

# DIVERSITY IN THE ENGINEERING PROFESSION

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## ABSTRACT

The Canadian Council of Professional Engineers (CCPE) has recently undertaken a national consultation process with our constituent members (provincial and territorial engineering associations/ordre), the NSERC Chairs for Women in Science and Engineering and several other interested stakeholder groups. This process has culminated with policy recommendations for actions that could be undertaken at the national level. This paper will report on the process, the results and an overview of the activities that the CCPE and other stakeholder groups would like to initiate over the next several years.

In addition, pertinent findings from recent studies and surveys undertaken by the Canadian Engineering Resources Board (CERB) will be discussed. An overview of the demographics of the engineering profession across Canada will be provided in addition to some key facts and figures on the gender distribution of engineering students at both the undergraduate and graduate levels in recent years. Some additional information on how Canadian enrolment and degrees awarded in engineering compares to other countries around the world is also included.

## BACKGROUND

In 1995, the CCPE Board of Directors established a gender equity committee. The committee reviewed a detailed report prepared by the Canadian Committee on Women in Engineering in 1992 entitled “***More Than Just Numbers***”. The report contained a lengthy list of action items and an extensive summary of the issues facing women in engineering, the keys to success for women, ways to measure this success and suggested reasons why Canada’s engineering profession needs more women. The gender equity committee’s report was received by the CCPE but no action was taken.

CCPE Council then requested that a National Meeting on Women in Engineering be held in 1999/2000. This meeting occurred in late January 2000 in Ottawa. Representatives from all provincial engineering associations, the NSERC Women in Engineering Research Chairs, the National Council of Deans of Engineering and Applied Sciences, the Canadian Federation of Engineering Students, and YES-VACC were in attendance along with representatives from the CCPE. A draft policy paper on Diversity in Engineering was developed at this meeting in

addition to some suggested implementation items. Most of the participating organizations had provided advance written summaries of their current or planned initiatives related to Women in Engineering, which were highlighted at this meeting.

Given that the Canadian Engineering Resources Board (CERB) was tasked with workplace issues, it was decided that the development and implementation of this policy should become part of the mandate of this Board. The draft policy was reviewed in detail at the CERB meeting in March 2000. The CERB received the draft Diversity in Engineering policy as a work in progress at this meeting. In addition, the policy was briefly discussed at the joint session of the CERB and Canadian Engineering Qualifications Board (CEQB) in early March. Comments arising from these meetings were then incorporated into the draft policy. The only significant change made to the policy was to include minorities and handicapped individuals or other “under-represented” groups.

The revised policy was then re-circulated to the CERB and the participants of the women in engineering meeting during the month of April and was brought forward to the CCPE Board of Directors for their information in May 2000. All comments provided will be incorporated into a final draft, which will then be voted upon by the CERB and, once approved, tabled at the September 2000 meeting of the CCPE Board of Directors.

### CCPE DRAFT POLICY STATEMENTS

The draft policy statements developed for diversity within the engineering profession were written to conform to the Carver Policy Governance Model adopted by the CCPE in 1999. The key message, which forms the basis for the policy, is as follows:

*The engineering profession supports principles of fairness and equity in all aspects of engineering culture, practice, and education. Diversity in the engineering profession, which is reflective of Canadian society, enhances our profession and society-at-large.*

The policy then provides further emphasis on several main topics: representation in governance, participation in the formation of an engineer, retention and awareness. Within each of these topic areas, several specific policy statements are included, which will lead to the development of implementation plans:

- ❑ **Representation in Governance** (CCPE Boards and Committees reflect the gender balance within Canadian society)
- ❑ **Participation in the Formation of an Engineer** (diverse participation in engineering strengthens the engineering profession, which includes making K-12 female students aware of engineering as a career option and encouraging gender balanced application and enrolment into both under-graduate and postgraduate engineering programs)
- ❑ **Retention** (a work environment that allows engineers to achieve a professional and personal balance enhances the profession, supports the retention of members, and promotes career path choices – includes flexible work options, equitable compensation and retention of members through their career evolution)
- ❑ **Awareness** (awareness of the diversity in the profession enriches its value, relevance, and public recognition – CCPE recognizes and publicly celebrates the contribution of women engineers)

