Gender Differences in Engineering Education: An Exploratory Study

by

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I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Despite significant efforts to boost female enrollment levels and retention rates in engineering programs, females continue to make up only a small portion of the Canadian undergraduate engineering student population. However, this traditionally-male field is undergoing a culture change as a result of the recent establishment of a female minority. New initiatives that are encouraging women to enter the field are also challenging assumed gender differences previously used to legitimize women's low participation.

Through a series of multiple-choice, scenario-based questionnaires, this exploratory study seeks to establish whether or not gender differences observed in the broader population are applicable to the unique engineering undergraduate population at the University of Waterloo. In particular, respondents are quizzed on their preferences for specific job attributes and aspects of life outside of work. In addition, short-answer open-ended questions are used to gauge the level of integration experienced by female students in the faculty. Attention is paid to the general academic and social engineering environment as well as the specific dynamics of mixed-gender groups.

Although some gender differences, such as higher preference for earnings on the part of males and work-life balance on the part of females, are in line with previous findings, other differences are found to be either absent or reversed. A surprising side effect of our culturally-diverse sample is the emergence of cultural background as a strong factor which, besides gender, affects work and life attribute preferences, especially preferences for task challenge and earnings. Another interesting outcome of the study is the resulting asymmetry between factors that respondents acknowledge as contributing to their happiness, and factors, which when absent, are found to contribute to the respondents' unhappiness. The study also reveals that female engineering students find themselves in a balancing act between perceived privileges due to their minority, and reduced participation and decision making power due to perceptions of engineering projects as stereotypically in the male domain.

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Chapter 1

Introduction

Until very recently engineering programs in North America were exclusively male. It was not until World War II that efforts were made to boost female ranks in engineering.[6] These efforts were largely effective, with female enrollment levels sustaining a steady upward trend for most of the second half of the 20th century. However, this trend was gradually halted and female enrollment slowly reached a plateau. According to the Canadian Council of Professional Engineers , total female enrollment in engineering programs across the country has been steadily declining after breaking the 20% wall at the turn of the 21st century.[44] (Refer to Appendix A for a summary of enrollment data in engineering schools in Canada and at the University of Waterloo in particular.)

This decline is generally unexplained; efforts to interest females in the engineering profession have persisted and intensified. Thanks to advertising and programs designed by universities and some engineering bodies, young women become aware of and learn about careers in engineering from a very young age. Programs such as 'Go Eng Girl' at the University of Waterloo are specifically designed to introduce talented young girls to the application of science through different fun projects. In many ways, young women today pondering their future careers can look at engineering as an inviting option, much more so than their counterparts only a few decades ago.

Attracting young women to engineering programs is not the only challenge. Engineering schools need to now understand why women lose their academic confidence [22] and leave the engineering profession once they have entered it.[27] From 1982 to 1989, for example, women were twice as likely as men to leave their careers in science and engineering. Contrary to what was imagined, only a third left for family reasons. The most common reason for leaving was switching to another occupation.[48]

The exit of women from science and engineering is concerning for many reasons. First, women are choosing to forego the time and financial investment made to complete the

demanding education. Second, they are also foregoing the financial rewards of working in high-demand jobs in technical fields. Finally, their exit from the engineering professions is leaving a small female presence and very few role models for young women considering a career in engineering.

Despite the recent drop in female enrollment levels, females have entered every type of engineering and a return to a program that is exclusively male is unlikely. Thus engineering finds itself as a male-dominated institution with a relatively large female minority that must be accommodated and sustained. Hence, two aspects emerge:

1. A rich body of research has been conducted with regards to the differences between genders. This knowledge could provide some insight into some of the issues affecting women in engineering.

2. The engineering field and its related organizations such as engineering schools and workplaces are facing a culture change brought about by a relatively new but now permanent presence of women in a traditionally male-dominated field.

In the next section, these two aspects will be discussed in depth, leading the way for the analysis of the original work done in this thesis.

Chapter 2

Women and Engineering

2.1 The Difference Between Genders

An important aspect of the discussion with respect to the state of women in engineering is the difference between the genders. The existence of differences is commonly accepted; however, it is the origin of such differences that puzzles researches and currently makes up an important chunk of scholarly work and debate. While some researchers attribute the differences to societal conditioning, others maintain that society is simply reinforcing and institutionalizing differences that are originally biological. Other researchers still, take from both of these lines of thinking and observe that both biological and social factors affect the objective and perceived differences between the genders.

2.1.1 The Biological Origin of Gender

Some researchers point to biological differences as the origin of and most plausible explanation for the differences between the sexes.[24] [7] Evolutionary social psychologists[1] believe that males and females are similar or the same in areas where they faced the same adaptive problems, but different in domains where they had different sets of adaptive problems to solve.[11] For example, they argue, both males and females have sweat glands, as an adaptation to the problem of high external temperatures. However, in the face of food shortages, females adapted to preferring male partners that could provide them with the resources to keep their children alive, while males were not faced with a similar adaptive problem.[11]

[1] For a more in-depth discussion of evolutionary psychology, see [70]

Some of the more contentions claims in this vein are made by researchers who explain the current disparity between men and women in high-prestige fields such as science, medicine, and engineering, as well as in high-level politics and management, in terms of an innate tendency and quality in men to be more competitive and ambitious than women. One such researcher is Steven Golberg, who in *Why men rule: A theory of male dominance*, claims to have studied every society, from the most primitive to the most industrialized. He contends that there are three universal truths pertaining to the human race: patriarchy, male attainment, and male dominance [24]

A very similar position is held by Kingsley Browne in his book *Biology at Work: Rethinking Sexual Equality*(see [7].)Browne maintains that there are distinct differences between the genders in both behaviour and capability. For example men are more competitive, status-driven, and risk-taking [43] while women are more nurturing and have a higher interest in children. In terms of capability, differences between the genders are evident in mathematical, mechanical, spatial, and verbal abilities. Although sometimes they may have a social cause, these differences are primarily biological and are directly reflected in the differences in occupational distributions.[8]Browne's view on the problem of women's minority status in non-traditional occupations is that

"when programs intended to recruit women into nontraditional areas produce disappointing results, or meet with initial success but are later plagued by high levels of attrition, it is often concluded that the programs have not gone far enough, when the real problem may be that they have gone too far."[8]

Some may argue that men reach the top of the corporate ladder or political establishment simply because they have a higher probability of achieving this by virtue of the greater number of men working in management or politics. However, even in occupations that have been traditionally dominated by women, research suggests that it is men (who are in the minority) who are perceived - not only by themselves, but also by their female colleagues - as having better qualities of becoming administrators and assuming more directing roles. [19]. In a study of gifted early adolescent children it was observed that boys aspired to careers that required more education and were considered more prestigious than girls did.[41]

There are criticisms to this theory. One of the main criticism rests with the somewhat fatalist flair of this theory positioning Nurture as completely powerless in the face of Nature. In a way, evolutionary psychology reduces humans to a product of genetic determinism. [53] This is perhaps an unfair criticism to the theory, in light of the great emphasis evolutionary psychologists have placed on humans as adaptive problem solvers, with their genetic make-up constantly changing to reflect these adaptations.[37]

Another criticism, which is more relevant to our discussion, is that evolutionary claims are political and not scientific. Critics lament the effect that the theory might have on

the feminist struggle for equality. If we accept that men are naturally more competitive and will always end up dominating the most prestigious and highest-paying occupations in every society, they argue, then wouldn't women's fight for equality be unjustly invalidated in the name of science?[53] The defence of evolutionary psychologists has been that

"although some worry that inquiries into the existence and evolutionary origins will lead to justification for the status quo, attempts to change the status quo cannot be effective if they ignore sex differences that actualy exist"[11]

2.1.2 The Social Construction of Gender and the Biosocial Model

According to sociologists who believe in the social construction of gender, there is little difference between the two sexes from a biological point of view. They point to society as the constructor of a much bigger divide between the sexes, which in turn creates genders. They identify other similar divides such as race, ethnicity, religion and age that are also socially constructed.[52, p.6] This arbitrary differentiation, they claim, is fundamental to hierarchical systems because it *"assumes, amplifies, and even creates psychological and behavioural differences in order to ensure that the subordinate group differs from the dominant"*[39, p.143]

Theories on the social construction of gender are largely based on the much-debated work of anthropologist Margaret Mead, who studied three primitive societies extensively. She concluded that all three had assigned arbitrary roles to sexes, roles that often contradicted our society's norms regarding gender roles.[40][2]

Theories about the social construction of gender have been especially popular among feminists and liberal feminists in particular. Liberal feminists believe that women have the same potential of becoming scientists as men, and once all barriers that are keeping women from entering and remaining in science are removed, women will achieve the same participation in science and engineering as in all other fields.[54, p.175] With respect to our discourse, it is important to point out that most projects intended to promote the entrance of women in the fields of science and engineering have used liberal feminist goals and none of the ideas about the basic differences between the genders that were discussed in the previous subsection. According to Rosser (1998)

"this is not surprising since people who believe that low numbers of women in science are caused by innate biological differences are unlikely to propose projects to change the educational or extracurricular environment as a mechanism to attract and retain women in science" [54, p.174]

[2]Incidentally, Mead's work has come under growing scrutiny. Goldberg dedicates a large portion of his (previously discussed) book debating and rejecting Mead's claims

Biological and social constructionist theories with respect to the differences between genders do not make up the scholarly work on the subject in its entirety. Some researchers have also advanced a hybrid of the two theories called the 'biosocial model'. According to this model physical attributes of men and women interact with the social contexts within which men and women live. Thus, the differences between the genders must be explained taking into account both the purely biological differences and the social adaptations that may have occurred, even when these social adaptations do not have a biological explanation.[76]

2.2 The Changing Culture of Engineering

The now-permanent presence of a female minority in all engineering programs forces a debate on how these women can be best accommodated and on the changes that may be necessary to the educational system in light of the theories on gender differences (discussed in the previous section.) Discussing the issue of women in engineering from a culture change point of view gives us an opportunity to use a rich body of research that has been conducted on the larger topic of organizational change. More specifically, one can use Kurt Lewin's field-theory on organizational change [38] which has been applied to various studies, such as the one by Coch and French [13].

Coch and French studied organizational change at a pajama factory. The change they were concerned with was the transfer of employees from a task they were used to, to a new one. They observed that in the original task a balance was struck between two opposing resultant forces, leading to a standard output level. The resultant force pushing upward on production was made up of several forces, such as the goal of achieving standard rates, pressure from management, and competition. On the other hand, the resultant force pushing downward on production was made up of forces such as the difficulty of the task, avoidance of strain, and internal pressures from the group to keep the standard output low. When employees were transferred to another task, the equilibrium was disturbed; the new strengths of each of the opposing forces would determine the new standard performance.

A similar analysis will be conducted in the next subsections on female participation as an 'organizational' change affecting the field of engineering. One can thus identify forces that are pushing for more women to enter engineering as well as forces that are resisting it. As evidenced from the Coch and French example, both 'for' and 'against' forces could lie within the individuals and the group simultaneously.

2.2.1 Approaches to Attract and Retain Females in Engineering

Engineering was a field of study that remained within the male domain for a long time. Initially, engineering jobs were not acquired through engineering education, but rather through long apprenticeships in mines, railroads, etc. Before World War II only a few women had ventured into the field, often against very strong social prejudices that wished to direct them towards more traditional roles. However, during World War II, the United States faced a manpower shortage as a result of the great human investment in military operations. Thus, there was an unprecedented push to hire women with basic math and science skills and train them in various engineering roles that supported the war industry.[6] Similarly, engineering programs at universities opened their doors to women.[3] This was the original force that introduced women to the field of engineering.

More recently, there have been many approaches used to not only attract young women to engineering education and careers but also to retain them in the field. One of the most successful approaches to date to counteract the problem of failing to appeal to young women has been to 'humanize' engineering. At the foundation of this approach is the basic idea of combining engineering with the concern for the preservation of the environment and the quality of human life. [49] It was this approach that drove the creation of multidisciplinary programs such as biomedical engineering and environmental engineering, which have been quite popular among young women and have seriously boosted the total female enrollment in undergraduate engineering programs.

In this vein, another good approach proven to successfully entice women to enter engineering has been to add more inter-disciplinary non-technical options to engineering programs that are traditionally not multidisciplinary (such as electrical, mechanical, and chemical engineering). Languages and soft skills are examples of such non-technical options that female engineering students have appreciated seeing included in the curriculum.[57]

Another positive force has been the critical mass approach. Here the idea was to attract enough women to one engineering school or program that the number of females would eventually sustain itself.[14] This approach is not just confined to efforts of retaining women in engineering; it also applies to the engineering student population at large. Research shows that in schools where the percentage of engineering students is higher, their retention rate is also higher.[2] Similarly, it is expected that a program in which females are no longer a minority will lose the strong male orientation and acquire a more neutral atmosphere. Once the program has become more neutral, the invisible barriers keeping many women from joining will likely disappear.

