

## **WOMEN IN ENGINEERING AT UBC: A CASE FOR SUPPORT OF NETWORKING ACTIVITIES**

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### **Abstract**

On average, only 18% of first year engineering students at UBC are women. As well, it appears that the attrition rates for female engineering students are higher than those for their male counterparts, although this number is more difficult to track due to the high degree of variability in student programs. In this paper, we analyze and discuss survey data collected in 2006 at the University of British Columbia from the university's engineering student population. This survey was proposed in a paper presented at CCWEST in 2006 which reported on a focus group study at UBC and the general state of programs for women in engineering across Canada. The goal of this survey was to evaluate perspectives of the social climate for male and female students in the UBC engineering program and to identify any differences in interest and valuation of programs and activities for male and female students. Specifically, we were interested in what programs and activities would attract and retain women students, and we asked students to identify any barriers they saw to their engineering career. Respondent information such as sex, year, and engineering discipline was also collected

Statistically significant outcomes of this survey indicate that women students do feel more stereotyped than male students. They do not see themselves participating in engineering activities such as design, building/implementation and debugging as often as men do. Women value career related support and information more than men. Both men and women students were in favour of gender equity, but women were more aware of gender barriers to engineering education and careers than men. While the awareness to education barriers appears to decrease as women move through the education system, the awareness to career barriers seems to be heightened. Women gave positive responses to participating in directed women-in-engineering support programs, with 50% of respondents indicating that they would participate in networking activities.

The outcomes of the survey give guidance to activities to support women in engineering and identify issues for further investigation and consideration. Within UBC engineering programs, further efforts are needed to ensure women students fully participate in all aspects of engineering design activities. Efforts need to be taken to address the concerns held by women students about barriers to their education and to their career, and further analysis, beyond the scope of this study, is needed to investigate reasons for these perceived barriers. Finally, WIE (Women in Engineering) programs should consider networking events as an important tool for supporting women students in engineering.

*Index Terms – Engineering Student Survey, Climate in engineering at UBC, Women in Engineering Students.*

## **1 Introduction**

In March 2006, a web based survey of engineering students at the University of British Columbia was conducted<sup>1</sup>. The aim of this survey was to gather data that can be used to direct research and programs for supporting women in engineering, as well as to advocate for, and inform the development of, programs for all engineering students.

The survey was conducted by the “grassroots” Networking Engineering Women organization at UBC (NEW@UBC)<sup>2</sup>. This survey attempted to investigate a variety of issues that challenge university students in engineering, including support for engineering students in general and women students in particular. Behavioural Research Ethics Board approval was obtained for the survey, and the Faculty of Applied Science, UBC, assisted by emailing the survey invitation to all registered undergraduate engineering students. Graduate students were contacted through their departmental graduate secretaries. Students were also contacted through mailing lists which were set up by NEW@UBC. The complete survey is included in Appendix 1. Since very limited resources were available to complete the survey and no professional statistical consulting services were affordable to the group to set up or refine the questions, or analyze the data, further professional study would be necessary to confirm the results of this work.

### **1.1 Background**

The Faculty of Applied Science at UBC comprises the School of Architecture and Landscape Architecture, the School of Nursing, and Engineering. Engineering offers 11 different undergraduate programs leading to the Bachelor of Applied Science degree in chemical and biological, civil, electrical, computer, materials, mechanical, mining, geological, integrated, and environmental engineering as well as engineering physics. The Faculty offers graduate programs leading to the Master of Engineering, Master of Applied Science, and Doctor of Philosophy

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<sup>1</sup> Funding for this survey was provided by the JADE Bridges Programme, NSERC Chair for Women in Science and Engineering, BC/Yukon.

<sup>2</sup> The NEW@UBC program has been renamed as the Women in Engineering program at UBC, <http://wie.apsc.ubc.ca/about/index.php>, and is now supported through a student development officer within the Faculty of Applied Science.

degrees. Applied Science also comprises the School of Engineering at UBC Okanagan, which offers degree programs in civil, electrical, and mechanical engineering; however these programs commenced after the time of this survey and are not included in this report. The undergraduate program in Vancouver has a common first year after which students apply to join one of the 11 programs listed above.

