

# **Paying Heed to the Canaries in the Coal Mine**

*Strategies to attract and retain more women in the engineering  
profession through Green Light Leadership*

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# Executive Summary

## ***Making sense of the status quo***

In June 2009, Engineers Canada sent a single qualitative question to professional engineers across Canada: “What is the vision of success you would like to see for women engineers in Canada?”

The intent was to capture people’s perceptions about their workplace situations to better understand the prevailing cultural conditions in the workplace that influence career decisions. Quantitative data alone cannot capture this. By September 2009, the question had yielded 2,432 responses, 58.8 percent from women and 41.2 percent from men, revealing what professional engineers of both genders deal with on a daily basis – in other words, their current reality. Common themes emerged from the majority of responses that painted a rather bleak picture of a current reality that, if left unchanged, bodes ill for the future of both Canada’s engineering profession and its competitive edge on the global stage.

The survey results suggested that in the academic and workplace settings, there widely exists:

- A “glass ceiling” that prevents the progression of women into more senior roles.
- The persistence of an “old boys club” mentality that fails to extend to women the same degree of professional respect, appreciation and advancement afforded their male counterparts.
- An unwillingness by many employers to provide the flexibility needed by most female engineers to balance work and family in their role as child bearers.
- A common sentiment that work-life balance issues also often apply to men with comparably negative consequences.

Engineers Canada carried out this survey to better understand the factors responsible for the persistent low representation of women among the ranks of professional engineers, a phenomenon also seen in the United States and other western economies.

Despite a number of equity and diversity initiatives over the past decade to attract more young women to study engineering and to retain them in the profession after entering the workforce, representation remains low, with, at best, marginal improvements.

According to data from Engineers Canada and Statistics Canada, in recent years, engineering and applied science programs accounted for approximately 46 percent of enrolments by men, but fewer than 10 percent of enrolments by women among first-year students at the college level. At the university level, after rising moderately for several years, the proportion of women enrolled in undergraduate engineering programs has slipped back to about 17.5 percent from 21 percent in 1999.

Women comprised 47 percent of the Canadian workforce in the 2006 census. The participation rate of women in the engineering field averaged 13 percent. Meanwhile, employment growth in engineering and technology occupations overall surged by 45 percent between 1997 and 2008, according to Census data, compared to a growth rate of 24 percent for all other occupations. Despite the fact that there has been a dramatic increase in the number of new jobs in engineering and technology, the vast majority are still taken by men. Similar trends are noted in the United States.

## ***The trouble spots***

But why? By drawing from an extensive body of existing research into root causes behind the low representation of women in the engineering profession, we defined the problem as it exists at three stages of the career path:

**Elementary and high-school:** Here classroom curriculums and the guidance of faculty often fail to take into account the differences in how girls learn compared to boys and to develop course material for the maths and sciences that will engage girls and inspire them to consider a career as a professional engineer. Girls often suffer from a lack of awareness of the career opportunities that exist among the various engineering disciplines and the societal benefits they generate.

**On the college and university campus:** Research shows that young women pursuing engineering degrees derive significant benefit from having female role models among faculty. However, female representation here too, remains weak. Old boys club cultures persist at many institutions of higher learning that also dissuade young women from the field. However, young women who do complete an engineering degree are invariably top performers who claim a disproportionate share of scholarships and other awards.

**In the workplace:** As suggested by the results of Engineers Canada's 2009 survey and validated by other research in both Canada and the U.S., female professional engineers often face negative influencers in the workplace, some literature uses the term "antigens" that drive them from the profession at an inflection point that typically comes five to 10 years into their career. Work-life balance emerges as a key issue for women trying to advance in workplace environments dominated by a male mindset. Many women still carry the burden of responsibility for running the home and find themselves disadvantaged, even discriminated against, by their role as child-bearer.

## ***The need for action***

We argue the negative consequences of allowing this status quo to persist by citing research that speaks to the value of diversity in the workplace to drive creativity, innovation and economic competitiveness. We also explore the challenges facing the industrialized world with an increasingly fierce global competition for talent as the retirement of the baby boomer generation, declining birthrates and a shrinking cohort of young people to enrol in post-secondary studies chip away at the workforce. Addressing the female attraction and retention dilemma is crucial for any industrialized nation faced with a shrinking pool of skilled labour.

