage them to continue in engineering in their studies and post-graduation.

Making contact with many women engineers in a wide range of areas is necessary in order to have a successful job shadow programme. The programme has now evolved into an on-line mentoring programme to foster more meaningful student-professional relationships, rather than a one-day interaction.

On-line Mentoring Programme: MENTOR-LINK

Recently, the WIE project launched a pilot, e-mail based mentoring programme for women engineering students. MENTOR-LINK is a motivational programme to support students in their career planning process, and to help their transition to the world of work.

MENTOR-LINK has been designed to inspire some of the talented young women enrolled in undergraduate engineering programmes at Ryerson through a meaningful relationship with a dynamic mentor and an engaging, facilitated, four-month programme. If successful, the programme will be expanded in upcoming academic years to accommodate more students and mentors.

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 Coordinator, 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.

Although the programme is structured around dialogue only, mentors have the option of arranging a work-site visit for their student, similar to the job shadow programme.

The programme 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 began 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 Incoming 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 programme of study. Each entering student is sent an invitation in the mail, and student volunteers who make the incoming student contacts remind students about the event.

Senior women engineering students are also invited to attend so that they may share their undergraduate experiences in their respective programmes and network with incoming 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 Coordinator of the WIE project hosts regular drop-in hours in order to field any questions or concerns from women engineering students. The Coordinator 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 initiatives combine volunteer work with specific skill-building opportunities. The new high school workshop programme 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 first year statistics were recorded), when only 2.9% of full-time engineering students were women [3]. In 1999, a decade after the Montreal tragedy, the absolute number of women studying in Canada's 33 engineering faculties has more than doubled: from 4,276 to 8,739 [4]. This figure represents 20.7% of all engineering students. In the province of Ontario alone in 1998, there were 3,164 (or 21.4%) female engineering students, again an increase of more than 50% since 1991, as shown in Figures 2 and 4.

By discipline, the enrolment was the highest in environmental engineering (42%), followed by chemical (39%), civil (23%), electrical (15)%. The lowest enrolments were in mechanical (13%) and computer engineering (12%) [3].

Enrolment 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 enrolment figures at Ryerson, while still below provincial and national average, now show signs of catching up.

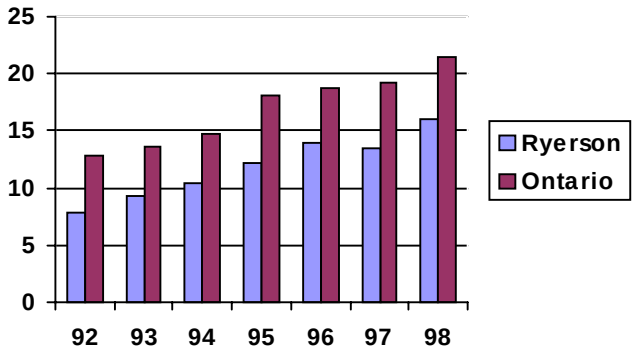

Figure 4: Enrolment (in %) of female engineering students at Ryerson vs. Ontario.

On a graduate level, on average, 70 women were granted doctoral degrees in engineering and applied science between 1996 and 1999. This represents about 10% of all PhD degrees. In the same period of time, the number of women enrolled in full-time engineering doctoral programmes averaged 470. This represents 15% of all engineering doctoral students. The number of women enrolled in Masters programmes is 23% [3].

The increased enrolment figures in undergraduate and graduate engineering programmes are also beginning to translate into an increased number of women engineers and women engineering faculty. Among Engineers in Training in Ontario (EIT is a professional designation for those with less than four 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).

There are many contributing factors: an increased awareness among the society at large of career opportunities for women, globalisation, changing perceptions of engineering, increasing emphasis on communications and people skills, the booming Canadian economy, and changes in the engineering profession

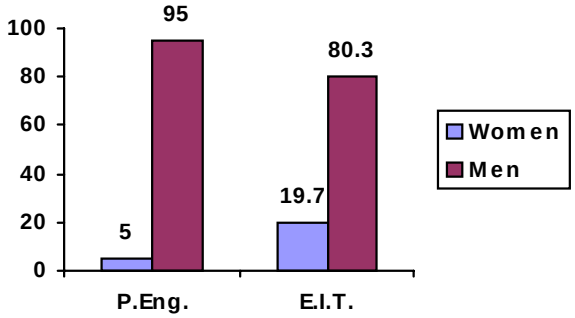

Figure 5: Registrations (in %) with Professional Engineers Ontario (PEO) in 1998.

in the wake of the Montreal massacre. 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, has also had an undeniable effect on enrolments at Ryerson.