In 2005, there were 3259 students registered in engineering, of which 600 (18%) were women<sup>[1]</sup>. Table 1 shows the breakdown of participation of women in the various programs by discipline. Comparison of the numbers reported by the Canadian Council of Professional Engineers<sup>[2]</sup> indicates that these numbers are in-line with the national average, which shows a downtrend in the enrollment of women in engineering.

## 1.2 Survey Participation

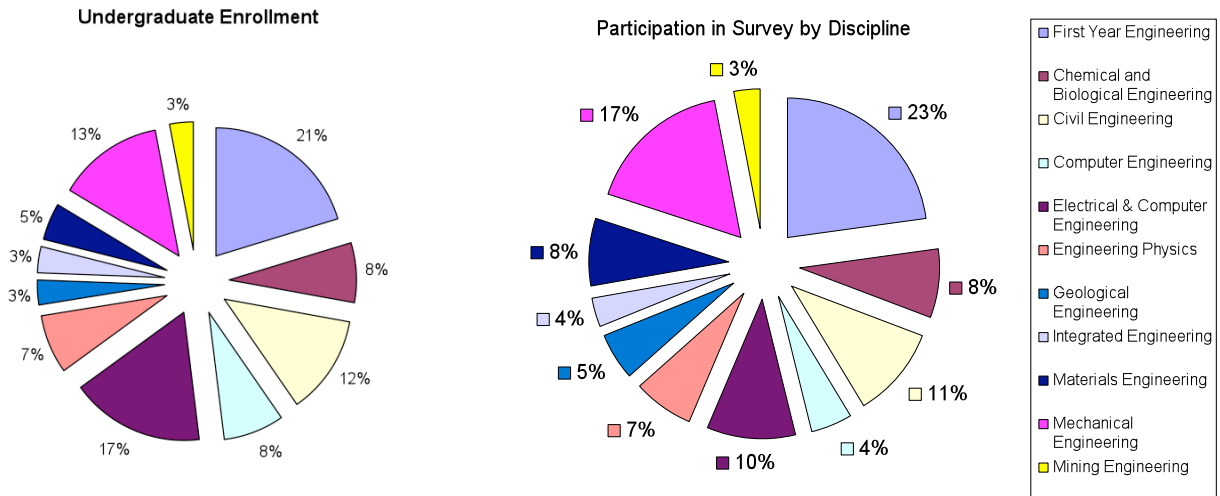
As shown in Table 2, 264 students participated in the survey. Although more men participated than women, the participation rate by women represents 18% of the female student population versus an only ~6% participation rate by men. A small number of graduate students participated in the survey, totaling about 15% of the respondents and split fairly evenly by gender. A large proportion of the participating undergraduate students were from the common first year program, and the percent participation by program was roughly comparable to the number of students enrolled, excepting computer engineering, c.f. Figure 1. UBC has a very high coop participation rate, and the industrial experience of men and women in various industries was comparable, Table 3.

**Table 1:** Percentage women in Engineering programs at UBC, 2005<sup>[1]</sup>.

Engineering Program		Enrollment Year					Grand Total
		1	2	3	4	5	
		18%					
CHML	Chemical		22%	48%	34%		36%
CIVL	Civil		25%	27%	26%		26%
CPEN	Computer		17%	13%	14%		15%
ELEC	Electrical		14%	17%	11%		15%
ENPH	Engineering Physics		8%	13%	4%	11%	9%
ENVE	Environmental			25%	43%		33%
GEOE	Geological		26%	32%	23%		27%
IGEN	Integrated		29%	15%	14%		19%
MECH	Mechanical		15%	10%	13%		13%
MINE	Mining		21%	18%	12%		17%
MTRL	Metals and Materials		32%	15%	18%		19%
Grand Total			19%	20%	17%	11%	18%

**Table 2: Survey participants by gender.**

Gender	Total	
Male	151	57.20%
Female	113	42.80%
Total	264	



(a) (b)  
**Figure 1: Undergraduate Participants. (a) Undergraduate enrolment in departments at UBC. (b) Percentage of undergraduate student survey respondents by discipline. In both graphs, the largest pie slice represents first year engineering, and from there, the legend is read clockwise.**