## ***Long-term positive change through Green Light Leadership***

Having stated the underlying causes of the issue and argued why it merits attention brings us to how to bring about change. By reviewing the extensive research that has been carried out, one common theme emerges -- the status quo cannot be allowed to continue. Change is needed.

But how? By drawing on the philosophies and methodologies of the LeaderSHIFT© Practicum developed by the Calnan Group, we apply principles of planned organizational change to define the role of the **Green Light Leader** and create a road map for how Engineers Canada and other stakeholders can effect real and lasting change that will turn a positive vision for the future into reality for *all* professional engineers, regardless of gender, age or ethnicity.

We define the Green Light Leader as a formal or informal leader within an organization who is sick and tired of doing things the same, challenges and even defies the status quo, engenders trust, musters the necessary resources, leads the charge and makes a positive difference.

We conclude by outlining a process for positive organizational change that leverages Green Light Leadership and can be applied in any workplace or campus setting. Engineers Canada is well positioned to initiate this process and be a catalyst for change – to overcome the barriers that bar women from rewarding careers as professional engineers and to sharpen the competitive edge of Canadian business.

## Introduction

*“Women have proven themselves as competent as men in any endeavour. Success depends first on breaking the glass ceiling. I have seen this throughout my career. So many men just do not want to see women in their profession. I think they feel threatened. I would like to see women as principals in engineering firms and in the most senior engineering positions in all levels of government. Encouraging women to first get into the field is the main challenge. This can only be achieved if they see a bright future in engineering. After that, it’s up to all of us in the profession to recognize achievement and reward it.”*

– Female respondent, August 17, 2009

*“My daughter starts off in environmental engineering this fall ... I hope that she is able to be part of a team of engineers that embraces her for engineering knowledge and that she is treated as an equal by her peers. It worries me that there are not enough female mentors available for her. Not that a male mentor is a problem, it just doesn’t seem to work as well ... The old boy’s network does still exist. I worry that the glass ceiling in many consulting firms will not be broken during her career, that her superior talent may be overlooked due to her gender and that she will get frustrated in the male-dominated profession and move on.”*

– Male respondent, August 14, 2009

*“I have a daughter who will go to university next year, and I would never recommend her to study engineering even though she is smart and great in math. I do not want her to waste her life tilting at windmills. As a woman engineer I have wasted too much of my time and energy to prove myself that I am equal to a male engineer. I think it has been fruitless. Some things will never change.”*

– Female respondent, August 8, 2009

*“Equality in numbers, positions and salary – these are superficial stats. I would like to see changes in engineering culture, to adapt to and incorporate what women bring to it ... I hope for a less aggressive and more communicative professional culture, less male bravado with respect to workplace hazards and excessive overtime – both genders would benefit from this.*

– Male respondent, August 9, 2009

These remarks, drawn from the comments of respondents to a survey of professional engineers carried out by Engineers Canada in the summer of 2009, illustrate the reality in which many professional engineers, both female and male, function on a daily basis.

Some may argue that these are merely perceptions, distorted by the filter of individual bias and subjectivity, but there is often a thin line between perception and reality. There is no denying statistical data that reveals how few women are enrolling in post-secondary engineering programs, how many leave the profession after a period of time and how female representation in the profession continues

to stagnate (and even decline) in Canada and the United States.

It is clear that North America is struggling with an acute problem to attract and retain women to the ranks of professional engineers. Which raises three fundamental questions – Why does this problem exist? And what can be done to attract and retain more women to the engineering profession? This paper will try to seek answers to these questions.

## Why?

There has been no shortage of quantitative and qualitative research that articulates why so few women are attracted to careers in engineering – these factors will be detailed in the course of this paper. The greater challenge is to understand why many women chose to leave the profession after achieving their licensure and embarking on their career.

To better understand the prevailing cultural conditions in the workplace that influence these career decisions, Engineers Canada in June 2009 sent a single qualitative question to engineers across Canada: “*What is the vision of success you would like to see for women engineers in Canada?*”

There is plenty of data in terms of numbers. This specific question was introduced to capture people’s perceptions about their workplace situations – in other words, their current reality. The respondents’ comments above are representative of the common themes that emerged from the survey results, painting a rather bleak picture of a current reality that, if left unchanged, bodes ill for the future of the profession and its contribution to Canada’s economic competitiveness.