[3]Their arrival, especially in universities which did not feature any coed programs, was met with a real culture shock. Male students were faced with *"the sight of brunettes, red-headed, and what's even worse, blond engineers" while the new female arrivals had to get accustomed to "whistles and cat-calls"*.[5]

An extreme implementation of this approach is the creation of single-sex classes for female engineering students. It is argued that in these classes women would be free from competition with men and more likely to develop high self-esteem and confidence in their faculties as engineers. This model was tried in Germany and showed that *"the traditional and sometimes old-fashioned culture of engineering degree courses, even in a mechanical engineering department, can be changed to a more woman friendly culture"*[57] Proponents of single-sex education at engineering schools point at the success this model has had over its co-ed counterpart in improving female confidence and performance in mathematics and other technical subjects at the grade and high school level [28] [25] [58]

2.2.2 Resistive Forces to the Culture Change

Stereotypes

From a young age, children are conditioned to think of engineers as men designing buildings (or bridges) and machines. [33] Stereotypes of scientists and engineers as males are so strong that in an experiment at an elementary school, children did not accept visiting female scientists as such, observing that they did not fit within the stereotypical mould of a scientist. Instead, they insisted, the visitors looked more like teachers![9]

Popular culture may have helped the case of women in science and engineering, often depicting female scientists and engineers as attractive, confident, intelligent, and competent. However, these images often come with other subtleties, such as the portrayal of these women as single and lacking a family life, or hinting at the struggle that they must face in order to 'prove' their competence and intelligence to their male colleagues.[65]

One of the problems that comes with stereotyping is a dis-identification of females from their engineering major. As Steele (1997)argues, *"to sustain school success one must be identified with school achievement in the sense of its being a part of one's self-definition"*.[63] Hence, in order to have achievement motivation, women must be able to make their success in the field -or lack there-of- part of their self-evaluation. As an example, according to this reasoning, if a female engineering student wants to be motivated to succeed, she must consider her grades in the program an important component of her self-worth. Steele goes on to argue that for this crucial link to form, *"one must perceive good prospects in the domain, that is, that one has the interests, skills, resources, and opportunities to prosper there, as well as that one belongs there, in the sense of being accepted and valued in the domain."*[63]

The perception of 'good prospects' could be easily swayed negatively by persistent societal stereotypes. Anecdotal evidence suggests that females in engineering programs may try to minimize the weight of field-related measures, such as their interest and academic success, on their feelings of self-worth.

On the other hand, students who have a strong identification link with their major are more vulnerable to low self-esteem as a result of bad grades. In their research, Crocker et al (2003) observed that *"women in engineering, who are marginalized by virtue of negative stereotypes about their ability and the underrepresentation of women in the field, are particularly vulnerable to drops in self-esteem in response to unexpectedly poor grades if they stake their self-worth on academic performance; this vulnerability may contribute to the high rate of attrition for women in engineering"*[16]

In a way, dis-identification with the engineering studies and field is only one side effect of negative stereotypes. Stereotypes become even more problematic when the stereotyped individuals and groups become aware of the stereotypes and internalize them. Once internalized, the stereotypes pose a serious threat, resulting in the individual undermining his own performance.[62] More specifically, stereotype threat will affect the overall performance of females in tasks that are perceived as being male-typed. Research has shown that exposing females to TV commercials that depict stereotyped gender roles of males and females elicits them to performing worse on the quantitative portion of an aptitude test than in the case when they were not exposed to the commercials.[4] [17]

Gender Displays

As female ranks in engineering slowly increase, males in the field are faced with the novelty of working with a female engineer. These men will often have no previous experience working with such an exemplar. Their challenge is to form a new category; their female colleague fits in neither the category of the male engineer they are used to, nor in the category of the 'secretary' in which they have previously seen most women in the workplace. The confusion leads to potentially uncomfortable situations for women, who are expected to be emotional, and either a sexual object, or a wife and mother, depending on their age and other similar factors.[47]

The presence of a new female minority in a workplace that was previously completely male, may compel the men to put greater emphasis on gender displays. Padavic and Reskin (2002) define gender displays as *"language or rituals so characteristic of one sex that they mark the workplace as belonging to that sex."*[52] In this respect, gender displays further reinforce stereotypes and their associated threat.These displays are very common in male-dominated workplaces such as the military and construction. In these fields, language often revolves around sex and the sexual objectification of women. In one study of the experiences of women professionals in construction sites, the harassment experienced as a result of these displays became normative and accepted as an occupational hazard. [73]

Engineering programs at universities would not be immune to gender displays either.

[4]Similar research addressing the effect of stereotype threat on the performance of African Americans has yielded similar results. When made aware of negative stereotypes regarding the intelligence of their group as a whole, African American students decreased their performance on a difficult verbal test.[64]

For example, orientation for Engineering freshmen at the University of Waterloo includes the following rhyme that is to be repeated by aspiring engineers out loud many times during the day throughout orientation week:

"We are, we are, we are the engineers, we can, we can, demolish 40 beers, drink hard, drink hard, so come along with us, cause we don't give a damn, for any damn man, that don't give a damn for us!"

There are two important themes in this rhyme, that deserve our attention. First, a strong connection is established between being an engineer and drinking. In this regard, it is not 'social' drinking that is encouraged, but rather 'binge' drinking of a traditionally masculine alcoholic drink such as beer. The drinking theme has become one of the staples of the engineering identity, with multiple engineering events centred around heavy drinking. At the University of Waterloo for example, Pub Crawl (where engineering students drink at a long string of establishments starting at noon), D.U.S.T.E.D (an event that takes engineering students to an unsuspecting small town establishment with the purpose of drinking the establishment dry), and Beginning, Middle, and End of Term parties are some of the most important high-turnout events organized by the Engineering Society.

The second theme in the rhyme is the perceived pride and lack of caring about other people's opinions. However, caring and being in touch with one's emotions is a stereotypically female trait. Learning and reciting this rhyme, a first-year female student is introduced to a very masculine program, that is proud and loud about its dominating gender.

Gender displays are not just a male monopoly. Females in engineering will often assume the same masculine displays professed by their male colleagues, in order to distance themselves from the 'negative' female stereotype, thus further emphasizing the masculinity of the profession. In interviews with female engineering professionals, they *"singl[ed] out those women who are easily 'offended,' who are 'chit-chatty,' and who 'paint their nails',"*. They also exhibited a reluctance to talk about sexism in the workplace, to identify with the feminist movement and to become part of Women in Engineering societies and events.[29]

Regression to Early Roles

Engineering and sciences in many ways equate higher learning and earnings. Traditionally, women have been discouraged from possessing more knowledge and money than men. An old proverb from Morocco nicely illustrates this point:

"Don't take a wife who has money, she will treat you with arrogance and say to you, Fetch water" [which is women's business][74]

A similar theme is found in Japanese proverbs:

"A smart woman ruins the castle" or

"If a woman is smart, she will fail to sell cows"[in other words, fail to properly do a woman's work][67]

When females did indeed possess intelligence, they were encouraged to conceal this knowledge from males. The following is a passage from Jane Austen's *Northanger Abbey* (1818), in which Austen describes what the public view of a well to-do girl might have been like in England at the turn of the 19th century.

"[Catherine] was heartily ashamed of her ignorance - a misplaced shame. Where people wish to attach, they should always be ignorant. . . . A woman, especially, if she have the misfortune of knowing any thing, should conceal it as well as she can. . . . But Catherine did not know her own advantages; did not know that a good-looking girl with an affectionate heart, and a very ignorant mind, cannot fail of attracting a clever young man . . . " [3, p.71]

If one believes that such views have now expired, one is mistaken. The language and the context have perhaps changed, but the underlying theme largely remains. In *The Presentation of Self in Everyday Life* (1959), Erving Goffman likened the concealment of intelligence and the exercise of modesty on the part of women to a 'performance' that young women must put on in order to conform to some ideal societal values that award them a lower position than the women award themselves:

"American college girls did, and no doubt do, play down their intelligence, skills, and determinativeness when in the presence of datable boys . . . These performers are reported to allow their boy friends to explain things to them tediously that they already know; they conceal proficiency in mathematics from their less able consorts; they lose ping-pong games just before their ending."[23]

Anecdotal evidence suggests that even today young women continue to play down their math abilities for various reasons. For some, it is the fear of appearing 'nerdy' and thus unappealing to the other sex, for others it is the desire to not upset their boyfriends who may be not as capable in math. [77]

Even more concerning is the negative effect that a woman's display of confidence and competence might have on her chances of being hired. Some research has suggested that these displays may go against commonly accepted stereotypes, thus making competent women less hirable.[55]

Competitiveness and the Boot-Camp Environment

One of the most visible male-oriented characteristics of the engineering education is its academic competitiveness. This transcends the academic challenge presented by the program and extends to the deliberate encouragement of competition between students. Research shows that men, unlike women, are more likely to enter competition and thrive in it. Competing with others is seen as a motivator to perform. Women, on the other hand, are more likely to shy away from competition.[43]

Competitiveness is ingrained in the engineering curriculum. At the University of Waterloo, for example, one of the trademarks of this competitiveness is the class ranking system, unique to the faculty of engineering. At the end of each academic term, each engineering student is informed of their class rank according to their term average for the term. One's rank becomes the foremost indicator of one's performance and is used extensively to nominate students for awards and scholarships. According to this system, good grades alone will not put a student on the coveted Dean's Honours List. Instead, only students whose term average minus their ranking is greater than or equal to 80 will earn this honour.[45]

Another mark of this male orientation is the 'boot camp' and 'toughen up' mentality that is pervasive throughout the entire program. Originally, this mentality had more of a physical context: the first engineering jobs were in machine shops, rail-road yards, or surveying crews. As such, these positions required physical strength and endurance, thus reinforcing the male camaraderie and at the same time 'naturally' excluding females. [6]

Nowadays, the inherent challenge of the program is often enhanced by deliberate near-impossible deadlines and the complete absence of any form of nurturing on behalf of faculty and the academic staff.[12]

Gender and Technology

Finally, there is an undeniable link between technology and masculinity. This link was formed in the late nineteenth century when mechanical and civil engineering, fields that were very closely related to the male professional identity and far from accessible to females, emerged as the very definition of technology. Our modern understanding of the term was largely formed at this time,resulting in our "*taken-for granted association of technology with men.*"[72]

One interesting dichotomy that has emerged is that of 'hard' and 'soft' technology. 'Hard' technology encompasses artefacts most often associated with industry and war, such as industrial plants, weapons, and space rockets. In our culture, 'hard' technolgoy *is* technology. 'Soft' technology on the other hand encompasses artefacts that use 'smaller scale' science, and could even be organic (such as drugs). Women are more likely to be in contact with 'soft' technology type artefacts, but because these types of artefacts are not normally identified as 'real' technology, women's encounter with technology is not recognized as such.[21]

According to Faulkner (2001), these hard-soft dualisms extend to the two 'styles' of science. The masculine style brings objectivity and emotional detachment with "abstract theoretical (especially mathematical)and reductionist approaches to problem solving". The feminine style, on the other hand, brings "subjectivity", "emotional connectedness", and "concrete, empirical...approaches to problem solving". Both of these styles are fundamental and necessary in scientific endeavours; however, the masculine one has come to define the way science is perceived.[21] In our contemporary culture women are often depicted as

guided by emotions and intuition, thinking with with their heart instead of their brain. When one thinks of science, one thinks of rationality and logic; a scientist is expected to use reason to solve problems, with no room for emotions.Thus a woman scientist or engineer will often face an identity problem in efforts to reconcile her cool-headed intelligence and rationality with her 'womanly' image as a warm, nurturing, and emotional creature.[10, p.36]

Another relevant link is that of curiosity driving discovery. As such, curiosity and an interest in science are highly-awarded behaviours that an engineer is expected to exhibit. Thus, women that desire to fit in within the engineering culture must maintain and demonstrate an interest in technology [29] However, studies have shown that curiosity is a trait more prevalent in males than females.[4] One wonders if women would be somewhat handicapped by lacking in this important trait, but the necessity of curiosity as a prerequisite for the making of a good engineer - or at least a good female engineer- deserves its own discussion, certainly beyond the narrow scope of this thesis.

Chapter 3

Purpose of Study and Methodology

3.1 Purpose of Study

In the previous chapter, we sought to find what the body of literature has to say about two specific aspects relating to the issue of women in engineering. First, we briefly explored the various theories regarding the origin of gender differences. Although roughly split between those who believe in the social construction of gender differences and those who believe that these differences are fundamentally biological, most researchers would acknowledge that men and women have different preferences with regards to job attributes such as earnings, responsibility, balance, work environment.[36]

Secondly, we conducted an in-depth analysis of the forces that are attracting or discouraging women from entering or remaining in the engineering field. The analysis framed engineering (and in particular engineering education) as a culture in transition.

Consequently, in this study we seek to further explore these two issues in a slightly different context. In particular,

1. Using some of the dimensions along which other researchers have observed gender differences, we will test to see if the same differences can be observed in the engineering undergraduate population, as in the broader population, and

2. Based on the previous discussion of forces for and against women's integration in the field, we will explore the current culture in the undergraduate environment of the engineering faculty.

The intent of this study is purely exploratory and no hypotheses will be put forward. At this point, we pose two questions:

1. To what extent are the gender differences identified by literature generalizable to the undergraduate engineering population, and

2. What is the level of integration experienced by female students in that same environment?

3.2 Methodology

To help answer the posed questions, a survey was devised, comprising of 3 sections: In the first section, the respondents were asked questions about their gender, age, marital status, faculty and year of studies, as well as whether or not they were born in Canada.(See Appendix B) If the latter was true, they were further asked about their country of birth and the year they had come to Canada.

The other two sections are described in detail in the following two subsections.

3.2.1 The Multiple-Choice Section

The purpose of the multiple-choice section of the survey was to assess and compare male and female preferences and expectations of their lives at work and outside of work. It was our goal to determine what factors respondents would identify as sources of happiness or unhappiness in various circumstances. These factors were largely borrowed from pre-existing dimensions in the literature regarding masculine-typed, feminine-typed, and neutral job attributes, summarized in a meta-analysis of over 200 samples that looked into the job attribute preferences of various subgroups by Konrad et. al.[36], as presented in Table 3.1.

There was a concern that situational factors might be affecting the respondents, therefore the scenario method was chosen as the best alternative in helping to eliminate this bias.[46] Using the scenario method, we sought to create a story that would resonate with the fears and expectations of our respondents, prompting them to respond to something specific, rather than the abstract. It was our hope that respondents would place themselves in the shoes of the fictitious characters we created and give us a glimpse of their own preferences and aspirations for their careers and family lives.

Each respondent was given two scenarios. In each scenario, the respondent was introduced to a fictitious engineering alumnus, who had graduated five years prior. In the scenarios, both graduates[1] briefly described their lives at work and outside of work with an emphasis on the level of happiness experienced. The only difference between the two graduates was that while one described themselves happy, the other complained of being

[1]From here on, the terms 'graduate', 'engineering alumnus' and 'fictitious character' will be used interchangeably.