As mentioned previously, it is anticipated that these policy statements will be adopted by the CCPE Board of Directors at their meeting in September 2000. The next step required is to develop a policy implementation plan. Some suggestions that were brought forward and identified as priorities by the attendees of the January meeting on Women in Engineering included the following:

- ❑ support/fund K-12 activities that support girls’ interest in science, engineering and technology
- ❑ encourage all provincial/territorial associations to develop strategies to register all engineering students
- ❑ advocate flexible work options to provincial/territorial associations and businesses
- ❑ develop a national awareness program to promote women in engineering
- ❑ develop a CCPE Award for outstanding women or promoters of women in the engineering profession
- ❑ actively recruit women for CCPE Boards and committees
- ❑ collect data on why women leave the profession

- ❑ develop a web-based resource centre
- ❑ find out what provincial/territorial association initiatives are well-received by members and disseminate information nationally

The CERB will further develop this implementation plan over the next several months and has already begun some preliminary budgeting for future years.

## **WOMEN IN ENGINEERING AT CANADIAN UNIVERSITIES**

The CERB undertakes an annual survey of accredited engineering programs offered at Canadian universities. The survey gathers information on the enrolment and number of degrees awarded at the undergraduate and postgraduate levels.

### **Undergraduate Engineering Programs**

At the full-time undergraduate level, the numbers of women have increased substantially since 1975 when only 3.6% (849) of the total students enrolled in engineering were women (see Table I)<sup>1</sup>. This percentage has gradually been rising and most recent figures from 1999 indicate that 9,047 women (20.5%) of women are enrolled in Canadian undergraduate engineering programs. Although there are 10 times as many women studying engineering now as there were 25 years ago, there are still far fewer women studying engineering compared to many other programs at universities.

**TABLE I  
TOTAL FULL-TIME UNDERGRADUATE ENROLMENT OF WOMEN STUDENTS**

Year	Total Enrolment	Women	% of Total
1975	23,594	849	3.6%
1980	30,080	2,388	7.9%
1985	33,835	3,660	10.8%
1990	35,872	5,013	14.0%
1995	40,926	7,718	18.9%
1999*	44,036	9,047	20.5%

\* Draft data for 1999 was verified in May and June 2000.

Popular disciplines in 1999, where more than 40% of students were women, included biosystems, chemical, environmental and geological engineering. More traditional disciplines such as civil, industrial & manufacturing, materials & metallurgical and engineering science continued to enroll between 20 and 30% of women. The largest number of women (1,580 students) were enrolled in electrical engineering in 1999, however, this represented only 16.5% of the total. Mechanical engineering programs also continued to maintain a smaller share of women with 14% of the total in 1999 and computer engineering with 12.5% of the total.

Ontario enrolled the largest share of female engineering students in 1999, with almost 46% of the total, which is not surprising given the number of universities in Ontario and its relative population. Québec enrolled 23% of Canada's female engineering students in 1999 followed by Alberta with 11.9% of the total.

While there has been a substantial increase in the number of undergraduate degrees awarded to women over the last 25 years, recently the numbers have reached a peak. In 1999, a drop of over 100 is anticipated from the 1998 level of 1,621 degrees awarded to women. This may indicate that even though the number of women entering engineering programs is increasing, there may be some which either discontinue their studies or move into other university programs.

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<sup>1</sup> Canadian Council of Professional Engineers, "Canadian Engineers for Tomorrow –Trends in Engineering Enrolment and Degrees Awarded: 1994 to 1998", Ottawa, Canada, 1999.

## **Postgraduate Engineering Programs**

At the postgraduate level, the numbers of women enrolled in full-time engineering programs have increased overall in the past 5 years. The number of women enrolled in full-time masters engineering programs has increased to 23.6% of the total in 1999 (an increase of 2.6% from 1995). Similarly, there has been an almost 5% increase in the percentage of women enrolled in full-time doctoral engineering programs since 1995. This increase in female enrolment at both the masters and doctoral levels has occurred at a time when the number of men enrolled has decreased.