The qualitative survey results demonstrate the need for persistent and concerted corrective action. Otherwise, the engineering profession, the heart and soul of the innovation economy so espoused by industry leaders such as Terry Matthews as the crucial element of a bright and prosperous future for Canada, will suffer from having only one half of the adult talent pool to draw on at a time when the supply of skilled labour is expected to fall short of demand within the next decade.

*Female professional engineers, it could be said, are akin to canaries in the coal mine; their plight warns of a greater threat that extends far beyond the immediate and obvious issue of equity and fair play in the workplace.*

## What?

A number of existing studies, by Engineers Canada and other industry stakeholders, have examined these underlying causes and suggested various courses of action to address them, from outreach programs that educate youth on the opportunities and merits of an engineering career, to employing more progressive human resources policies in the workplace that are more responsive to the distinct needs of female employees. The intent of this paper is not to challenge the findings or recommendations of these previous efforts, but instead to use them as the foundation upon which to define the next step – namely **how** these recommendations can be turned into action that yields long-term, positive change. There are numerous cases where many of these corrective measures have been implemented – and yet, the challenge of maintaining and increasing female representation remains.

The challenge, as always, is finding the champion, the **Green Light Leader**, who is sick and tired of doing things the same, challenges and even defies the status quo, engenders trust, musters the necessary resources, leads the charge and makes a positive difference.

Green Light Leaders are formal or informal leaders who:

- Are in positions where they are doing well and want to do even better
- Value their people and are responsible for the development of people as a key component of organizational sustainability
- Understand that how people are managed has a huge impact on productivity, innovation, quality, commitment and ultimately on profit
- Are curious about new ways of thinking and leading. They seek creative approaches to sustained change, rather than a quick fix
- Have the courage to challenge cherished beliefs, behaviors and assumptions and to push back when needed
- Lead others, regardless of their level, to be more innovative, productive and profitable

## **How?**

Identifying a problem and recommending corrective measures is one thing. Instigating a course of action that yields positive and long-term change is quite another. Drawing on the philosophies and methodologies of the LeaderSHIFT© Practicum developed by the Calnan Group, this paper will apply principles of planned organizational change to define the role of the Green Light Leader and create a road map for how Engineers Canada and other stakeholders can effect real and lasting change that will turn a positive vision for the future into reality for *all* professional engineers, regardless of gender, age or ethnicity.

## ***Paper Outline***

### **Part I: The Root Causes**

We will present data that illustrates the lack of female representation in the profession and review existing research, the results of Engineers Canada's 2009 qualitative survey as well as original interviews with various stakeholders conducted expressly for this paper, to identify and define the negative influencers that account for these numbers.

### **Part II: The Consequences of the Status Quo**

Why should we be concerned that women make up only a small minority of the profession, or that they contend with ingrained workplace cultures that do not take full advantage of their expertise, creativity and unique perspective? What impact does this have on an organization's productivity, innovation, quality and ultimately its profit? What risk does this lack of engagement with one half of the working population pose to a nation's economic competitiveness? We will review third-party research that answers these questions and argues why increasing the participation of women in the profession is a matter of economic survival.

### **Part III: Making a Difference**

What must we do to attract and retain women in the engineering profession and ensure they have the same opportunities for advancement as their male counterparts? We will articulate the three key inflection points at which intervention can have the most profound positive impact and what form this intervention must take by drawing on the insights and conclusions of both qualitative and quantitative sources.

## **Part IV: The Shift from Root Cause to a Vision of Success**

Once we have identified *what* needs to be done, *how* do we make it happen? Uncovering the root cause of a problem is helpful – to a point. An important and often unnoticed truth is that “what we focus on expands.” The longer attention and resources are focused on a problem, or on problem solving, rather than a vision of a reality in which that problem no longer exists, the more daunting and all-consuming that problem becomes. To accomplish a goal, we must look past where we are and focus on where we want to be. Only by looking back from this future point of imagined success can we see how to accomplish the shift in thinking that will bring about the kind of organizational change and individual growth that will encourage more women, as well as other under-represented groups, to pursue an engineering career.

## **Part V: Putting Theory into Practice**

Where and how must we begin to change the structure and the thinking of a culture so that people can find ways to work and communicate more effectively with each other throughout all levels of their organization? Our focus here will be on a program of concrete and actionable steps drawn from the Calnan Group’s LeaderSHIFT© Practicum and built around leveraging Green Light Leadership.