**Table 3: Work environment experience of survey participants.**

Do you have experience working in any of the following environments?	Male		Female		Total
Product Development	29	9.97%	15	7.98%	44
Technical Sales	13	4.47%	9	4.79%	22
Field Work	52	17.87%	33	17.55%	85
Construction/Manufacturing	42	14.43%	19	10.11%	61
Research and Development	58	19.93%	46	24.47%	104
Consulting	28	9.62%	16	8.51%	44
Municipal/Government	16	5.50%	17	9.04%	33
Utilities/Communications	9	3.09%	4	2.13%	13
Primary and Resource Industry	19	6.53%	22	11.70%	41
High Technology	25	8.59%	7	3.72%	32
Total	291		188		479

## 2 Survey Results

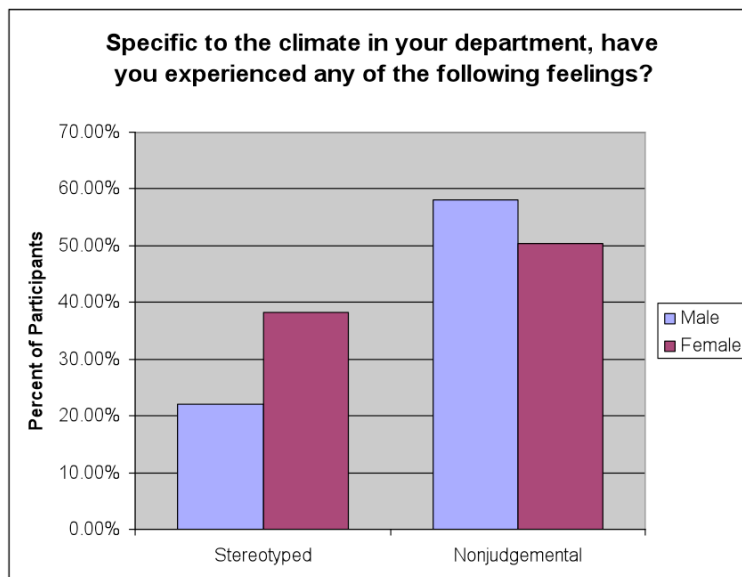
Beyond general demographic information, the survey questions covered the following areas that were hypothesized as being important to the participation and support of students in engineering: departmental climate, student group project involvement, career development, and extra curricular participation. Student views on gender balance within engineering and whether or not gender barriers exist in engineering were also requested. On these questions, the analysis was

performed using a two-tailed t-test against the null hypothesis that there existed no difference between the views of male and female students. The significance level ( $\alpha$ ) was 0.05.

Finally, questions, mainly directed towards women students, inquired about the usefulness of various women in engineering programs.

## 2.1 Departmental Climate

The department's climate questions are listed in Appendix A, (5) and (6). No statistically significant differences were found in these climate responses by gender except for, in question (6), *with women feeling more stereotyped than men* ( $t(206) = 2.40, p < .05$ ), Figure 2.



**Figure 2: Significant response to feeling of being stereotyped.**

## 2.2 Student group project involvement

Questions (7) and (8) inquired about the level and type of involvement of students in group projects. Significant results were found for men self reporting higher levels of participation than women self reported in the following in the following areas:

- Design ( $t(217) = 3.51, p < .05$ )
- Building/implementation ( $t(211) = 2.17, p < .05$ )
- Debugging ( $t(201) = 3.63, p < .05$ )

## 2.3 Career development

Questions (9) and (10) inquired about skills and support that students felt were necessary to their career, and whether they felt they had sufficient opportunity to obtain such skills and support. Question (11) inquired about the most effective ways to provide career skills. While there was no significant difference between men and women in terms of the opportunities to obtain skills

and support, or the modes of providing desired skills, women found the following career development activities to be more necessary to their education than men:

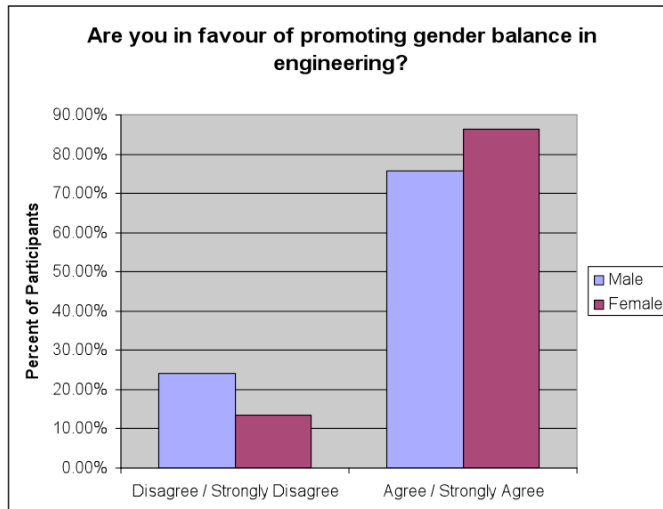
- Learning about graduate school opportunities, (  $t(234) = 3.11, p < .05$  )
- Information/skills for transition from school to industry, (  $t(233) = 2.72, p < .05$  )
- Career related support / career plans, (  $t(235) = 4.06, p < .05$  )
- Outreach programs specific to your department, (  $t(234) = 3.94, p < .05$  )