There has been a small change in enrolment of women in part-time postgraduate studies in the past five years. At the masters level, an increase of 1% occurred, again at a time when the number of men enrolled in part-time masters programs has decreased. At the doctoral level, there was a drop in the number of women enrolled at the part-time level from 32 in 1995 to 29 in 1999 (the overall percentage increased slightly to 10.4% due to the drop in the number of men enrolled).

Similar to undergraduate enrolment trends, popular disciplines among women at the postgraduate level were biosystems, chemical, environmental and geological engineering (see Table II). In 1999, no women were recorded as pursuing doctoral studies in computer engineering and only one in industrial & manufacturing engineering. In 1999, Ontario and Québec each enrolled approximately 35% of female Canadian full and part-time postgraduate (masters and doctoral) students. In the same year, British Columbia enrolled 12.4% and Alberta 10% of female postgraduate students (full and part-time).

**TABLE II**  
**1999 TOTAL FULL-TIME POSTGRADUATE ENROLMENT OF WOMEN STUDENTS**

Discipline	Total			Total		
	Masters Enrolment	Women	% of Total	Doctoral Enrolment	Women	% of Total
Biosystems	129	55	42.6	60	15	25.0
Chemical	500	181	36.2	340	98	28.8
Civil	936	254	27.1	522	78	14.9
Computer	50	13	26.0	3	0	0.0
Electrical	1614	333	20.6	849	110	13.0
Engineering Science	134	30	22.4	73	8	11.0
Environmental	57	16	28.1	21	4	19.0
Geological	40	14	35.0	8	4	50.0
Ind. & Man.	106	24	22.6	14	1	7.1
Mat. & Metal.	132	26	19.7	114	20	17.5
Mechanical	903	149	6.1	453	68	15.0
Mining/Mineral	113	24	21.2	110	19	17.3

The total number of masters degrees awarded to women decreased from 1998 to 1999 and has also decreased overall since 1995. 349 masters degrees were awarded to women in 1999 compared to 409 in 1998. At the doctoral level, there was a substantial increase in the number of degrees awarded in 1999. 84 degrees were awarded to women in 1999, which is an increase over the 57 awarded in 1998 (57 were also awarded in 1995). Less than 10% of doctoral degrees awarded went to women in several disciplines: engineering science, geological, industrial & manufacturing and mining/mineral engineering.

## **WOMEN IN ENGINEERING AT INTERNATIONAL UNIVERSITIES OR EQUIVALENT INSTITUTIONS**

In 1999, the CERB included a comparison of Canadian enrolment and degrees awarded trends with other countries around the world in the "*Canadian Engineers for Tomorrow: 1994 to 1998*" publication. International statistics were collected from a variety of sources, however, the United Nations Educational, Scientific and Cultural

Organization (UNESCO) served as a major source for data<sup>2</sup>. All Canadian data reported on was for accredited undergraduate engineering programs only, however, the international undergraduate data may have included some non-accredited or equivalent programs.

### **Undergraduate Engineering Programs**

Similar to Canadian trends, the number of women enrolled in engineering programs in the U.S. and Mexico has steadily increased from the early to mid 1990's. In Western Europe, female enrolment in engineering generally increased at a faster rate than total enrolment with the exceptions of those countries where the overall engineering enrolment was in decline, such as in Belgium, Denmark and to a lesser extent Germany. In Eastern Europe, female enrolment generally decreased at a slower rate than total enrolment in the early to mid 1990's<sup>3</sup>.

Indonesia, Japan and the United Arab Emirates all noted large increases in female enrolment in the first half of the 1990's. Many other countries in the Middle East also reported an increase in female enrolment. From available data, most countries in Central and South America noted an increase in female enrolment. Egypt, Tunisia and Uganda combined, recorded female enrolment increases almost 10 times that of total enrolment in this time period. Australia and New Zealand noted that female enrolment increases were double the increases in total enrolment during the first half of the 1990's. It is important to note that many countries that noted large increases in female enrolment had a smaller base of female students in the early 1990's than Canada, for example.

The number of degrees awarded to women in the U.S. was 18.5% of the total in 1998<sup>4</sup> (women in Canada received more than 20% of engineering undergraduate degrees in 1998). Many countries around the world recorded similar percentages of female graduates to Canada (between say 15 – 20%). Some countries awarded 30% or more of undergraduate degrees to women:

- ❑ Portugal, Bulgaria, both the former and Federal Yugoslav Republics in Europe and,
- ❑ Honduras, Cuba and Columbia in Central America.