Table 3.1: Gender-typed job attributes, as presented in Konrad et. al. (2000)[36]

Role and stereotype	Job attributes
Masculine	
Income provider	Earnings, benefits, security, openings
Dominance	Leadership, responsibility, power
Aggression	Power
Achievement	Opportunities for promotion, challenge, task significance, accomplishment
Autonomy	Freedom/autonomy
Exhibition	Prestige, recognition
Endurance	Challenge, not physical work environment
Feminine	
Homemaker	Good hours, easy commute, location, not opportunities for travel
Affiliation	Opportunities to make friends, working with people, not solitude
Nurturance	Opportunities to help others
Succorance	Good co-workers, good supervisor
Deference	Not leadership
Abasement	Not power

unhappy. In all cases the graduate was of the same gender as the respondent. The following is an example of a scenario written for a 'happy graduate', directed to a female respondent:

"Mary graduated 5 years ago from your program of study and recently made a short visit to campus. You and Mary had a chance to have a coffee together and she confided that she is very happy with her job."[2]

After the introduction, the respondent was given a list of 9 factors that might have been contributing to the graduate's happiness at work. The factors were meant to encompass typically 'male' and typically 'female' attributes, following from Table 3.1. Table 3.2 summarizes how these attributes were put in a context, as shown in the example of the graduate named 'John', directed to a male respondent. In this as well as all following cases, the order in which the items were presented was randomized. This was done with the intention of avoiding primacy or recency biases.

The respondent was then asked to choose five attributes out of the 9 listed which they imagined the graduate was most happy about. In a follow-up question, the respondent had to pick the top three choices out of the five selected and rank them one to three; with one being the work attribute they imagined the graduate to be most happy about.

[2]See Appendix D for the original survey questions and their presentation

Table 3.2: Job Attributes of the "happy" graduate

	Work Attribute	Actual Phrasing in Survey
'Male' Attributes	Challenge	John works on a challenging project
	Importance	John works on the most important project for the company
	Travel	John travels often in his job (He just returned from a 2 week overseas trip)
	Promotion	John is given a lot of responsibility and has assumed a middle management position
	Remuneration	John's salary is above average compared to what people with a similar background are paid
'Female' Attributes	Environment	John's supervisor and most of his colleagues are nice people
	Opportunities to Help	John often helps other employees with their own projects
	Work-Life Balance	John is able to balance work and life outside of work
	Socialization	John has made some good friends at work which he often sees outside of work

A similar procedure was repeated for the 'life outside of work' portion of the survey. The respondent was notified that the graduate was also very happy with their life at home and given eight factors that were potentially contributing to their happiness. Again the factors were either typically male or typically female, as shown in Table 3.3:

The respondent was asked to choose the 4 four factors they imagined were contributing most to the graduate's happiness at home. Of the four selected attributes, they had to then choose and rank the top two choices.

The respondent was then given the second scenario the one with the 'unhappy' graduate. A similar procedure to the first scenario was repeated. Tables 3.4 and 3.5 show how the phrasing of the job and life attributes was changed to reflect the unhappy state:

Only half of the male respondents were introduced to graduates that were described as still unmarried (in other words single or in the dating stage). The other half were introduced to graduates who were married with children. Still, the graduates in the second category retained the characteristic of being happy or unhappy, according to the scenario.

In all cases, respondents were only introduced to fictitious graduates of the same gender.

Table 3.3: Life Attributes of the 'happy' graduate

	Work Attribute	Actual Phrasing in Survey
'Male' Attributes	Hobbies	John has a lot of time for his hobbies
	Friends	John has a lot of friends that he spends time with
	Socializing	John is currently single but he often goes out on dates
	Car	John has bought the car of his dreams
'Female' Attributes	Closeness to Family	John is geographically close to his family and he sees them often
	Family Relationship	John's relationship with his family is excellent
	Relationship to Significant Other	John and his significant other have a very good relationship
	House	John has purchased a home which he has decorated to his liking

It was hoped that by answering questions about someone of the same gender they were more likely to mirror some of their own experiences and desires in their answers. It was speculated that if respondents answered questions about graduates of the opposite gender, they were more likely to introduce stereotypes in their assessment of what made the characters happy or unhappy.

In summary, there were 8 fictitious graduates created, as combinations of three factors: gender (male or female), marital status (unmarried or married), and state of happiness (happy or unhappy). Each respondent was introduced to only two graduates, who were of the same gender as the respondent, both having the same marital status (chosen at random), and differing on the state of happiness.

3.2.2 The Short-Answer Section

The third part of the questionnaire included a series of three open-ended short-answer questions that aimed to gauge the general feel of the engineering culture at the University of Waterloo. Again, the scenario method was employed. Respondents were introduced to a fictitious senior high school student (Anna) who had been accepted to an Engineering program at the University of Waterloo. Since the main focus of this part of the survey was to understand the level of integration of women in this culture, only a female fictitious character was created.

Table 3.4: Job Attributes of the 'unhappy' graduate

	Work Attribute	Actual Phrasing in Survey
'Male' Attributes	Challenge	Michael doesn't work on any challenging projects
	Importance	The project Michael is working on is not very important to the company
	Travel	Michael rarely gets to travel in his job
	Promotion	The years spent at the company haven't translated into any promotions
	Remuneration	Michael's salary is below average compared to what people with a similar background are paid
'Female' Attributes	Environment	Michael's supervisor and most of his colleagues aren't very nice people
	Opportunities to Help	Michael rarely helps other employees with their own projects
	Work-Life Balance	Michael often works long hours and he doesn't have a good work-life balance
	Socialization	Michael hasn't made any friends from work that he sees outside of work

In the first question[3], Anna asks the respondent about the positive and negative aspects of the social life for an engineering student. She is particularly interested in parties, Engineering Society activities, and opportunities to socialize with classmates.

In the second question, Anna asks about the positive and negative aspects of the academic life in engineering. She goes on to specify the kind of issues she is most interested in which are listed as classes, professors, assignments, and exams.

Finally, in the third question, Anna expresses her concern about working on projects and assignments in mixed-gender groups and asks the respondent about their own opinion on what the positive and negative aspects of such situation might be.

[3]See Appendix E for the original phrasing of the questions.

Table 3.5: Life Attributes of the 'unhappy' graduate

	Work Attribute	Actual Phrasing in Survey
'Male' Attributes	Hobbies	Michael works long hours so he doesn't have much time for his hobbies
	Friends	Michael only has a few friends. He rarely sees them
	Socializing	Michael is single and hasn't had much luck with dating
	Car	Michael is still driving that same old car that he had back in undergrad
'Female' Attributes	Closeness to Family	Michael lives far from his family and rarely gets to see them
	Family Relationship	Michael doesn't have a very good relationship with his family
	Relationship to Significant Other	Michael is in an unfulfilling relationship
	House	Michael hasn't been able to buy a home yet and is still renting an ugly home

Chapter 4

Sample Characteristics

In total 245 male and 89 female students from two consecutive terms (Fall 2008 and Winter 2009) of an undergraduate Management Sciences course filled out the survey. The demographic composition of the sample (summarized in Table 4.1) was such that approximately 94% of the males and 71 % of the females were in math or engineering. Another interesting aspect of the sample was its diversity, with only 45.5% of the respondents having been born in Canada. A majority of the foreign born students had immigrated to Canada from East and South Asia (41.9% of the entire sample.)[1]

Although the students were not specifically asked about past work experiences, given the mandatory co-op program in engineering, high co-op participation in math and other faculties, and the high percentage of students that reported being from engineering and math, it is safe to assume that most students had some type of previous work experience, either through co-op or some other type of employment.

As already mentioned, in the **multiple-choice section** of the survey respondents were divided into those that were given scenarios of unmarried graduates (123 males and 47 females) and those that were given scenarios of married graduates (122 males and 42 females).

Only a portion of the respondents from the multiple-choice section of the survey completed the **short-answer section**. Of all the responses collected only a fraction was in-

[1]Countries that students reported as their birthplace and that were categorized under East Asia were the People's Republic of China (including Hong Kong and Macau), Taiwan, South Korea, and Japan. Those that were categorized under South Asia were India, Pakistan, Bangladesh, Sri Lanka, and Iran. Of the students in the Europe group, roughly half immigrated to Canada from Eastern European countries such as Romania, Poland, Russia, Ukraine, and former republics of the Yugoslav Federation, while the other half reported being short-term exchange students from countries such as Sweden, France, Germany, and Spain. The classifications mentioned above were conducted according to the United Nations' classification system.[18]

Table 4.1: Sample Demographics

	Male	**Female**
Average Age (years)	20.62	21.01
Program		
Engineering	205 (83.7%)	47 (52.8%)
Math	25 (10.2%)	16 (18.0%)
Other	15 (6.1%)	26 (29.2%)
Average Year of Studies	2.66	3.13
Marital Status		
Single	159 (64.9%)	51 (57.3%)
Dating	83 (33.9%)	36 (40.4%)
Place of Birth		
Canada	110 (44.9%)	42 (47.2%)
Other	135 (55.1%)	47 (52.8%)
East Asia	66 (26.9%)	25 (28.1%)
South Asia	40 (16.3%)	9 (10.1%)
Europe	16 (6.5%)	7 (7.9%0
Saudi Arabia	7 (2.9%)	2 (2.2%)
Other	6 (2.4%)	4 (4.5%)
Total	**245**	**89**

cluded in the study. The selection criteria included the program of study of the respondent (preference was given to those in male-dominated programs), and the overall content and quality of the answer in terms of insight it offered. More articulate and detailed answers were more likely to be selected. As a result of the selection, a sample of 38 respondents was generated. Of those, 20 were males (all in engineering) and 18 were females (split between engineering (13) and math (5)).

As mentioned in the method description, the first and the second question were concerned with perceptions of engineering students with regards to the engineering culture both academically and socially. For those two questions, only the answers from engineering respondents were considered.

Chapter 5

Data Analysis

The two sections of the survey were very different in nature and thus required individually-tailored methods of analysis, as described in the following sections.

5.1 The Multiple-Choice Section

Comparison of subgroups was first done using the one-tailed two-sample Kolmogorov-Smirnov (K-S) test. The test can indicate whether data from the sample drawn from one population is larger in value than the one drawn from another.[60, p.144] We will use an example item from the survey (as shown in Table 5.1) to demonstrate the manner in which the test was used. When asked to indicate the most important factors that were contributing to John's (Mary's) happiness in his (her) work situation, the following numbers were collected with respect to the 'working on a challenging project' item.

Table 5.1: Kolmogorov-Smirnov test example

	Challenging Project	1st Choice	2nd Choice	3rd Choice	Top Five	Not Top Five	Total
Number of responses	John(male)	18	16	17	40	32	123
	Mary(female)	4	8	2	16	17	47
Cumulative Distribution (S)	John(male)	0.146	0.276	0.415	0.740	1.000	
	Mary(female)	0.085	0.255	0.298	0.638	1.000	

Thus, 18 of 123 male respondents ranked this item as their first choice, 16 as their second, and 17 as their third. 40 of them placed it in their top five choices, but not in their top three, while the remaining 32 did not even select it in the top 5. Analogous data was collected for female respondents. Thus, all the responses could be classified under 5 possible categories: 1st choice, 2nd choice, 3rd choice, top five, and not top five.

Next, the observed cumulative distribution (S) was calculated for each category. For example, the observed cumulative distribution of females in the '2nd choice' category Sf(2nd choice) is calculated by adding up the responses in the first two categories and then dividing the sum by the total number of responses; i.e. (4+8)/47=0.276, and so on. The K-S two-sample test statistic D can be calculated as follows:

$$D_{male,female} = max[S_{male}(X) - S_{female}(X)] \tag{5.1}$$

for X={1st choice, 2nd choice, 3rd choice, top five, and not top five} In our example, the statistic is found to be 0.117. To determine the significance of D, we first compute:

$$\chi^2 = 4D^2_{male,female}\frac{mf}{m+f} \tag{5.2}$$

where m is the total number of male responses and f is the total number of female responses.[60, p.148] In our case, $\chi^2 = 1.854$. This new statistic can be approximated to the chi-squared distribution with 2 degrees of freedom. For our example, the distribution gives a p-value of 0.396, which is an indication that we would most likely fail to accept the hypothesis that males place a higher preference on a challenging project than females do.

5.2 The Short-Answer Section

The content of the answers was coded, categorized, and then queried with the help of NVivo (Version 7) software that enables research on qualitative data. The coding process was done in two phases. In the first phase, any issue that came up was coded and made into a node while paying attention to identifying nodes that had similar content. Because the common issues were not known at first, the results of the first phase were rough, resulting in many different nodes, each with a low frequency of appearance. Once the main themes of the students' answers were identified the data analysis entered the second phase. This consisted of recoding the entire set of answers once more, this time with a better understanding of the context, issues raised, and language used by the respondents. The issues that appeared with the most frequency were made into nodes. As a next step, queries were conducted for each node in order to identify in what proportion the issue was raised by males and females.

Chapter 6

Results

6.1 The Multiple-Choice Section

6.1.1 Initial Findings

Since there were many factors in play, several subgroups of respondents emerged depending on whether the respondents were male or female, faced with a happy/unhappy and married/unmarried graduate, and whether in their work or life situation.

Study of the 'Happy-at-Work' and 'Unhappy-at-Work' Scenarios

First, the various combinations for the scenarios of a graduate who was happy at work were compiled. Table 6.1 summarizes the results of the K-S 2-sample tests. Three pieces of information are key. The first is the presence or absence of a significant difference. The marker 'ns' denotes an absence of a significant difference (p-value greater than 0.1). When a significant difference is found then the actual p-value is presented. The second piece of information is the sign of the p-value. When the sign is positive, the first sample places a greater importance on the issue compared to the second sample. The opposite is true when the given p-value is negative. Finally, if the significant difference is greater than 99.9% (or p-value less than 0.001), the p-value is stated as plus or minus 0.001 and accompanied by an asterisk (*).

The first and second data columns of Table 6.1 compare the responses of those respondents that were introduced to the single graduate to those introduced the married counterpart, with the gender factor kept constant. One significant difference was detected in the male population (first column) on the importance of working on a challenging project. Male respondents introduced to the single graduate placed greater importance on this item as a source of happiness compared to the sample introduced to the married counterpart.