## 2.4 Extra curricular activities

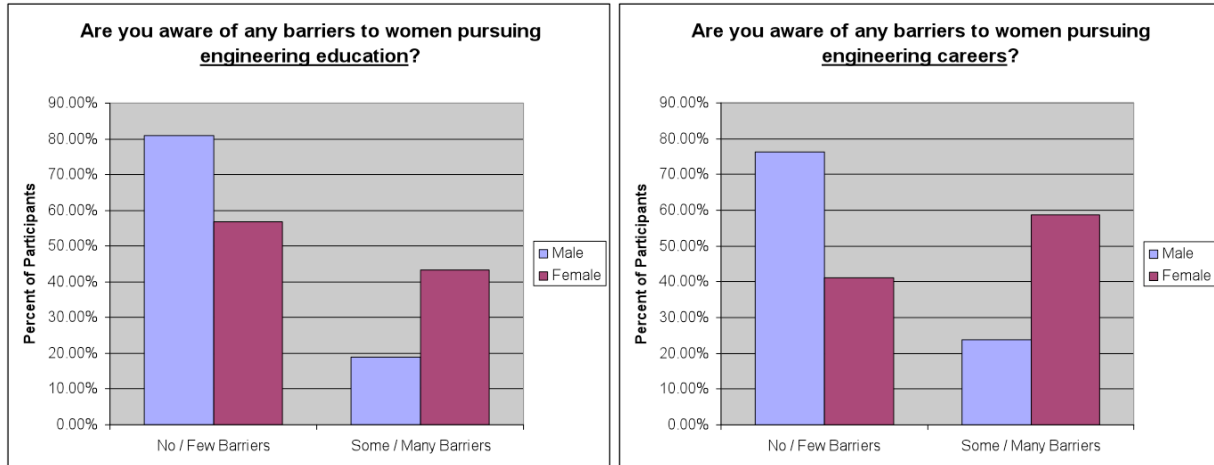
Questions (12) and (13) investigated participation rates for men and women in various extra curricular activities, and reasons for not participating. No significant differences were found for either question.

## 2.5 Gender Barriers in Engineering

Question (15) asked if students were in favour of promoting gender balance in engineering; 80% of students were in favour with no significant differences between the mean responses for men and women, Figure 3. Questions (16) and (17) investigated the perception of barriers to women in pursuing engineering education and engineering careers. For these questions there was a much higher perception of barriers by women, Figures 4, with almost 60% of female respondents indicating some or many barriers to women pursuing engineering careers.



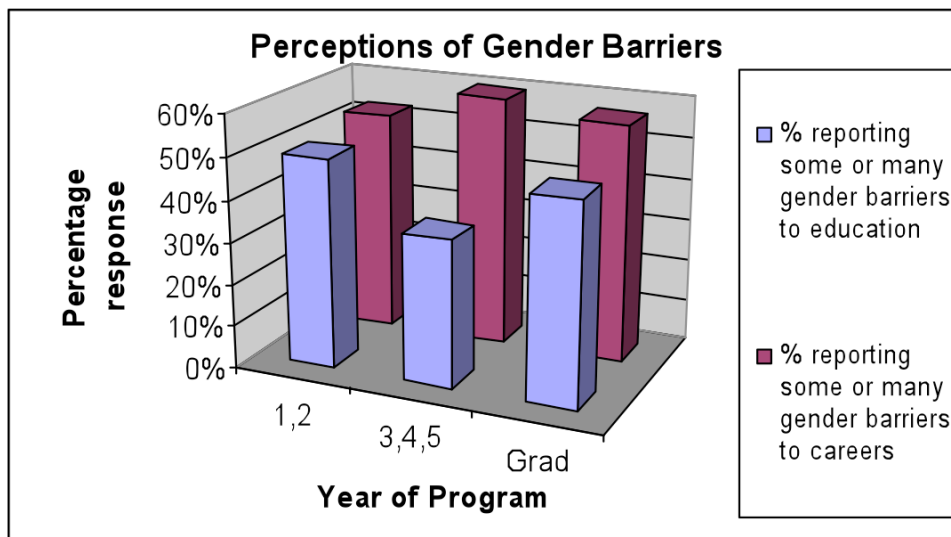
**Figure 3: Approximately 80% of students were in favour of promoting gender balance in engineering.**