Several countries were noted to award 10% or less of degrees to women in the early to mid 1990's:

- ❑ Germany, Switzerland and Austria in Western Europe,
- ❑ Japan, Sri Lanka and Singapore in Asia and,
- ❑ Iran in the Middle-East.

### **Postgraduate Engineering Programs**

In the U.S. and Mexico female enrolment increased in the early to mid-1990's. In Mexico, the increase was more substantial. Other countries around the world where female enrolment increased substantially in the first half of the 1990's included Austria, Portugal, Spain, Finland, Switzerland, Slovakia, Poland, Korea, Japan, Sri Lanka, Iran, Turkey, Jordan, Israel and Australia. On the other hand, significant declines in female enrolment occurred in Bulgaria, Egypt, Morocco and Tunisia in the same time period.

The number of female graduates from postgraduate engineering programs increased in the U.S., similar to Canadian trends. In 1998, women received almost 20% of masters engineering degrees awarded in the U.S., which was similar to the 21% recorded in Canada. A larger percentage of women (12%) received doctoral degrees from the U.S. in 1998 than in Canada (9%). In Western Europe, most countries awarded similar percentages of degrees to women as in Canada. Several countries such as Finland, Norway, Spain, Bulgaria, Croatia, Estonia, Poland, Slovakia, Yugoslavia, Columbia, Chile, Turkey and the Syrian Arab Republic awarded more postgraduate degrees to women than in Canada from the early to mid 1990's. Switzerland, Austria and Japan continued to award less than 10% of postgraduate degrees to women in this time period.

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<sup>2</sup> Canadian Council of Professional Engineers, "Canadian Engineers for Tomorrow –Trends in Engineering Enrolment and Degrees Awarded: 1994 to 1998", Ottawa, Canada, 1999.

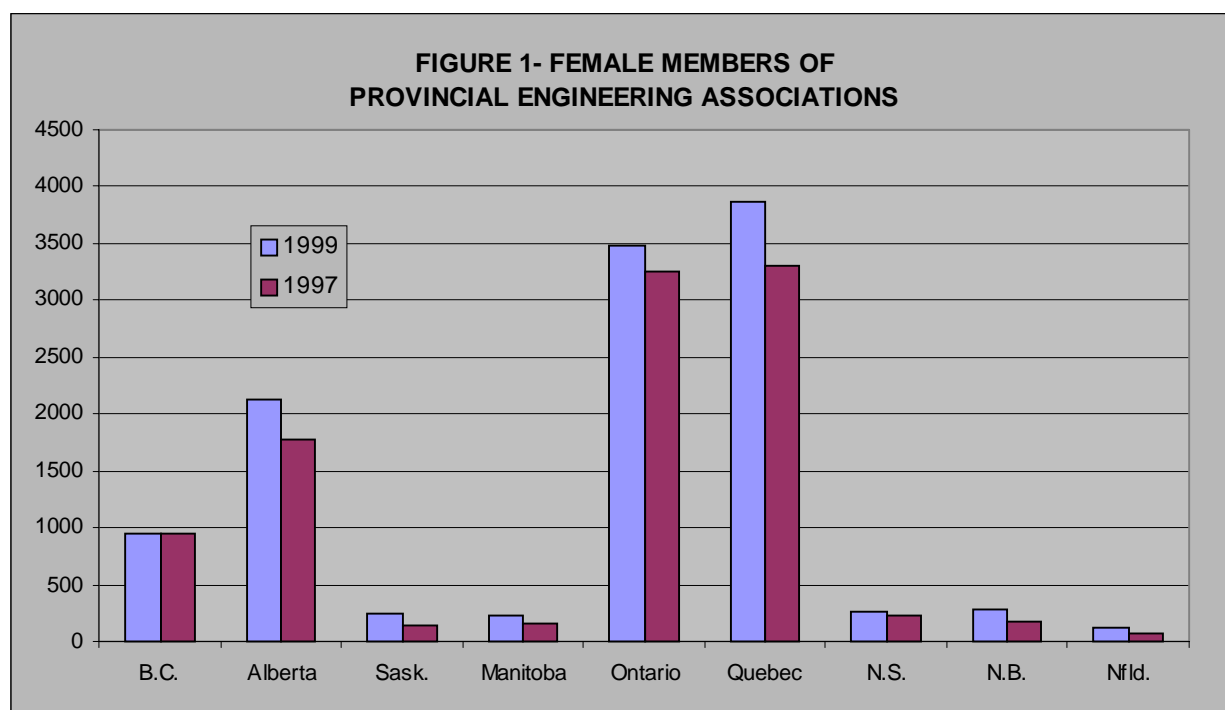
<sup>3</sup> UNESCO Publishing and Bernan Press, "1998 UNESCO Statistical Yearbook", U.S., 1998.