Table 6.1: Comparison data for the 'happy at work' scenario

	Direction of Difference and Significance			
	Unmarried vs. Married		Male vs. Female	
	Males	Females	Unmarried	Married
X works on a challenging project	+0.007	ns	ns	ns
X works on the most important project for the company	ns	ns	ns	ns
X travels often in his/her job ((S)He just returned from a 2 week overseas trip)	ns	ns	ns	ns
X is given a lot of responsibility and has assumed a middle management position	ns	ns	-0.056	ns
Xs salary is above average compared to what people with a similar background are paid	ns	ns	+0.064	+0.012
Xs supervisor and most of his/her colleagues are nice people	ns	ns	ns	ns
X often helps other employees with their own projects	ns	ns	ns	ns
X is able to balance work and life outside of work	-0.001*	-0.001*	-0.095	-0.005
X has made some good friends at work which (s)he often sees outside of work	ns	ns	ns	ns

The other detectable difference between the 'unmarried' and 'married' groups was the importance of work-life balance. Respondents that were given the scenario of the married graduate placed a greater importance on balance as contributor to happiness than the respondents that were given the unmarried graduate scenario. The confidence level of the finding for both genders is greater than 99.9%.

The third and fourth data columns of Table 6.1 compare male to female responses in the 'unmarried' and 'married' scenarios respectively. In the case of the 'unmarried' scenario, female respondents placed a greater importance on being given responsibility and being promoted than their male counterparts did. This difference was not observed in the 'married' case. On the other hand, differences on the importance of a high salary and a good work-life balance came up consistently between males and females in both 'married' and 'unmarried' scenarios. In particular, males placed a greater emphasis on a high salary as a source of happiness than females did, while the direction of the difference was reversed on the issue of work-life balance. That is, regardless of their marital status, females identified work-life balance as a source of happiness more than males will.

Next, the various combinations for the scenarios of a graduate who was unhappy at work were compiled. Table 6.2 summarizes the results of the K-S 2-sample tests.

Table 6.2: Comparison data for the 'unhappy at work' scenario

	Direction of Difference and Significance			
	Unmarried vs. Married		Male vs. Female	
	Males	Females	Unmarried	Married
X doesn't work on any challenging projects	ns	ns	ns	ns
The project X is working on is not very important to the company	ns	ns	ns	ns
X rarely gets to travel in his/her job	ns	ns	ns	ns
The years spent at the company haven't translated into any promotions	ns	ns	ns	ns
X's salary is below average compared to what people with a similar background are paid	ns	ns	+0.017	+0.015
X's supervisor and most of his/her colleagues aren't very nice people	ns	ns	ns	ns
X rarely helps other employees with their own projects	ns	ns	ns	ns
X often works long hours and (s)he doesn't have a good work-life balance	ns	-0.018	ns	-0.008
X hasn't made any friends from work that he sees outside of work	ns	ns	ns	ns

In the first two data columns, comparisons are made between answers given by respondents in the 'unmarried' scenario and those in the 'married' one. The only significant difference detected is in the female population on the importance of a good work-life balance. Female respondents that were given the 'married' scenario thought of the lack of a good work-life balance as a greater source of unhappiness than the ones that were given the 'unmarried' scenario.

In the third and fourth columns gender-based comparisons are made in both 'married' and 'unmarried' scenarios. Males placed a greater importance than females did on the impact a below-average salary can have on the level of unhappiness. The difference was more pronounced in the 'unmarried' case. When it came to the issue of a bad work-life balance, females thought worse of it than males did in the 'married' case. There was no difference observed in the 'unmarried' case.

Study of the 'Happy-in-Life' and 'Unhappy-in-Life' Scenarios

While Tables 6.1 and 6.2 summarized K-S test results for scenarios that dealt with the work situation, Tables 6.3 and 6.4 below present the results from scenarios dealing with life outside of work, in the happy and unhappy case respectively. A few interesting results emerge.[1]

Table 6.3: Comparison data for the 'happy in life outside of work' scenario

	Direction of Difference and Significance			
	Unmarried vs. Married		Male vs. Female	
	Males	Females	Unmarried	Married
X has a lot of time for his hobbies	+0.03	ns	+0.052	+0.12
X has a lot of friends that he (she) spends time with	+0.001*	+0.045	ns	ns
X is currently single but (s)he often goes out on dates *(or, in the married case, X and his (her) wife(husband) go often out together without their kids)*	——	——	ns	ns
X has bought the car of his(her) dreams	ns	ns	+0.01	+0.05
X is geographically close to his (her) family and (s)he sees them often	ns	-0.044	ns	-0.02
X's relationship with his (her) family is excellent	-0.001*	ns	ns	ns
X and his significant other have a very good relationship *(or, in the married case, X and his (her) wife (husband) have a very good relationship)*	ns	ns	ns	ns
X has purchased a home which (s)he has decorated to his/her liking	-0.08	ns	-0.001	ns

Looking at the first and second data columns, it appears that when males envision themselves unmarried, they are more likely to point at having a lot of time for hobbies and friends as a source of happiness than when they envision themselves married. Conversely, it is items like having a good family relationship and buying and decorating a home that females imagine becoming sources of happiness when they are married.

When comparing female responses, fewer differences between the 'unmarried' and the 'married' cases were observed. It appears that females in the 'unmarried' situation placed

[1]The dashed cells in the first two data columns are as such because a comparison was not appropriate between the 'married' and 'unmarried' scenarios when it came to this particular issue.

Table 6.4: Comparison data for the 'unhappy in life outside of work' scenario

	Direction of Difference and Significance			
	Unmarried vs. Married		Male vs. Female	
	Males	Females	Unmarried	Married
X works long hours so (s)he doesn't have much time for his (her) hobbies	ns	ns	ns	ns
X only has a few friends. (S)He rarely sees them	+0.01	ns	ns	ns
X is single and hasn't had much luck with dating *(or, in the married case: X and his (her) wife (husband) rarely go out without their kids)*	——	——	+0.039	-0.01
X is still driving that same old car that he(she) had back in undergrad	ns	ns	ns	+0.033
X lives far from his family and rarely gets to see them	ns	ns	-0.039	ns
X doesn't have a very good relationship with his family	-0.001	ns	ns	ns
X is in an unfulfilling relationship *(or in the married case: X and his (her) wife (husband) have an unfulfilling relationship)*	-0.001*	-0.001*	ns	ns
X hasn't been able to buy a home yet and is still renting an ugly home	ns	ns	ns	ns

a higher preference on having a good social circle, while females imagining the 'married' situation placed higher value on being close to their families.

Data columns 3 and 4 of Table 6.3 show that regardless of the marital status, males consistently place a higher value than females on having time for their hobbies and owning their dream car. The difference is more pronounced in the 'unmarried' case. The differences are reversed in direction in the 'married'case. Here females are more appreciative of being close to their families. In the 'unmarried' population, female respondents linked the ownership of a nice home to their happiness.

The emotional status is reversed in the 'unhappy in life' scenario summarized in Table 6.4. When comparing the 'unmarried' to the 'married' scenarios, while keeping gender constant, a few differences emerge. Unmarried males point at a poor social life as a source of unhappiness more than married males do. Married males on the other hand think worse of having a bad relationship with their families. There is one pattern that seems to be gender-universal in this case. Both male and female respondents were more likely to point

out to being in a unfulfilling relationship as a source of unhappiness when married (thus with their spouse), than when unmarried (thus with their boyfriend or girlfriend).

A few significant differences are also observed in the comparison of males and females (keeping the marital status constant) in columns 3 and 4. In the 'unmarried' scenario, males -more than females- link being single (and not dating) to being unhappy. In the 'married' scenario however, females imagine never going out without their kids a source of unhappiness more than their male counterparts. Finally, in the 'married' scenario an old car is a greater source of unhappiness for males, while in the 'unmarried' one, females (more than males) point out to living far from their families as a reason to be unhappy.

6.1.2 Satisfiers versus Dissatisfiers

The title of this section is borrowed from Herzberg's two-factor theory. Herzberg proposed that the set of factors that makes employees happy is different from the set that makes them unhappy. [26] He pointed out that the absence of certain factors can create dissatisfaction, while their presence will not guarantee job satisfaction.

An interesting and unexpected result was observed when comparisons were made between the 'happy' and 'unhappy' scenarios, keeping all other factors constant. K-S tests revealed that there are significant differences between the factors that respondents identify as sources of happiness and the factors contributing to a state of unhappiness, both at work and in life outside of work. Drawing from Herzberg's theory and being careful not to over-interpret the K-S test results, we will define dissatisfiers as the factors which, when absent, are identified by respondents as a greater source of unhappiness than they are a source of happiness when present. Similarly, we will define satisfiers as the factors that when present are a greater source of happiness for respondents than they are a source of unhappiness when absent.

Tables 6.5 and 6.6 summarize the findings for the 'work' and 'life-outside-of-work' scenarios respectively. Looking at Table 6.5, working on an important project and having the opportunity to travel through work are universal dissatisfiers and satisfiers respectively. In other words, regardless of gender or marital status, when looking at their work situations, not working on an important project is a greater source of unhappiness than working on one is a source of happiness. Conversely, having the opportunity to travel is a greater source of happiness than not having this opportunity is a source of unhappiness. Making good friends at work is also a universal satisfier, except for in the case of unmarried females.

Other interesting results also emerge:

- Working on a challenging project is a satisfier to unmarried males.
- Promotions are dissatisfiers to all males, regardless of marital status

Table 6.5: Comparison of 'happy' vs. 'unhappy' scenarios in the work situation

	Direction of Difference and Significance			
	Unmarried		Married	
	Males	Females	Males	Females
X works on a challenging project X doesn't work on any challenging projects	+0.001	ns	ns	ns
X works on the most important project for the company The project X is working on is not very important to the company	-0.028	-0.008	-0.003	-0.018
X travels often in his/her job ((S)He just returned from a 2 week overseas trip) X rarely gets to travel in his/her job	+0.002	+0.008	+0.006	+0.03
X is given a lot of responsibility and has assumed a middle management position The years spent at the company haven't translated into any promotions	-0.004	ns	-0.027	ns
X's salary is above average compared to what people with a similar background are paid The years spent at the company haven't translated into any promotions	ns	ns	ns	-0.90
X's supervisor and most of his/her colleagues are nice people X's supervisor and most of his/her colleagues aren't very nice people	ns	-0.015	ns	ns
X often helps other employees with their own projects X rarely helps other employees with their own projects	-0.039	ns	ns	ns
X is able to balance work and life outside of work X often works long hours and (s)he doesn't have a good work-life balance	-0.006	ns	ns	ns
X has made some good friends at work which (s)he often sees outside of work outside of work X hasn't made any friends from work that he sees outside of work	+0.009	ns	+0.001*	+0.001

- Salary is a dissatisfier for married females (although the relatively big p-value makes this result only marginally significant)
- Working with nice colleagues and supervisors is a dissatisfier for unmarried females
- The opportunity to help colleagues on their own projects and having a good work-life balance are both dissatisfiers for unmarried males

We can also extend the idea of satisfiers and dissatisfiers to the scenarios presenting life outside of work. Looking at Table 6.6 we observe that the only universal dissatisfier is having time for hobbies.

Having bought a home and decorated it to the respondent's liking emerges as a near-universal satisfier, applying to every group except for unmarried males. Other interesting findings are also worth mentioning:

- Having a lot of friends to spend time with is a dissatisfier for married men
- For both genders in the 'unmarried' category, being single but going on a lot of dates is a dissatisfier while having a good relationship with your significant other is a satisfier
- Having bought the dream car is a satisfier to unmarried males
- Being close to the family and seeing them often is a satisfier to married females while simply having a good relationship with the family is a satisfier to married males

6.1.3 Effect of Cultural Differences

As mentioned in Section 3.2 the make-up of our sample had the interesting characteristic of being very ethnically diverse, with slightly more than half of respondents having been born in a country other than Canada. Most in this category were born in South and East Asia. Hence, an interesting question worth exploring was: Are there differences in preferences based on the respondent's country of birth? Creating subgroups of respondents based their birth country would have been very cumbersome and we would have lost the comfort of a large sample size. Instead we opted to separate our sample into two groups: Canadian-born and foreign-born.

Table 6.7 summarizes comparison results when two factors are considered: gender and place of birth. The other factors are kept constant; specifically, all respondents are in the unmarried, happy at work and at life-outside-of work scenario.