**Figure 4: Perception of barriers to women pursuing engineering education and careers.**

A further breakdown of statistics was done to investigate whether perceptions about gender barriers changed as women moved through the engineering program. Unfortunately, the breakdown reduces the statistical significance of the results. However, the percentage responses warrant further investigation, Figure 5.

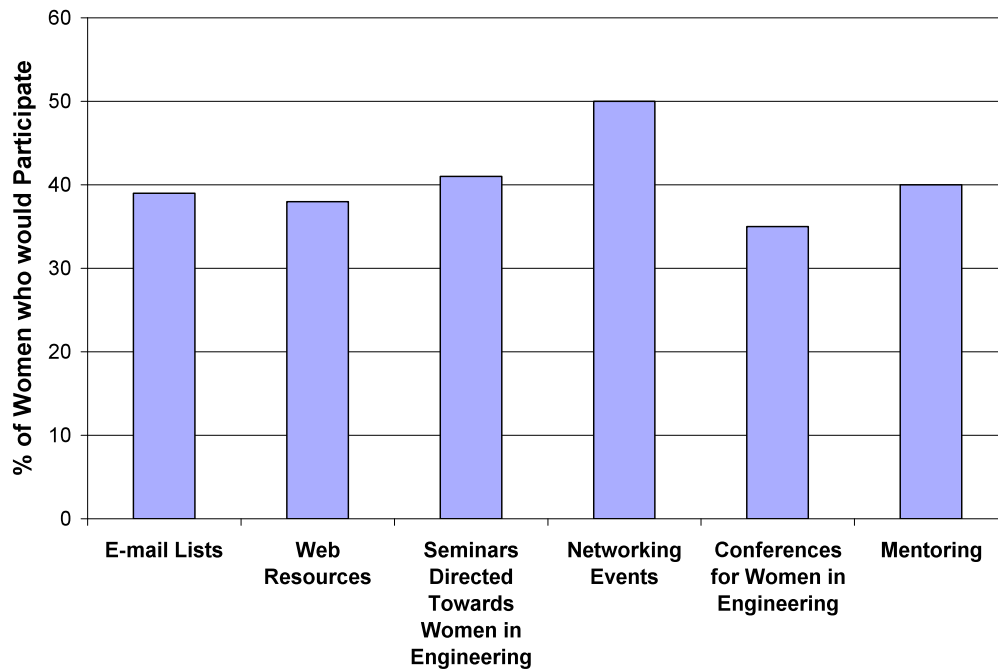
We found that *less* senior women students (years 3, 4, and 5 – 48 question respondents) reported awareness of gender barriers to engineering education than junior women students (years 1 and 2 – 30 question respondents). That is, 35% seniors versus 50% juniors reported some or many barriers to education. However, *more* senior women students reported awareness of gender barriers to engineering careers – 60% seniors versus 53% juniors reported career barrier awareness. Furthermore, 33% of women graduate students (21 respondents) reported that *many barriers exist* to engineering careers, the highest response rate in that category of any broken out group.



**Figure 5: Perception by women students of gender barriers to engineering education and careers.**

## 2.6 Women in Engineering Support programs

Question (18) surveyed students about which of a selection of programs would be useful to women students. For this component, only the responses from female students were considered as they are the target audience. Figure 6 shows that networking events were the most popular among respondents but that for all programs suggested over 30% of respondents identified that they would participate.



**Figure 6:** Percentage of women students that indicated they would participate in proposed women-in-engineering support programs.