<sup>4</sup> Engineering Workforce Commission of the American Association of Engineering Societies Inc., "Engineering & Technology Degrees – 1998", Washington, D.C., 1999.

## WOMEN IN THE ENGINEERING PROFESSION IN CANADA

The CERB also undertakes surveys and studies of the Canadian Engineering Profession. In 1997, a National Survey of the engineering profession was completed. This survey described the characteristics of Canada's engineering profession including many key employment descriptors. The primary objective of the survey was to develop an initial profile of the engineering profession. A second National Survey is tentatively scheduled for the year 2002. In addition, the CERB has begun an annual Mini-Survey of the provincial/territorial engineering associations. This Mini-Survey is less extensive in scope to a full National Survey but provides some vital statistics on the engineering profession. Data collected from the Mini-Survey included information which was readily available from the databases of the provincial/territorial engineering associations, whereas a National Survey included a Census survey of actual members of the engineering profession.

By comparison, the results of the 1999 Mini-Survey indicated an increase in the number of female members at most of the provincial engineering associations since the 1997 National Survey (see Figure 1). The female members noted in Figure 1 included professional engineers, engineers/members in training and a variety of other membership categories at the various associations. PEI and the Northwest Territories also noted an increase in membership and the Yukon recorded a small decrease. Overall, women represent more than 6% of the membership at the various provincial/territorial associations across Canada. The Ordre des Ingenieurs du Québec maintained the largest percentage of female members at 9.2% of the total in 1999. Most other provinces/territories recorded percentages between 4.5 and 7%.



The number of female members at the provincial/territorial engineering associations has been increasing at a gradual rate over the last 20 years<sup>5</sup>. Approximately 25% of new entrants to the profession are women, which is slowly increasing the relative percentage of women in the profession over time. Not surprising, the proportion of women to men is greater in the younger age categories. Similar to enrolment trends, women show a stronger preference for careers in chemical, industrial & manufacturing and environmental engineering. A significantly lower percentage of women are pursuing careers in computer, electrical and mechanical engineering. A higher percentage of women in the profession have pursued a master's level program than men.

<sup>5</sup> Canadian Council of Professional Engineers, "1997 National Survey: Summary of Findings", Ottawa, Canada, 1998.

At the occupational level, women and men under 40 reported working as managers with similar frequency<sup>6</sup>. Women over 40 reported being senior managers less often than men. Women also recorded slightly higher unemployment rates in 1997 than men in some age ranges and women between the age of 32 and 46 tended to hold part-time positions more often than men. In general, job functions were similar for men and women although a higher percentage of women were employed in the engineering service sector.

## **SUMMARY**

The CCPE and the CERB will continue to move forward with the process required to adopt the policy options discussed in this paper. In addition, the CERB intends to develop a series of action plans for implementation over the next several years. The CERB will also continue to gather information on diversity within the university engineering community and the Canadian engineering profession through such initiatives as National Surveys, Mini-Surveys and annual publications of Engineering Enrolment and Degrees Awarded at Canadian universities. Further work will also be carried out in a variety of areas through such initiatives as the CERB's Engineering Work In Canada Program (a multi-year set of studies aimed at providing a clearer definition of issues affecting the profession).

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<sup>6</sup> Canadian Council of Professional Engineers, "1997 National Survey: Summary of Findings", Ottawa, Canada, 1998.