Table 6.6: Comparison of 'happy' vs. 'unhappy' scenarios in the life situation

	Direction of Difference and Significance			
	Unmarried		Married	
	Males	Females	Males	Females
X has a lot of time for his hobbies X works long hours so (s)he doesn't have much time for his (her) hobbies	-0.006	-0.001*	-0.001*	+0.005
X has a lot of friends that he (she) spends time with X only has a few friends. (S)He rarely sees them	ns	ns	-0.09	ns
X is currently single but (s)he often goes out on dates (or, in the married case, X and his (her) wife go often out together without their kids) X is single and hasn't had much luck with dating (or, in the married case: X and his (her) wife (husband) rarely go out without their kids)	-0.001*	-0.076	ns	ns
X has bought the car of his dreams X is still driving that same old car that he(she) had back in undergrad	+0.02	ns	ns	ns
X is geographically close to his (her) family and (s)he sees them often X lives far from his family and rarely gets to see them	ns	ns	ns	-0.90
X's relationship with his (her) family is excellent X doesn't have a very good relationship with his family	ns	ns	+0.004	ns
X and his significant other have a very good relationship (or, in the married case, X and his (her) wife (husband) have a very good relationship) X is in an unfulfilling relationship (or in the married case: X and his (her) wife (husband) have an unfulfilling relationship)	+0.001*	+0.002	ns	ns
X has purchased a home which (s)he has decorated to his/her liking X hasn't been able to buy a home yet and is still renting an ugly home	ns	+0.008	+0.027	+0.032

Table 6.7: Canadian vs. foreign born students in the happy at work and in life situations

		Male vs. Female			Canadian vs. Foreign Born		
		Canadian Born	Foreign Born	All	Male	Female	All
Work	Salary	0.23	0.12	0.064	-0.012	-0.094	-0.001
	Challenging Project	0.51	0.45	0.396	0.038	0.27	0.026
	Nice Coworkers	0.42	0.08	0.72	-0.16	-0.51	-0.19
	Balance	-0.26	-0.2	-0.095	0.17	0.85	0.17
	Responsibility	-0.19	-0.22	-0.045	0.83	0.45	0.81
Life	Hobbies	0.26	0.18	0.052	-0.42	0.9	-0.54
	Friends	-0.24	0.23	0.48	-0.74	0.07	0.52
	Decorated Home	-0.12	-0.008	-0.001	0.65	0.74	0.81
	Dream Car	0.52	0.005	0.0065	-0.79	0.51	0.92
	SO Relationship	0.98	0.83	0.89	0.047	0.48	0.024

Some of the numbers in Table 6.7 were also presented in previous sections and are included here to provide a larger context. More specifically, the data under 'Male vs Female'–>'All' was previously included in Table 6.1. The following are some interesting observations:

- An above-average salary is a greater source of happiness for the foreign born than it is for the Canadian born, for both males and females. We had previously observed that males identify a good salary as a source of happiness more than females do; however, we can now add that this difference was potentially driven by the large sample of foreign-born men embedded in the general male-population
- Canadian born males place a higher importance on working on a challenging project than their foreign born counterparts
- In the foreign born population, males place a higher importance on working with nice colleagues and supervisors than females do.
- When looking at females, those that were born in Canada identify having lots of friends to spend time with as a greater source of happiness than those born elsewhere.
- We had previously observed that while males exhibit a preference for purchasing a dream car, females place higher value on purchasing and decorating a home. However, it appears that the differences are mostly driven by the foreign-born population. When looking at the Canadian born population, the differences between males and females on these two issues are not significant.

A similar analysis could be conducted for all other scenarios: married and happy, unmarried and unhappy, married and unhappy. The results would however exceed the scope of this study. This analysis however has the merit of pointing out that the country of birth is a result-affecting factor that was not necessarily predicted when the questionnaire was designed.

6.2 The Short-Answer Section

6.2.1 Engineering Social Life

Table 6.8 summarizes the main nodes that were identified in the answers to the first question. In addition, the number of respondents that brought up the issue is given, categorized by gender. For example, 3 males and 8 females believed that the Engineering Society (EngSoc) bettered the social life of engineering students. These numbers correspond to 15% and 62% of all males and females respectively. The nodes were also categorized in terms of the perceived mood of the issue raised: positive, negative, and neutral.

Table 6.8: Summary of the answers to the question on social life in engineering

		Number of Remarks (Frequency)		
	Issue	**Males**	**Females**	**Total**
Positive	**EngSoc helps the social life**	3 (15%)	8 (62%)	11 (33%)
	Good friendships created in the class context	8 (40%)	6 (46%)	14 (42%)
Negative	**Heavy workload prohibits social life**	11 (55%)	8 (61%)	19 (58%)
Neutral	**Social life is to be found outside Engineering and/or EngSoc and big parties**	7 (35%)	3 (23%)	10 (30%)
	There are very few females in the program	7 (35%)	2 (15%)	9 (27%)

One of the items that the question hinted at and that was brought by a good part of the students was the relevance of EngSoc in the development of social life for engineers. A total of 11 of students made some comment about EngSoc, the majority being females. Students mention popular activities that are organized, such as the engineering pub-crawls, and other parties that are spread out throughout the term. A female engineering student puts it this way:

"Whether you are a girl or a boy, there are plenty of opportunities to meet new people and have a lot of fun. There are three pub crawls a term, from which I have not heard anything but positive feedback. There are also parties at the beginning, middle and end of term to celebrate exams and beginnings of education."

As one can see from Table 6.8, only three male respondents made positive comments about EngSoc. Such a disproportionate response was not expected, but one can speculate that given the scarcity of females, it is plausible that they would get a lot of attention and as a result have a better time in engineering activities. One of the male respondents (classified here as a positive EngSoc remark) hints at precisely that:

"[I]am personally not involved in much partying or [E]ng[S]oc, but there is a huge potential for girls in [all] departments"

One of the most impressive categories that came up as a response to the first question was the level of appreciation students have for the friendships created in the engineering classes.[2] Over 40% of the student brought this up, proportionally distributed between males and females. The number is even more impressive considering that such a response was not hinted at or prompted by the question itself, but was nonetheless spontaneously mentioned:

"The positives are that you spend the next 5 years with the same classmates, which means you become friends with almost everyone and you form a tight bond with your class"

In the category with the greatest number of remarks respondents confess to Anna that the social life in engineering is seriously inhibited by heavy workload of the program. Almost 60% of the respondents brought up this issue, again proportionally distributed between males and females. Like the previous category, this one is also very impressive not only because of the large number of respondents who remarked it, but also by virtue of its spontaneity. A male respondent articulates the issue as follows:

"Although you will make amazing friends and spend a lot of time with them at school, it will be difficult to find time outside of class to go out with them. Engineering has a very heavy course load and UW is reputed for its excellence. Thus, you have to work extremely hard, almost all the time. Parties are great when you get time to go to them"

There were two categories that were classified as neutral. Remarks in the first one identified the need for engineering students to find a good social life outside engineering and EngSoc parties. These remarks were made by about a third of the respondents, fairly distributed between both genders. A few of the remarks hinted at a perception that EngSoc

[2]Engineering is unique among other faculties in its practice of grouping students from the same discipline in classes that stay together from the beginning to the end of the program. For most of the curriculum, students from the same class have identical schedules and thus spend a greater part of their time in undergraduate with their peers.

is a fairly exclusive club, where the same people organize and attend parties that are mainly involved around drinking:

"I don't drink, so I don't go to parties. Nor do I attend EngSoc events - mainly because they focus on drinking"

"There are a number of parties and keggers thrown in first term by students in engineering.EngSoc activities often don't have a large turnout and EngSoc in general seems to be a kind of exclusive group - then again I never really attempted to get involved."

The second category in the 'neutral' class summarized comments that brought up the issue of the small number of females in the engineering program. Close to 30% of all respondents commented spontaneously on this issue, a disproportionate portion of them being male. Although categorized as neutral, the comments themselves often assume positive or negative tones. It is the males that are the most likely to present the small number of females in the program as an opportunity for Anna to expand her social life:

"Being a female it will be easier to be social as guys want to have a girl as a friend and you would get invited to all the parties"

"You will be the life of the parties in engineering. . . . It may be tough at times to have the girl-talks that you may desire, but the guys in engineering are always there to cheer you up and you will still have a great time if you know that you want to be an engineer"

Both female respondents, on the other hand, placed the scarcity of females in the context of a challenge that being a minority might bring:

"Typical females in engineering are not girly-girls, and most of them are used to having many guy-friends. Often they don't get along with [other] girls. The guys get that, so you don't have to worry about being ostracised because you are female. You will have to deal with joking though, and with some people being intimidated by you."

"Negatives: Highly competitive, male dominated faculty, can be intimidating, most events revolve around drinking beer"

6.2.2 Engineering Academic Life

Table 6.9 gives a summary of the most important categories that came up from the comments in response to the second short-answer question. The question asked respondents about positive and negative aspects of the engineering academic life.

One type of comment that came up in both under a positive and negative light was the fact that classes for all engineering students are pre-set by the respective departments. From a positive point of view, having a pre-arranged schedule can be advantageous because students do not need to worry about the intricacies of fitting often overlapping classes into

Table 6.9: Summary of the answers to the question on academic life in engineering

	Issue	No. of Remarks (Frequency) Males	Females	Total
Positive	**Department will take care of scheduling all your classes**	1 (5%)	5 (38%)	6 (18%)
	You are always in the same class with the same people good for bonding	5 (25%)	1 (8%)	6 (18%)
	Professors and TAs are helpful	6 (30%)	4 (31%)	10 (30%)
Negative	**Some professors are not good instructors/lack English skills**	10 (50%)	2 (15%)	12 (36%)
	The workload is very heavy	9 (45%)	9 (69%)	18 (55%)
	Everyone has to take the same classes at a preset schedule - no individual freedom	5 (25%)	4 (31%)	9 (27%)
Neutral	**The program is very challenging. Expect your marks to drop**	7 (35%)	7 (53%)	14 (42%)

their time table while ensuring that they are taking all the mandatory courses in the terms that they are offered. Moreover, the department will assign identical schedules to all students from the same engineering class. This aspect was captured in another 'positive' category, where students acknowledge the strength friendships created in class.

"Your courses are picked for you. Plus, the faculty can arrange your exams to be nicely laid out for they know you're all together and don't have to worry about any other classes overlapping."

"One positive aspect is that since you are with your class for all your courses you really get a good relationship with your classmates and the people around you."

On the other hand, many students complained of the lack of freedom associated with the rigid schedule:

"It is hard however to branch out of engineering and take classes in a subject of interest because it is very hard to fit them into your schedule which is already filled with mandatory core courses"

All in all, regardless of how the pre-set schedule was perceived, close to 64% of the students brought this issue up; this 'feature' of engineering is unique among other faculties at UW and thus a staple of the engineering experience from both an academic and social point of view.

Comments about professors (instructors) and teaching assistants (TAs) were also very

numerous and placed under two different categories, depending on whether the comment was positive or negative. 30% of the students remarked the helpfulness of teaching stuff, with one student having some particularly encouraging words for Anna:

"Especially entering first year engineering, you will notice that there is help offered to you left right and center; you have multiple TAs that are available online as well as after class in office hours, you can go to the WEEF lab where there are general help sessions, and there are also tutorial sessions that are highly recommended to attend. Furthermore, the class professors also arrange their own office hours, so you can go see them if you need any help or are stuck"

On the other hand, an even greater portion of students (36%) noted the incompetence of some instructors. Particularly common were comments about their lack of English and communication skills:

"Professors, well, you win some and you lose some; some are great and others not so much"

"Some professors have problems speaking English and therefore it's hard for some students to understand what the professor is trying to explain. In general all professors are very good except [for the] communication part"

It is important to note here that although positive remarks about instructors were proportionally distributed between genders, the same can not be said for the negative ones. While half the male respondents complained about the quality of instructors/teaching, only 15% of their female counterparts did. Research suggests that males tend to attribute failure to external factors and/or luck while women are more likely to look for the source of failure in their own shortcomings.[66] One can only speculate that the reason so many male respondents complained about the teaching shortcomings of professors was because this is seen as an external factor that would not compromise their confidence in their own abilities.

Over half of respondents evenly (though not proportionally) distributed between genders pointed out the heavy workload associated with the engineering education at UW. Women were slightly more likely than man to bring this issue up. The following are two typical comments placed in this category:

"As mentioned, academic life will be pretty heavy, and it gets heavier as you progress through to your last year. [E]very term seems harder than the previous term, more work load, as well as increased difficulty of things that you will learn"

"The assignments, exams, midterms, everything basically is a lot of work. In the end, you just have to stick it through. So, I would say the negative aspects of academic life are lack of sleep, long hours of hard work and physical and mental exhaustion"

Finally, over 40% of the students made a point to warn Anna about overall challenge she was about to face in her first year and the unavoidable drop she was likely to see in her first year marks compared to the ones she had earned in high school:

"A positive aspect of academics at UW is that they are very challenging. You will be kept on your toes every term. You learn a lot about who you are and what you are capable of though because of the challenge your classes will provide"

"You will need to try different study and work techniques until you find the one that works with your style. Do not expect to get the same marks as high school and definitely don't expect to be top of your class"

Overall, virtually every respondent brought up the heavy workload and/or the challenging aspects of the engineering education. The general mood is one of overwhelming work, easily picked up by the unusually articulate and vivid descriptions given by the students themselves.

6.2.3 Working in Mixed-Gender Groups

Table 6.10summarizes the issues that respondents brought up in response to the third open-ended question, which asked them about the positive and negative aspects associated with working on assignments or projects in mixed-gender groups.

Table 6.10: summary of the answers to the question on mixed gender groups

		No. of Remarks (Frequency)		
	Issue	**Males**	**Females**	**Total**
Positive	**Males put females at a privileged position because of their scarcity.**	6 (30%)	3 (17%)	9 (24%)
	Different perspectives contribute to a good experience	8 (40%)	8 (44%)	16 (42%)
Negative	**Awareness of some possibility of harassment or discrimination**	16 (80%)	11 (61%)	27 (71%)
Neutral	**It is advisable to have at least one other female in the group to improve gender balance**	0 (0%)	3 (17%)	3 (8%)

The most important positive (advantage) that was identified by a great portion of respondents (40% of them, proportionally distributed by gender) was the multiple perspectives made available to the group. Respondents identified the diversity of viewpoints and opinions, as well as the different ways genders might approach a problem as a great

benefit to the process of problem solving in the context of engineering projects. The following comments are two typical answers given by a male and female student respectively:

"A positive aspect of working in groups with members of opposite genders is that you get different views on how to approach problems and will get very different solutions from people of different genders"

"The positive aspect of having members of opposite sex is that they usually view the problems from different perspectives"

A majority of the respondents that brought up the diversity of perspectives as an advantage used very similar phrases to the ones given as examples here. This, together with the tendency of some respondents to connect working in gender-diverse groups to the larger context of diversity in the workplace (be it gender, race, or ethnicity), suggests that the answer to the question is perhaps 'common knowledge'. Most would have been exposed to ideas on diversity in the workplace in employee trainings/orientations in their co-op experiences, as well as in Management Sciences courses (such as the one all respondents were taking at the time).[3]

The consensus among both male and female respondents seems to be that one of the advantages of being a female engineering student when it comes to group work, is the ease with which said female will find a group to work with. The scarcity of females in the program makes each exemplar a desired addition to any group. All male respondents that brought up the scarcity of females identified it as an advantage to Anna and as an (implied) disadvantage to themselves:

"Since you will one of the few girls in the class, you'll get lots [of] attention."