### 3 Outcomes and Recommendations

Based on an initial evaluation of the results of this survey, the women in engineering group at UBC developed the following mission, vision, and goal statements to address

- The sense of being stereotyped
- The low self-reported participation rates of women in some important aspects of engineering group work
- The high interest in career support programs
- The perceived gender barriers
- The high interest in networking

**Mission :** *To build strong supportive networks for women in engineering.*

**Vision:** *A sustained, supportive, and inclusive environment that encourages women to participate fully and equitably in the engineering profession.*

**Goal:** *to attract, retain, and support women in engineering through networking.*



The women in engineering group identified networking opportunities as a potential strategy for addressing these issues. Networking among women students reduces the sense of being stereotyped by allowing students to develop a sense of community and recognize that they are part of a larger and diverse group of women. Networking women students with industry women allows students to develop career role models which can help support career transitions and to get women past perceived barriers. These concepts are now being adapted and implemented at UBC through the new, staff supported WIE program that is replacing the grassroots group that implemented this survey.

Finally, further work is needed within the context of the design of programs at UBC to address the need for full participation by women students in engineering activities. A more focused study of why women students in engineering at UBC perceive barriers to their education and careers, and an analysis as to how to address these concerns, is an important next step for this work.

### **Acknowledgements**

The authors would like to acknowledge the work of the original NEW@ubc group: Nicole Bennett, Donna Dykeman, Monica Dannon-Schaffer, Kim Bogan, and Dana Kulic who worked on various aspects of developing and implementing the survey. The support of the JADE Bridges Programme, NSERC Chair for Women in Science and Engineering, BC/Yukon is also gratefully acknowledged.

### **References**

1. UBC\_Applied\_Sciences\_Student\_Services\_Office, "Applied Science Enrollment Statistics 2005," E. Croft, Ed. Vancouver, 2005.
2. Canadian\_Council\_Professional\_Engineers, "Canadian Engineers for Tomorrow," Ottawa, ON CANADA 2005.

### **Biographical Information**

Anja Lanz, an Engineering Physics student at the University of British Columbia, is very involved with women in engineering projects and committees both on and off campus. She has chaired the Building Communities Symposium '07, spearheaded the creation of the first-ever female representative to the department of Engineering Physics, and is currently leading a new networking group of engineering women in the Vancouver region.

Elizabeth A. Croft received the B.A.Sc. degree in mechanical engineering in 1988 from the University of British Columbia, the M.A.Sc. degree from the University of Waterloo in 1992 and the Ph.D. degree from the University of Toronto, Canada in 1995. She is currently an Associate Professor and Assistant Head in Mechanical Engineering at the University of British Columbia. Her research interests include human-robot interaction, industrial robotics, and mechatronics.

Susana Zoghbi received her B.A.Sc. in mechanical engineering in 2003 from Universidad Simon Bolivar in Venezuela, her M.Sc. in Mathematical Physics from the University Centrocidental

"Lisandro Alvarado" in 2007 and is currently enrolled in graduate studies in mechanical engineering at UBC. Her research is focused on human-robot interaction.

## Appendix A. Survey

The following survey was implemented in web form on Survey Monkey ([www.surveymonkey.com](http://www.surveymonkey.com)). The text includes the questions but not the exact format of the survey as implemented on the survey website.

### Welcome

**This survey is presented by the Networking Engineering Women group at UBC. new@UBC is a project by engineering students and faculty with a focus of increasing and enhancing the participation of women in engineering. This group is sponsored by the Jade Bridges Program: <http://www.jadeproject.ca/bridges/index.htm>.**

**This survey is investigating a variety of issues that challenge university students in engineering, including support for engineering students in general and women students in particular. The results will be used to direct research and programs for supporting women in engineering.**

**The survey data will be reviewed and used to present aggregate results on opinions of students, and will be published in conference publications relating to women in engineering. It will be used to advocate for and inform the development of programs for engineering students. Identifying information will not be collected, and the results will be presented as a whole.**

**Your participation is completely voluntary. We invite men and women to participate in this survey. Your opinions are very important, and your answers will be kept confidential and anonymous. DO NOT PUT YOUR NAME ANYWHERE ON THIS SURVEY**

**The survey should take approximately 10 minutes to complete, please fill out each question carefully and honestly. If you do not wish to answer a question, feel free to leave it blank or choose the N/A option if provided.**