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BIOGRAPHIES

Malgorzata Zywno is a Professor in the Department of Electrical and Computer Engineering at Ryerson Polytechnic University in Toronto, Canada. She completed her undergraduate degree at the Technical University of Lodz, Poland, and earned her Master of Engineering degree in Electrical Engineering from the University of Toronto, specialising in Control Systems. She joined the Electrical Engineering Department at Ryerson in 1982, and received the rank of Professor in 1991. Her teaching and research interests include linear, non-linear (adaptive), intelligent control (fuzzy logic) and system modelling and identification. Since 1997, Professor Zywno has been exploring the implications of technology-aided pedagogy, including the effect of individual cognitive preferences on learning through computer-based instruction. She has extensive experience in developing multimedia and Internet-based courseware, specifically in the area of control systems.

Professor Zywno is a Research Associate of the Centre for Quality Service Research at Ryerson and has recently been appointed an Associate of the newly formed Ryerson Centre for Engineering Education (RCEE). She is also an active member, and past Chair, of Women In Engineering Committee at Ryerson and is involved in several WIE projects, including the *Discover Engineering* summer camp. Her research interests in this area include an investigation of issues of recruitment and retention strategies for women in engineering.

Professor Zywno is a member of the Institute of Electrical and Electronic Engineers (IEEE) and is a registered Professional Engineer in the Province of Ontario, Canada. Over the years, Professor Zywno has volunteered her services in a variety of capacities to the engineering profession, including a Task Force on Admission (1991-93), and since 1993, Academic requirements Committee (ARC) of the Professional Engineers Ontario (PEO), which is a self-regulating body licensing engineers in the province of Ontario.

Kimberley Gilbride is a Professor in the Department of Applied Chemistry, Biology and Chemical Engineering at Ryerson Polytechnic University in Toronto, Canada. She received her BSc degree from Concordia University in 1980, her MSc degree from University of Guelph in 1982, and her PhD degree in Microbiology from the University of Toronto in 1989. Dr Gilbride joined Ryerson in January 1989 and teaches in the areas of microbiology, molecular biology and biotechnology. Dr Gilbride's research involves using molecular techniques to study the structure and function of bacterial communities. She currently holds a grant from the Natural Sciences and Engineering Research Council to study the diversity of microbial populations in industrial and municipal wastewater.

Her other research interests include the recruitment and retention of women into non-traditional careers, specifically engineering and natural sciences. She has been involved with WIE Committee projects since its inception in 1989 and chaired the committee between 1998 and 2000. Her activities in this area include designing evaluation materials and analysing data to assess the impact of *Discover Engineering* programmes and helping to establish the high school workshop programme.

Nadine Gudz is currently a graduate student at University of British Columbia, Vancouver, BC, where she pursues her Masters degree in Urban Planning. Between 1998 and 2000, she was a Projects Coordinator for Women in Engineering at Ryerson Polytechnic University. Ms Gudz carries an extensive portfolio of projects relating to science and engineering education for youth, in particular, promoting equal access to learning. During her undergraduate studies at the University of Guelph, Guelph, ON, she worked as the Director of Creative Encounters with Science (CES), a student-run, non-profit science and engineering programme for youth, educators and parents.

Before commencing her position at Ryerson, Ms Gudz interned in the Office of Science and Technology, Organization of American States (OAS), Washington, D.C. At Ryerson, Ms Gudz has coordinated the high school outreach programme, arranged in-class presentations, campus career days and a summer engineering camp for young women in high school: *Discover Engineering*. Her other focus was counselling and referrals for women engineering students and coordinating mentorship and professional development opportunities for students.