"The positive aspect is that they will most like love to work with you if you have a good head on your shoulders and look good."

One respondent confessed his downright inexperience with mixed-gender group work:

"Personally, I have yet to work with an opposite sex here in UW, there are only about 8 girls or so in my class and 100 guys"

Female respondents are not oblivious to males' desire to work with them. One female respondent puts it this way:

"[G]uys like having girls in their group. [I]t makes them feel unique for there are fewer girls and they feel almost lucky to have a few in their groups"

One of the most interesting categories of Table 16 is the one on the negative aspects of being a female engineering student working with males. This is a large category in itself,

[3]One respondent related gender diversity to Ashbys Law of Requisite Variety (Ashby, 1956)[1], arguing that having both males and females work in a group increased the overall response variety of the group.

encompassing many nuances ranging from fleeting comments about possible awareness of sexual harassment to straight detailed advice on how to navigate being the only female in a group. The most common type of comment, however, brings up the problem of females not being given equal responsibilities to their male counterparts from the beginning and having to somehow earn their respect through their smarts and hard work. This awareness makes up 8 out of the 11 comments made by females in this category. Often, they have a warning tone, predicting that she might not treated as an equal and advising her to stand up for herself:

"... [I]f it does occur that somebody is treating you with lesser respect because of your sex, it is important to report it. The only way that individual will stop discriminating you is if you let them know that you will not tolerate it (which you should not)"

"[S]ometimes the males will think you can't do anything mechanical and will not give you a change to use machinery etc. [D]on't let them do this to you!"

Sometimes the tone is simply an encouraging one, assuring Anna that at the end of the day, she will be given all the respect she deserves.

"On the negative side, you may see a few boys treat girls less seriously that they treat other male engineers. Don't let that bother you. They'll soon realize better."

A considerable portion of the comments simply state a condition of inequality between the genders, often rooted in personal experience:

"Sometimes difficult as the female gender is sometimes considered inferior or inadequate, depending on the type of engineering you go into."

"It can be negative because sometimes [guys] may think that their ideas are the best and they would like to take control"

"Every now and then you come across ... the arrogant jerks who think you'll ruin their project just by choosing the title, but most people are normal."

The same type of comment is echoed by male respondents, although in this case the warning or encouraging tones are absent:

"You might not get the most important task that the group needs to accomplish but your opinion will always be heard and considered."

"However, their might be stereotypes related to gender. For e.g. if a project involves dealing with some saw then that task will be assigned to some male rather than a female. If project involves coloring piece of wood then they will allow female to do such tasks"

"As a girl, you may need to gain the respect from some people who may not think girls can be engineers but that is not hard as long as they aren't too stubborn"

Male respondents were unique in their tendency to bring up mixed gender group work as an opportunity for flirting and relationships:

"A positive aspect is that you get to check [guys] out if they're hot; a negative aspect is if they are creepy and they keep checking you out."

"This can also be a drawback because you will most likely get some sexual comments, but maybe not nearly as many as other girls in other areas of the University"

"A negative aspect of have members of opposite sex work together in a group is that you can get people having relationships with each other, which can lead to drama between group members and splitting the group or making it awkward for everyone in the group to work together."

Chapter 7

Discussion

7.1 The Multiple Choice Section

It was our hope that the multiple choice section of the survey would be able to test if the same gender differences observed in the broader literature were applicable to the unique environment of the undergraduate engineering population. Even within the context of masculine environments, our sample was unique because our respondents had already had work experiences as a result of the mandatory co-operative program for all engineering students at the University of Waterloo. Our goal was to observe if and how male and female undergraduate engineering students differed with respect to their preferences for specific job attributes. In addition, we were also interested to see if gender differences could be noticed in preferences for some somewhat stereotypical aspects of life outside of work.

A detailed discussion of the results of our multiple-choice section and an honest evaluation of the methodology utilized is presented in the following two subsections.

7.1.1 Discussion of Results

Initial Findings

The analysis of results from the first portion of the survey revealed some interesting insights into what undergraduate engineering students foresee as having value in their careers and lives outside of work after graduation.

A comparison between genders revealed that perhaps the most consistent difference between the two was the importance attached to maintaining a healthy balance between life and work for females compared to males. The topic of work/life balance is a hot

one. Research suggests that although new graduates value work/life balance greatly, they are compelled to work long hours, resulting in an increasing imbalance between the work and life spheres.[68] The issue is even more problematic for women in male-dominated occupations, such as academia and most engineering fields. New engineering fields, such as software engineering have accomplished a virtual 'blurring' of the work-life boundary through new practices such as flexible work-hours.[59]Women enter these fields as "conceptual men" and are expected to do the same type of work and work the same amount of hours as their male colleagues. However, if and when these women become mothers they are presented with two options: they must either leave their occupation all together to focus on their families, or they must essentially become 'fathers', relying on their partners to work reduced hours or renounce their work all-together.[51] The latter, however, is harder to implement. For example, although organizations have encouraged egalitarian policies with respect to parental leave, men are less likely to take advantage of paternal-leave benefits.[52, p.170] With all of these barriers to maintaining a healthy work-life balance and a successful career in engineering at the same time, it is understandable why females, more than males, in our survey pointed at work-life balance as one of the most important factors contributing to happiness in their careers.

Another important difference between the two genders was the value attached to a good salary. This item was more important to males than it was to females, regardless of factors such as marital status or whether or not the respondent was imagining a happy or unhappy scenario. This result is consistent with existing research. A meta-analysis[1] of over 200 samples that looked into the job attribute preferences of various subgroups revealed that in the subgroup of undergraduates in a masculine major, males place a higher value on earnings than females do.[36]

As previously mentioned, the dimensions used to design the survey were adapted from Konrad et. al.(2000) meta-analysis, as summarized in Table 3.1. Table 7.1, on the other hand, compares the results of our survey (with respect to job attribute preferences, in the unmarried happy-at-work subgroup) to those of the meta-analysis. We only chose the subset of results from the meta-analysis which were coming from studies done on undergraduate students in masculine majors. The table shows whether or not the attribute was deemed more important by males or females. The strength of the significance of the difference is denoted as 'weak', 'medium', or 'strong'.

As one can see from this table, some of our results did not match those of the meta-analysis. For example, responsibility at work is identified as one of the most strongly 'male' job attributes. However, the opposite was true in our survey. When our respondents imagined the fictional character as single and happy at work, females more than males pointed at being given responsibility at work as one of the key factors contributing to

[1]The 'male' and 'female' typed categories that were used to design the items in the multiple-choice section of our survey were borrowed from this study.

Table 7.1: Job-attribute preferences - comparison between the meta-analysis and our study

Attribute	**Meta-analysis**	**Our Study**
Masculine-typed		
Earnings	Male(Weak)	Male(Medium)
Promotion	Male(Weak)	Female(Medium)
Responsibility	Male(Strong)	Female(Medium)
Task significance	Male(Weak)	No significant difference
Feminine Typed		
Work Environment	Female(Medium)	Female(Weak)
Help Others	Female(Medium)	No significant difference
Good coworkers	Female(Medium)	No significant difference
Good supervisor	Female(Medium)	No significant difference
Not gender-typed		
Task enjoyment/interest	Male(Weak)	No significant difference

that happiness. The explanation for this puzzling inconsistency could be found in some of the insights we gained from the short-answer portion of the survey. It is true that being given a lot of responsibility at work is likely associated with a high status and thus more appealing to males. This would also be consistent with the predictions of evolutionary social psychologists, as discussed in Chapter 2. However, the short-answer portion of the survey revealed that females in engineering programs are often discriminated against by their male colleagues and are rarely given any 'real' work or any decision making power. It is thus understandable that a work situation in which they are given responsibility would be highly desirable for females.

Other surface inconsistencies were also present. In the meta-analysis, feminine-typed attributes such as opportunities to help others at work and having nice supervisors and co-workers were expectedly found to be more desirable to females.[36] However, no significant differences between the genders were present in our study with respect to these attributes. Similarly, masculine-typed attributes such as task significance and prestige were found to be more desirable to males in the meta-analysis.[36] In our study, however, males and females didn't differ significantly in their preference for these attributes. It is important to note however that these results are not necessarily contradictory. The gender differences in the meta-analysis, although significant, are only slight in magnitude. In our survey, the direction of the difference between genders was consistent with that of the meta-analysis, however the magnitude of the difference was small and not statistically significant. Therefore, similar patterns were observed in our survey results to those of the meta-analysis.

As important as the results of the work-scenario portion of the survey were, more differences were observed when respondents were asked about their preferences in their lives outside of work. For the most part the identified differences were found in the most stereotypical items. For example, males were more likely to point at a new car and having a lot of time for hobbies as sources of happiness while females preferred a nicely decorated home. Other differences, however, pointed at deeper disparate attachments to friends, hobbies, partners, and families. For example, in the unmarried category, males were more likely then females to point at the inability to find any dates as a great source of unhappiness, whereas females where more likely to point at physical distance from their families as the culprit. We can speculate a reason for the difference. As revealed in the short-answer section, female students in engineering are scarce, making it difficult for the males to find female friends, and even more difficult to find girlfriends. It is thus understandable how imagining having a hard time finding a girlfriend even *after* graduation can be such a great source of unhappiness for our male respondents.

Satisfiers and dissatisfiers

An unexpected result of our study were the differences between the job attributes that made respondents happy with their presence (satisfiers) and the attributes that made the respondents unhappy when not present (dissatisfiers). As mentioned in Section 6.1.2, this asymmetry between job attribute preferences was first put forward by Frederick Herzberg in *The Motivation to Work.*[26] He divided factors into motivator factors (whose presence motivated employees, such as achievement, recognition, work itself, responsibility, promotion, and growth) and hygiene factors (whose absence is unmotivating to employees, such as pay and benefits, status, working conditions, relationships with co-workers, etc). Some of the results from our survey matched well with Herzberg's categories. For example, working on an important project was found to be a universal dissatisifer in our survey; similarly, Herzberg categorizes 'status' as a hygiene factor. However, although responsibility is one of Herzberg's motivation factors, in our study it was identified as a dissatisfier, especially in the male subgroup. It is quite possible that this item was also thought by the respondents as a 'status' item, especially since in the survey questionnaire it is accompanied by the assumption of a middle management position.

Interestingly, the results of our survey don't always match Herzberg's categories. Making good friends at work is an item that appears to be an almost universal satisfier for our respondents. However, Herzberg places relationships with co-workers in the hygiene pile. It would be naive to expect the interpersonal relationships with co-workers category in Herzberg's theory to exactly match the category in our survey. The phrasing in our category was such that the employee was implied to have a good relationship with other co-workers if he or she was friends with them and saw them after work. Such a narrow view of a good relationship with co-workers is probably not congruent with Herzberg's definition. Moreover, our category implies a boundary-crossing to the life sphere, where

respondents are also forced to consider their relationships outside of the work hours. Finally, Herzberg's theory itself has not remained unscathed by criticism. For example, it is argued that the factors easily overlap and that a hygiene factor may trigger a motivation factor which will act as a satisfier and vice-versa.[69]

Effect of Cultural Differences and Future Research

Perhaps the most unexpected results of our data analysis were the cultural differences in our respondents' preferences, which added yet another dimension to our discussion. Suddenly, factors that had only been discussed in terms of gender had a stronger variance along the cultural scale. For example, although preference for work-life balance and responsibility remained 'female-typed' regardless of cultural background, it was noticed that the preference for a good salary, although typically male, was much stronger in the foreign-born subgroup, regardless of gender. Similarly, the preference for a challenging project was much stronger for Canadian-born males than for the foreign-born ones.

In the 'life outside of work' category, although having time for hobbies, purchasing a home, and driving a nice car were gender-typed categories, having a good relationship with the significant other was by far the most preferred by the foreign-born males.

These results point at some strong cultural differences in job and life attribute preferences present in the diverse engineering student body. These results are to be taken with a grain of salt, as it will be discussed in the method evaluation below; however, a more focused and in-depth study of this phenomenon would be advantageous. Specifically, the study should better-determine the cultural identification of the respondents before including their preferences into that of the greater subgroup.

7.1.2 Method Evaluation

Strengths

As previously mentioned, close to 300 respondents completed this section of the survey. The large sample number gave us a great confidence in our analysis results. Moreover, our sample had some special characteristics that are unusual for the samples used in studies done in this area.[2] Most such studies employ first year undergraduates enrolled in liberal arts courses. In contrast our sample represented University of Waterloo students from almost all faculties with a crushing majority enrolled in programs from the Faculties of Engineering and Math.

Moreover, by virtue of the mandatory co-op program, most of our respondents had had at least some previous work experience and were thus better suited to answer questions with regards to their likes and expectations of the workplace. In contrast, respondents

[2]In specific, we are considering the studies meta-analysed in Konrad, et al (2000)

from most surveys in the literature had likely had little work experience outside summer employment in their high-school and undergraduate years.

Another interesting novelty of our sample was its rich diversity. Most other surveys employed North-American born students who were mostly Caucasian and from a homogeneous background. Our sample was not only extremely diverse in terms of Canadian-born and foreign-born but also within the Canadian-born group, coming from culturally-diverse areas of Canada.

One of the greatest strength of our survey was its design. Comparable studies usually ask respondents to rate their preferences on a given scale. This will often result in respondents rating a lot of items very highly or very lowly. Moreover, it is hard to map, say, a 5-degree scale to your actual feelings about a certain factor. By asking respondents to actually select a number of factors and then rank their top 3 or 2 choices we believe we forced them to think more carefully about what factors are more important to them and to clearly distinguish between those factors.

Weaknesses

In hindsight, we believe that there are some aspects of the methodology that could have been better implemented. First, one can discuss the appropriateness of multiple-choice section. This style of survey has the disadvantage of limiting responses to a pre-written list of options authored by the surveyor. Respondents did not have the option of adding their own reasons as to why the fictitious alumnus was happy or unhappy at work and in life. Thus, we ran the serious risk of only obtaining a narrow understanding of the preferences and values of our respondents. In our defence, the categories of items that were created for respondents to choose from were initially drawn from some pre-existing work in the literature. [36] Furthermore, allowing respondents to write their own set of reasons would have expanded the possible set of answers and seriously added to the time and effort required to analyse the responses. The sample size would have had to be limited to a much smaller number. Instead, we found ourselves with a survey that although limited in depth, allowed us to analyse responses from a sample size of close to 300, giving us greater confidence in the results.