**If you have any concerns or inquiries about the survey, please contact Elizabeth Croft at 604.822.6614 ([ecroft@mech.ubc.ca](mailto:ecroft@mech.ubc.ca)). If for any reason you do not want to be involved in the study, you are free to withdraw at any time. If you have any concerns about your rights or treatment as a research subject you may contact the Research Subject Information Line in the UBC Office of Research Services at 604-822-8598. Although answers to all questions are very important, do not complete any questions that you are not comfortable answering. If this survey is completed, it is assumed that you have provided consent to participate in this study.**

**If you do not wish to take this survey, please exit now using the link at the top right of the page.**

1. Please identify your primary department in the faculty of Applied Science at the University of British Columbia:

Engineering (First year)

Undergrad

- Chemical and Biological Engineering
- Civil Engineering
- Computer Engineering
- Electrical Engineering
- Engineering Physics
- Geological Engineering
- Integrated Engineering
- Materials Engineering
- Mechanical Engineering
- Mining Engineering

Graduate

- Biomedical Engineering
- Chemical & Biological Engineering
- Civil Engineering
- Electrical & Computer Engineering
- Geological Engineering
- Materials Engineering
- Mechanical Engineering
- Mining Engineering

2. What is your gender?

- Male
- Female

3. What year of your program are you currently enrolled in?

- First
- Second
- Third
- Fourth
- Fifth or higher
- Masters
- PhD

4. Do you have experience working in any of the following environments? (check all that apply)

- Product Development
- Technical Sales
- Construction/Manufacturing
- Research and Development
- Consulting
- Utilities/Communications
- Municipal/Government
- Primary and Resource Industry
- High Technology

5. Is your department more:

- |                                   |                               |                           |
|-----------------------------------|-------------------------------|---------------------------|
| <input type="radio"/> Friendly    | <input type="radio"/> Hostile | <input type="radio"/> N/A |
| <input type="radio"/> Homogeneous | <input type="radio"/> Diverse | <input type="radio"/> N/A |

- |                                     |                                       |                           |
|-------------------------------------|---------------------------------------|---------------------------|
| <input type="radio"/> Cooperative   | <input type="radio"/> Competitive     | <input type="radio"/> N/A |
| <input type="radio"/> Threatening   | <input type="radio"/> Non-threatening | <input type="radio"/> N/A |
| <input type="radio"/> Flexible      | <input type="radio"/> Rigid           | <input type="radio"/> N/A |
| <input type="radio"/> Traditional   | <input type="radio"/> Modern          | <input type="radio"/> N/A |
| <input type="radio"/> Closed-minded | <input type="radio"/> Open-minded     | <input type="radio"/> N/A |
| <input type="radio"/> Collaborative | <input type="radio"/> Individualistic | <input type="radio"/> N/A |

6. Specific to the climate in your department, have you experienced any of the following feelings?

- |                                    |                                      |                           |
|------------------------------------|--------------------------------------|---------------------------|
| <input type="radio"/> Isolated     | <input type="radio"/> Supported      | <input type="radio"/> N/A |
| <input type="radio"/> Accomplished | <input type="radio"/> Unsuccessful   | <input type="radio"/> N/A |
| <input type="radio"/> Challenged   | <input type="radio"/> Bored          | <input type="radio"/> N/A |
| <input type="radio"/> Confident    | <input type="radio"/> Self-conscious | <input type="radio"/> N/A |
| <input type="radio"/> Stereotyped  | <input type="radio"/> Nonjudgmental  | <input type="radio"/> N/A |

7. Approximately how many group projects have you worked on within your engineering education?

- 0-2
- 2-5
- 5-10
- 10-20
- 20+

8. With respect to group projects, what areas do you tend to contribute?

- |                                | Never | Sometimes | Frequently | Always | N/A |
|--------------------------------|-------|-----------|------------|--------|-----|
| Report write up                |       |           |            |        |     |
| Background research            |       |           |            |        |     |
| Design                         |       |           |            |        |     |
| Project leadership             |       |           |            |        |     |
| Building/implementation        |       |           |            |        |     |
| Testing                        |       |           |            |        |     |
| Debugging                      |       |           |            |        |     |
| Calculations/analysis          |       |           |            |        |     |
| Oral presentations/power point |       |           |            |        |     |