The choice of preferences listed in the multiple-choice section could be improved in itself. In the 'life' scenarios, the respondent is given two items concerning the family relationship. In the first, the alumni lives close to his/her family and sees them often. In the second, he/she has a great relationship with his/her family. (Naturally, in the 'unhappy' scenarios, the circumstances were different).These two descriptions are only subtly different and a rushed respondent that wanted to select family relationship as one of the items, maybe have simply picked the first option that mentioned family. Additionally, the purpose of including the two 'family' items was to gauge the importance respondents placed on family. By having two 'family' items, the weight of the preference for this item was perhaps

unfairly halved, by being split between two similar items. One may wonder if the results and conclusions presented here would have been different had we merged the number of responses assigned to each of the family items.

Another potential problem that may have arisen that we did not foresee was the overlap of the work and life scenarios. As previously described, each respondent was given the cases of two alumni, and for each alumnus, questions were asked about both the work and life situation. Moreover, questions regarding a happy work situation were always followed by questions about a happy life situation. The same was also true for the unhappy scenarios. Hence, whenever the respondent was asked questions about the life situation, he or she already had knowledge of what the work situation was like for the alumnus in the case. For example, a respondent answering questions about an alumnus that is happy with life outside of work already knew that that same alumnus was very happy (so perhaps well-paid, promoted, well-travelled, interesting projects, didn't work long hours, etc.) at work. This may have created biases in several ways. As an example, if the respondent had already given a high ranking to the item "Alumnus X has a good work-life balance", then it is possible that the item "Alumnus X has a lot of time for hobbies" may have not been ranked very high in the 'life' portion of the scenario because the respondent may have felt like he or she had already expressed a similar preference in the 'work' portion.

The phrasing of the items in the 'unhappy' scenarios may have also been problematic. Efforts were made so that the wording was mirroring the 'happy' scenarios. However, language can be tricky; it is possible that some items in the 'unhappy' scenario sounded more negative or less negative than their counterparts sounded positive in the 'happy' scenario. For example, in the 'happy in life' scenario, the 'hobbies' item was phrased as "Alumnus X has a lot of time for hobbies". Whereas in the 'unhappy counterpart, the same issue was phrased as "Alumnus X works long hours and doesn't have a lot of time for hobbies". We thus erroneously introduced a second dimension to this issue long work hours- and hence potentially damaged the required mirror quality that would have made the comparison valid. Overall, however, we believe this effect to have been minimal and we uphold the validity of the discussion made in Section 6.1.2 Satisfiers vs. Dissatisfiers.

There are also some problems with splitting all respondents into two groups: Canadian born and foreign born. First, the categorization is very binary in nature. Respondents that moved to Canada in their early childhood are grouped together with international and exchange students that had been in Canada for a much shorter time. Second, it is possible that a lot of students, who were actually born in Canada as second generation Canadians, were still raised under the strong cultural influence of their parents and their parents' country of origin. Moreover, all foreign-born respondents are grouped in together, regardless of their country of origin. It would be very naive to suggest that all these different places of origin have similar cultural values, but the hope here was that since it was found that most foreign-born students came from countries in South and East Asia, they would

have somewhat similar values when contrasted to the Western values of Canada. Finally, our sample size for each subgroup is greatly affected by this new categorization. This is worrisome for the female population, which was small to begin with.

7.2 The Short Answer Section

The purpose of the short-answer section of the survey was to help us explore the current culture in the undergraduate environment of engineering faculty. Our goal was to evaluate the level of integration currently experienced by the female students as a minority in this very masculine environment.

The following two subsections present a detailed discussion of the results of our survey as well as a critique of the particular methodology we employed.

7.2.1 Discussion of Results

The analysis of the results from the second portion of the survey revealed some interesting insights into the students perceptions about the culture in the Engineering faculty. The first two questions of the survey, which sought to test the general perceptions of the social and academic environment served as a backdrop to the third question, which investigated gender interactions in mixed-gender groups.

In particular, answers to the question on aspects of the social life revealed that it is seriously stifled by the heavy workload imposed on Engineering students. The same issue was also brought up when students discussed aspects of the academic life. It is important to note that it was only the perceptions of a heavy workload that were measured; respondents did not provide any quantifiable measures of how hard they must study. Studies on the workload of students pursuing an engineering education at other universities have revealed similar results. For example, a study at Lancaster University in England found that applied science students report a heavier workload than students in any other department. In fact, 75% of surveyed students reported that "there is too much work to get through."[50]. Other studies on the other hand, have found that contrary to what is believed, engineering students spend less time studying than they are normally expected to.[35] Regardless of the actual workload, it is the students' perceptions that are of concern in our discussion. Research has shown that two of the most important factors contributing to perceptions of a heavy workload are difficulties with the English language and the amount of scheduled class hours. [32] Considering that over half of our respondents had originated from non-English speaking countries and that scheduled classes take up 20-30 hours each week, the perceived heavy workload is justified.

Another interesting result was the acknowledgement by students that they are forging good friendships in the class context. This item appeared in answers to questions about both the social and the academic aspects of Engineering. Moreover, these friendships were always spoken of in favourable terms. This aspect of the Engineering education at the University of Waterloo is a direct result of the Faculty's policy of grouping student of the same program in tight-knit classes since their very first day of classes. This policy is unique not only with respect to other faculties at UW, but also with respect to other Engineering faculties in other universities. Engineering students at Queen's University for example do not enter a specific program until their second year[71], thus delaying and to some degree impeding the process of within-class socialization.

In summary, answers to the first two questions gave an interesting background on the social and academic life that a prospective engineering student should expect. However, the most interesting results by far were seen in the responses to the third question, which asked students to discuss positive and negative aspects of working in mixed gender groups.

Two favourable aspects to working in mixed-gender groups were identified: First, the two genders bring different perspectives to the project; second, if you are a woman working with men then you are likely to enjoy a lot of attention.

As briefly discussed in the previous chapter, the aspect of the different perspectives was brought up by over 40% of the respondents, evenly distributed gender-wise. Moreover, almost all of the responses in this category used very similar wording to describe the advantage of having both genders work together. The presence of a common language indicated that the respondents had a ready-made answer to the question. This result was not surprising. A large body of literature has indicated the value of diversity (more commonly along the axes of gender and race) in increasing constructive group processes and organizational effectiveness.[34] [15] However, the adoption of a diverse workplace, especially in environments or fields that are traditionally not-diverse (e.g. all-white or all-male) has also created the need for diversity training in order to help instil a new set of values to the organization.[56] Engineering students at the University of Waterloo are likely to receive diversity training both through the academic environment and through their co-op employers. As such, the respondents were likely to have been exposed to discussions of the advantages of diverse workplaces, which would explain their relatively 'standard' answers to the question.

The second positive aspect of mixed-gender work group respondents brought up was the special privilege women may find themselves in when working with their male peers. The interesting aspect of this type of response is that although it is females that would supposedly be in the privileged position, males were twice more likely to acknowledge this 'advantage' than women were. Moreover, three of the female respondents advised Anna to always work with at least one other female, to avoid being the only female in the group. It appears that the special position of being the rare woman in engineering work

groups is perceived differently by the two genders. Male respondents were likely to put it in favourable terms, whereas female respondents, while acknowledging the privilege, were more likely to also identify the discomfort their position put them in.

Further, female and male respondents warned Anna of the challenges awaiting her working with male colleagues on engineering projects. They warned her not only of possible harassment or flirting on the part of the males, but also of being discriminated against. In particular, 8 of the female respondents warned Anna that she would not be given the same responsibilities as the other group members and that she would likely have to prove herself to the other members before she could be treated equally.

Although unpleasant, this result is hardly surprising. Research into mixed-gender group work has demonstrated that gender distribution and the nature of the task are strongly related to aspects of group dynamics such as the emergence of the leader and member behaviour. [31] [42] [30] One particular study found that when the group's task is incongruent with the minority gender, members of the minority gender will be adversely affected.[31] In our context, engineering projects are perceived as strongly male-gendered tasks, thus being a female member as a minority in an otherwise all-male group can have negative effects on the minority member. Even if the task had been congruent with the minority gender, (e.g. report writing), it is still likely that the skills of the minority gender may not be trusted by the majority gender. In fact, research has shown that men display higher levels of trust for other men than they do for women, whereas the opposite is not true.[61]

7.2.2 Method Evaluation

The methodology of the short-answer portion of the survey had its strengths and weaknesses, as discussed below:

Strengths

The short-answer portion of the survey had the evident advantage of allowing respondents to identify the issues most important to them with regards to the engineering culture and experience with little prompting on the part of the surveyor. The answers that were included in the analysis were articulate and unequivocal; many respondents included specific examples from their own experience to sustain their answers, giving us a valuable context when evaluating and coding the answers. We may have suffered a loss of confidence in our results because of the small sample, but we more than made up for it in terms of the richness and depth of information obtained.

Some of the information was acquired from more subtle cues: we did not only profit from what the respondents said, but also from how they said it. For example, when asked about the advantages of working in mixed-gender groups, student cited 'different perspectives' en-masse. The use of almost identical language in answering this question

and the near-absence of personal examples was our cue that students saw gender diversity in the greater context of diversity in the workplace; the latter being hyped and advertised to a great extent in our culture. However, when asked about the disadvantages of working in mixed-gender groups, the coding process proved much more difficult. There were no two responses that were alike. The answers were careful, and examples were used extensively. This was perhaps an indication that students had rarely heard the topic discussed in public, and thus a common language describing the fall-outs of (gender) diversity in the workplace had not been established.

It is important to mention here that respondents displayed great honesty in their answers. The introduction of the fictitious high-school senior that was made to ask direct questions to the respondents aided in adding a sense of responsibility: they were to help out a 'real' person who was truly new to the Waterloo Engineering experience. Encouraging comments such as "I'm sure you'll do great, Anna!" were an indication of this.

Weaknesses

Unfortunately, the method used in the short-answer portion of the survey had also some unforeseen weaknesses. As previously mentioned, we were able to extract a great deal of detail and context from the respondent answers, however, the small number of responses made a thorough statistical analysis of the responses insignificant. In particular, the small sample number would have made a thorough analysis of the difference between male and female subgroups irrelevant. For example, in one of the previous sections, we observed that 62% of all female respondents versus 15% of the male respondents mentioned that EngSoc was helpful in creating a good social life for engineering students. However, with only 20 male and 13 female respondents, a valid inference of the difference in proportions between the two genders would not be possible.

Another weakness emerged from the coding process. It is possible that a bias could have arisen when the responses to be coded were selected. As mentioned in the method description selection was purely based on how articulate the response was and how rich was the information it conveyed. It is thus possible that the most articulate answers belonged to a subgroup of students that were native or near-native English speakers. Discarding of short and/or not easily comprehendable responses may have resulted in the loss of information coming from a great part of the foreign-born subgroup.

The most subjective step in the analysis of the responses was the coding of keywords and key ideas. The entire process was conducted by the author of this thesis. The author had the advantage of having experienced herself the engineering culture at the University of Waterloo. It was encouraging to see that the results confirmed a lot of the intuition acquired. However, having had previous preconceptions about what the culture was like may have introduced unnecessary biases. Although every best effort was made to avoid any such biases in the coding process, it would have been beneficial to have had a second

authority conducting their own coding in order to evaluate the effectiveness and quality of the coding results used in our analysis.

7.2.3 Future Research

Because of the limited time and number of respondents, the short-answer section was only one-sided. All respondents were introduced to one female future engineering student. This provided us with a great number of responses to sift through, thus enabling us to code a significant number of articulate and detailed responses. However, we do not know what the responses would have been like had the factious future engineering student been male. We could have easily divided the respondents into two subgroups and introduced a female character to one group and a male one to the other. However, as previously discussed, we would have further decreased the pool of information-rich responses. Thus, a future study mirroring this short-answer survey could be conducted. We predict that responses to the third question would be significantly different from the ones we encountered. In particular, the subtleties of the gender interactions would be less likely to come up. However, it is possible that other issues may become more prominent, issues that were eclipsed by those issues of gender interactions that were so prominent in our survey. We could speculate that discussions of leadership, decision-making, labour-division, and working with 'slackers' or 'control-freaks'would be the most frequent topics.

Another interesting question that arises is what would happen if the roles were been completely reversed. If instead of the male-dominated Engineering faculty, the study had been conducted in the female-dominated Arts, would the results change? One can imagine introducing a fictitious 'Andrew' character, a future Arts student to a group of respondents from the Arts faculty. Although some research indicates that even in female-dominated domains men are likely to assume a position of power [19], an exploration of the special interactions between the majority and the minority gender, in a setting so different from that of the Engineering project, would be worthwhile.

Chapter 8

Conclusion

At the onset of this study, we were hoping to answer two questions:

First, we wanted to see if the same gender differences reported in the broader literature could be detected in the fairly unique environment of the engineering undergraduate population at the University of Waterloo. In particular, we were interested in potential differences between males and females in terms of their preferences for certain job attributes and aspects of life outside of work. As expected, there were some differences that were detected between the genders, along the lines of those predicted by the literature. Men displayed a greater preferences for high earnings, while women placed more importance on the ability to balance work with life outside of work. On the other hand, no gender differences were observed with respect to some other attributes, such as task significance and working with nice colleagues and supervisors, which were found by the meta-analysis to be male and female typed respectively. In one case, our survey results even contradicted the finding of the meta-analysis which typed responsibility and promotion as male.

Our unique culturally-diverse sample revealed that cultural background, besides gender, affected work and life attribute preferences. In fact, whether or not the respondent was born in Canada proved to be a very strong factor that affected preferences for such attributes as task challenge and earnings. This is an outcome that is worth exploring further, deserving a much more in-depth analysis in future research.

Another interesting outcome of our study was the resulting asymmetry between factors that respondents acknowledged as contributing to their happiness, and factors, which when absent, were found guilty of contributing to the respondents' unhappiness. These results where somewhat in line with Herzberg's two-factor theory; however, it was hard to establish how well the job-attribute dimensions in our survey corresponded to the categories in Herzberg's theory.

Secondly, we wanted to test the level of integration experienced by the minority females in this traditionally male environment. Our study revealed that the situation of women in engineering programs seems to be a balancing act between two opposite forces. On the one hand, their scarcity further emphasizes their attractiveness to their male colleagues, thus increasing their (sexual)power over them. Females will have no problem finding lab partners and will likely not be reproached if their participation is not equal to their male colleagues. On the other hand, their participation and decision making power in the group is stifled because of the male-typed engineering projects the group will be working on. Moreover, the same minority status that raises the female's status as a potential group partner, is also to blame for the low expectations and trust the rest of the group will place on her once she has joined.

APPENDICES

Appendix A

Statistics on Female Enrollment in Undergraduate Engineering Programs

Table A.1: Female enrolment as class percentage in the Engineering faculty at UW[20]

Program	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**	**2001**	**2000**	**1999**	**1998**
Chemical	38	35	35	31	26	32	42	48	56	49	43
Civil	20	24	20	23	19	24	26	24	15	35	20
Computer	11	12	9	9	4	7	14	9	12	14	8
Electrical	8	5	12	9	11	20	25	17	19	19	24
Env(Chemical)	-	-	-	-	-	-	59	43	53	37	57
Env (Civil)	50	33	50	40	24	54	42	32	34	40	35
Geological	33	16	37	17	29	23	11	30	40	24	17
Management	35	23	-	-	-	-	-	-	-	-	-
Mechanical	8	7	6	8	9	8	10	19	15	12	14
Mechatronics	8	3	10	7	12	11	-	-	-	-	-
Nanotechnology	10	16	19	14	-	-	-	-	-	-	-
Software	10	10	7	13	7	14	16	17	-	-	-
Systems Design	25	21	16	27	20	29	36	36	34	33	34
Total	**18**	**15**	**16**	**15**	**13**	**17**	**23**	**24**	**23**	**24**	**23**

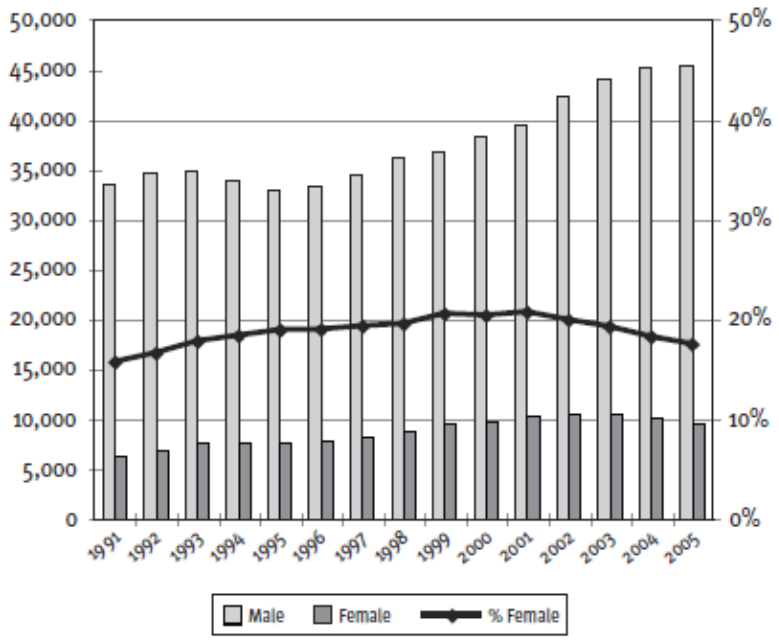

Figure A.1: Canadian Engineering enrolment by gender[44]

Appendix B

Sample Multiple Choice Section: Background Questions

Please tell us a few things about yourself:

1.Program of study

- ◯ Applied Health Sciences
- ◯ Arts
- ⊙ Engineering
- ◯ Environment
- ◯ Mathematics
- ◯ Science
- ◯ Other (Please Specify _____)

2.Year of studies

- ◯ First
- ◯ Second
- ⊙ Third
- ◯ Fourth
- ◯ Fifth
- ◯ Other (Please Specify _____)

3.Age

___years old

4.Sex

⊙ Male
◯ Female

5.Marital Status

◯ Single
⊙ Dating
◯ Engaged
◯ Married

6. Were you born in Canada? If the answer is no, please specify the country of birth and the year you came to Canada.

⊙ Yes
◯ No (Please Specify _____)

Appendix C

Sample Multiple Choice Section: Cases of Two Married Alumni

The Case of Tom

Tom graduated 5 years ago from your program of study. There have been many changes to Tom's life in the mean time: He married his sweetheart and they have already had 2 children. Recently Tom made a short visit to campus. You and Tom had a chance to have a coffee together and he confided that he is very happy with his job. Of the 9 items listed below, which 5 do you imagine Tom mentioning?

- ⊙ Tom is given a lot of responsibility and has assumed a middle management position
- ○ Tom travels often in his job (He just returned from a 2 week trip overseas)
- ⊙ Tom has made some good friends at work which he often sees outside of work
- ⊙ Tom's salary is above average compared to what people with a similar background make
- ⊙ Tom is able to balance work and life outside of work
- ○ Tom's supervisor and most of his colleagues are very nice people
- ⊙ Tom works on a challenging project
- ○ Tom often helps other employees with their own projects
- ○ Tom works on the most important project for the company

Of the 5 items you selected in the previous question, can you select and rank the 3 items you imagine Tom was most happy about?

◯ Tom is given a lot of responsibility and has assumed a middle management position
◯ Tom has made some good friends at work which he often sees outside of work
◯ Tom's salary is above average compared to what people with a similar background make
◯ Tom is able to balance work and life outside of work
◯ Tom works on a challenging project

Tom also said that his life in general is going well too. He mentioned 4 areas in particular, included in the list below. Which 4 do you imagine him mentioning?

⊙ Tom has a lot of friends that he spends time with
⊙ Tom and his wife have a very good relationship
◯ Tom and his wife have purchased a home which they have decorated to their liking
⊙ Tom has a lot of time for his hobbies
◯ Tom's relationship with his family is excellent
⊙ Tom has bought the car of his dreams
◯ Tom is geographically close to his family and he sees them often
◯ Tom and his wife often go out and socialize without their children

Of the 4 items you selected in the previous question, can you select and rank the 2 items you imagine Tom was most happy about?

◯ Tom has a lot of friends that he spends time with
◯ Tom and his wife have a very good relationship
◯ Tom has a lot of time for his hobbies
◯ Tom has bought the car of his dreams

The Case of Nick

Nick was in the same graduating class as Tom. Like Tom, Nick also got married a few years ago and he and his wife have already had their first child. You and Nick speak often on the phone. Unfortunately, Nick is not happy with his job. He often complains about 5 things in particular, included in the list below. Which 5 do you imagine Nick complaining about?

⊙ Nick's supervisor and most of his colleagues aren't very nice people
⊙ Nick's salary is below average compared to what people with a similar background are paid
◯ Nick doesn't work on any challenging projects
◯ The project Nick is working on is not very important to the company
⊙ Nick hasn't made many friends from work that he sees outside of work
◯ Nick rarely gets to travel in his job
◯ Nick rarely helps other employees with their own projects
⊙ Nick works long hours and he doesn't have a good work-life balance
⊙ The years spent at the company haven't translated into any promotions for Nick

Of the 5 items you selected in the previous question, can you select and rank the 3 items you imagine Nick complains most about?

◯ Nick's supervisor and most of his colleagues aren't very nice people
◯ Nick's salary is below average compared to what people with a similar background are paid
◯ Nick hasn't made many friends from work that he sees outside of work
◯ Nick works long hours and he doesn't have a good work-life balance
◯ The years spent at the company haven't translated into any promotions for Nick

Nick also said that his life in general isn't going very well either. He mentioned 4 areas in particular, included in the list below. Which 4 do you imagine him mentioning?

⊙ Nick and his wife haven't bought a house yet
◯ Nick and his wife rarely go out and socialize without the kids
⊙ Nick works long hours so he doesn't have much time for hobbies
◯ Nick and his wife don't have a good relationship
◯ Nick doesn't have a very good relationship with his family
◯ Nick has only a few friends. He rarely sees them
⊙ Nick is still driving that same old car that he had back in undergrad
⊙ Nick lives far from his family and rarely gets to see them

Of the 4 items you selected in the previous question, can you select and rank the 2 items you imagine Nick complains most about?

◯ Nick and his wife haven't bought a house yet
◯ Nick works long hours so he doesn't have much time for hobbies
◯ Nick is still driving that same old car that he had back in undergrad
◯ Nick lives far from his family and rarely gets to see them

Appendix D

Sample Multiple Choice Section: Cases of Two Unmarried Alumni

The Case of Mary

Mary graduated 5 years ago from your program of study and recently made a short visit to campus. You and Mary had a chance to have a coffee together and she confided that she is very happy with her job. Of the 9 items listed below which 5 do you imagine Mary mentioning?

- ◯ Mary often helps other employees with their own projects
- ◯ Mary works on a challenging project
- ⊙ Mary has made some good friends at work which she often sees outside of work
- ⊙ Mary is able to balance work and life outside of work
- ◯ Mary travels often in her job (She just returned from a 2 week overseas trip)
- ⊙ Mary's supervisor and most of her colleagues are very nice people
- ◯ Mary works on the most important project for the company
- ⊙ Mary is given a lot of responsibility and has assumed a middle management position
- ⊙ Mary's salary is above average compared to what people with a similar background are paid

Of the 5 items you selected in the previous question, can you select and rank the 3 items you imagine Mary was most happy about?

◯ Mary has made some good friends at work which she often sees outside of work
◯ Mary is able to balance work and life outside of work
◯ Mary's supervisor and most of her colleagues are very nice people
◯ Mary is given a lot of responsibility and has assumed a middle management position
◯ Mary's salary is above average compared to what people with a similar background are paid

Mary also said that her life in general is going well too. She mentioned 4 areas in particular, included in the list below. Which 4 do you imagine her mentioning?

◯ Mary is geographically close to her family and she sees them often
⊙ Mary's relationship with her family is excellent
⊙ Mary has purchased a home which she has decorate to her liking
◯ Mary is currently single but she often goes out on dates
⊙ Mary has a lot of friends that she spends time with
◯ Mary has a lot of time for her hobbies
⊙ Mary and her significant other have a good relationship
◯ Mary has bought the car of her dreams

Of the 4 items you selected in the previous question, can you select and rank the 2 items you imagine Mary was most happy about?

◯ Mary's relationship with her family is excellent
◯ Mary has purchased a home which she has decorate to her liking
◯ Mary has a lot of friends that she spends time with
◯ Mary and her significant other have a good relationship

The Case of Cathy

Cathy was in the same graduating class as Mary. You and Cathy speak often on the phone. Unfortunately, Cathy is not happy with her job. She often complains about 5 things in particular, included in the list below. Which 5 do you imagine Cathy complaining about?

◯ The years spent at the company haven't translated into any promotions for Cathy
◯ The project Cathy is working on is not very important to the company
⊙ Cathy's supervisor and most of her colleagues aren't very nice people
⊙ Cathy hasn't made many friends from work that she sees outside of work
◯ Cathy rarely gets to travel in her job
⊙ Cathy often works long hours and she doesn't have a good work-life balance
⊙ Cathy's salary is below average compared to what people with a similar background are paid
⊙ Cathy doesn't work on any challenging projects
◯ Cathy rarely helps other employees with their own projects

Of the 5 items you selected in the previous question, can you select and rank the 3 items you imagine Cathy was most unhappy about?

◯ Cathy's supervisor and most of her colleagues aren't very nice people
◯ Cathy hasn't made many friends from work that she sees outside of work
◯ Cathy often works long hours and she doesn't have a good work-life balance
◯ Cathy's salary is below average compared to what people with a similar background are paid
◯ Cathy doesn't work on any challenging projects

Cathy also said that her life in general isn't going well either. She mentioned 4 areas in particular, included in the list below. Which 4 do you imagine her mentioning?

⊙ Cathy hasn't been able to buy a home yet and is still stuck renting an ugly home
⊙ Cathy works long hours so she doesn't have much time for hobbies
⊙ Cathy doesn't have a very good relationship with her family
◯ Cathy is still driving that same old car that she had back in undergrad
◯ Cathy has only a few friends. She rarely sees them
⊙ Cathy is single and hasn't had much luck with dating
◯ Cathy lives far from her family and rarely gets to see them
◯ Cathy is in an unfulfilling relationship

Of the 4 items you selected in the previous question, can you select and rank the 2 items you imagine Cathy complains most about?

- ◯ Cathy hasn't been able to buy a home yet and is still stuck renting an ugly home
- ◯ Cathy works long hours so she doesn't have much time for hobbies
- ◯ Cathy doesn't have a very good relationship with her family
- ◯ Cathy is single and hasn't had much luck with dating

Appendix E

Sample Short-Answer Questionnaire

Reflections on Engineering

Anna, a high school senior is about to start Engineering at the University of Waterloo. She is concerned about what it will be like to be a female in Engineering so she asks for your opinion. What do you have to say to her about the issues she is most concerned about, as shown below?

Anna: What are the positive and negative aspects of the social life for an Engineering student at UW? I'm thinking about parties, EngSoc activities, and even just simply hanging out with class-mates.

You:_____

_____

_____

_____

Anna: What about the academic life? Can you tell me about the positive and negative aspects of classes, the way courses are laid out, professors, assignments, and exams?

You:_____

_____

_____

_____

Group Work Dynamics

Anna wonders what it will be like to work in groups with members of the opposite sex. She asks about your opinion on the positive and negative aspects of this type of situation.

Your answer:_____

_____

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