9. From the following list, what do you consider a necessary part of your education?

- |   | Not necessary | Somewhat not necessary | Somewhat necessary | Necessary |
|---|---------------|------------------------|--------------------|-----------|
| Developing communication skills                           |               |                        |                    |           |
| Developing team work skills                               |               |                        |                    |           |
| Developing managing skills                                |               |                        |                    |           |
| Developing technical skills                               |               |                        |                    |           |
| Learning about industry in general                        |               |                        |                    |           |
| Learning about specific jobs / job opportunities          |               |                        |                    |           |
| Learning about graduate school opportunities              |               |                        |                    |           |
| Building professional network                             |               |                        |                    |           |
| Specific career building skills, e.g. resumes, interviews |               |                        |                    |           |
| Information/skills for transition from school to industry |               |                        |                    |           |
| Career related support / career plans                     |               |                        |                    |           |
| Outreach programs specific to your department             |               |                        |                    |           |

10. From the following list, do you feel you have sufficient opportunity to learn those skills here at UBC through courses, programs, clubs and events?

Not sufficient    Somewhat not sufficient    Somewhat sufficient    Sufficient

- Developing communication skills
- Developing team work skills
- Developing managing skills
- Developing technical skills
- Learning about industry in general
- Learning about specific jobs / job opportunities
- Learning about graduate school opportunities
- Building professional network
- Specific career building skills, e.g. resumes, interviews
- Information/skills for transition from school to industry
- Career related support / career plans
- Outreach programs specific to your department

11. What methods would be most effective in providing desired skills?

Not effective    Somewhat effective    Very effective

- Extra-curricular seminars
- Web resources
- Career councilors that are engineers
- Mentoring program
- Elective course for credit

12. For each program, club, or event, please indicate if you are aware of it, have participated in it, or are planning to participate

Aware of program/event?    Participated this year or in past?    Plan on participating in the future?

- UBC Co-op Engineering Program
- UBC Engineering Tri-Mentoring
- UBC Career Services
- Engineering Government: e.g. EUS, Club Mech, IGENc
- Engineering Clubs: e.g. EWB, Engineers in Law and Business Development
- Engineering professional fraternity or sorority (Sigma Phi Delta, Alpha Omega Epsilon)
- Professional technical organizations: e.g. IEEE, CIC
- Engineering design teams and competitions: e.g. concrete toboggan, heavy lift
- Engineering conferences
- Engineering field trips
- Engineering career fairs and industry nights

13. For each program, club, or event, if you have not participated, please indicate why.

Not enough space in program    Not enough time    Not interested    Other reason

- UBC Co-op Engineering Program
- UBC Engineering Tri-Mentoring
- UBC Career Services
- Engineering Government: e.g. EUS, Club Mech, IGENc
- Engineering Clubs: e.g. EWB, Engineers in Law and Business Development
- Engineering professional fraternity or sorority (Sigma Phi Delta, Alpha Omega Epsilon)
- Professional technical organizations: e.g. IEEE, CIC
- Engineering design teams and competitions: e.g. concrete toboggan, heavy lift
- Engineering conferences
- Engineering field trips
- Engineering career fairs and industry nights

14. Approximately 60% of Canadian university students are female. The percentage of women participating in other professional degrees such as Law and Medicine are at or above 50%, and women represent approximately 40% of students in Science programs. However, less than 20% of Canadian engineering students are women.

Estimate the percentage of female students in your engineering department.

- 0-10%
- 10-30%
- 30-50%
- 50%+

15. Are you in favour of promoting gender balance in engineering?

Strongly disagree      Disagree      Agree      Strongly agree

16. Are you aware of any barriers to women pursuing engineering education?

No barriers exist      Few barriers exist      Some barriers exist      Many barriers exist

17. Are you aware of any barriers to women pursuing engineering professional careers?

No barriers exist      Few barriers exist      Some barriers exist      Many barriers exist

18. How useful would the following programs be to support/attract women to engineering studies?

Not useful      Somewhat useful      Useful      Would you participate?

E-mail lists for female students to share information, keep connected

Web resources with information relevant to female students

Seminars on topics relevant to female students

Networking events to meet other female students, professors and industry members

Conferences

Mentoring

19. You've reached the end of the survey!

Do you have any comments that you'd like to share with us? Such as...

- factors contributing positively/negatively to your department climate?

- barriers that you perceive in your education or career?

- suggestions for attracting women into engineering?

- suggestions for supporting women to stay in engineering?