In addition, we highlight several initiatives that have already been undertaken in Canada and the United States as anecdotal examples that embody the characteristics of the “Green Light Leader” who will champion and drive change.

## **In Conclusion**

We recap what we’ve learned and present a road map of what’s next for Engineers Canada, by outlining a program of positive organizational change that can be applied to both the university campus and the workplace.

## Part I: The Root Causes

In both Canada and the United States, women represent only a small minority of professional engineers. This statement holds true regardless of any difference in how a “professional engineer” is defined or qualified in either country. A plethora of data from various government agencies and industry associations on both sides of the border prove this beyond any doubt. Not only do women make up only a fraction of the talent pool, their level of representation continues to stagnate or even decline. This is particularly evident in undergraduate university programs – a key barometer of future labour supply. Clearly, the broader profession across North America is struggling to attract and retain women, as illustrated by the numbers.

### *By the numbers*

#### **Canada**

According to data from Engineers Canada and Statistics Canada, in recent years, engineering and applied science programs accounted for approximately 46 percent of enrolments by men, but fewer than 10 percent of enrolments by women, among first-year students at the college level. At the university level, after rising moderately for several years, the proportion of women enrolled in undergraduate engineering programs has slipped back to about 17.5 percent from 21 percent in 1999.

Women comprised 47 percent of the Canadian workforce in the 2006 census. The participation rate of women in the engineering field averaged 13 percent, a marginal increase from 12 percent in 2001 and compared to 8 percent in 1996. Meanwhile, employment growth in engineering and technology occupations overall surged by 45 percent between 1997 and 2008, according to Census data, compared to a growth rate of 24 percent for all other occupations. Translated this means that, despite the fact that there has been a dramatic increase in the number of new jobs in engineering and technology, the vast majority are still taken by men.

#### **The United States**

The United States experience is quite comparable. According to the National Science Foundation, in its *United States Women, Minorities, and Persons with Disabilities in Science and Engineering 2006* report, only 13 percent of engineers were women. Another of its surveys from December 2008 – *Women Scientists and Engineers and Managers in Business or Industry* – found that women accounted for only 8 percent of engineering managers.

Lastly, the *Engineering Workforce Commission, Engineering & Technology Enrolments, Fall 2006* report articulated a persistent lag in the number of women enrolled at the undergraduate level in engineering programs:

- In 1995, women accounted for 22.7 percent of enrolments

- In 2001, women accounted for 23.7 percent -- the peak of the 1995-to-2006 period
- In 2006, this proportion had slipped below where it was in 1995, to 20.8 percent.
- When 1995 and 2006 data is compared, enrolments by women had increased by only 3.84 percent, while male enrolments had climbed 13.4 percent.

## ***Looking behind the numbers***

But what factors account for these statistics? How do these factors differ at various stages of a woman's progression from student to professional working engineer? There are three key stages of an engineer's career path that must be examined:

- Elementary and high school
- College and university
- The workplace

### **Elementary and high school**

A significant amount of research has been devoted to further our understanding of why so few girls choose to pursue a career as a professional engineer. For the purposes of this paper, we will focus on the findings of a study titled *Right for Me? A study of Factors that Shape the Attitudes of Young Women Towards Mathematics and Science and Towards Careers in Engineering and Technology*. This study is part of the *Engineering and Technology Labour Market Study* undertaken jointly by Engineers Canada and the Canadian Council of Technicians and Technologists between 2007 and 2009 with the financial support of Human Resources and Skills Development Canada.

*Right for Me?* validated many commonly held beliefs and invalidated others through a qualitative survey of female students in secondary school, 12 focus groups with female students in secondary school, and interviews with secondary school teachers of math and science. Five secondary schools participated, located in Calgary, Halifax, Montreal, Toronto and Winnipeg. The survey drew 420 responses and the focus groups drew 98 participants.

In general terms, it was found that interest or participation in math and science curriculums at the high school level is seldom the issue – female participation in the maths and sciences is on par with that of male students. Rather, the dominant theme is that most young women either have little or no knowledge about what engineering or technology careers entail, or have strong negative perceptions that govern their choices for post-secondary education. Specifically, *Right for Me?* concluded that:

**1) Broad cultural factors account for gender preferences in academic interests and careers.**

Young women in the study were overwhelmingly drawn to health and social science fields of study. These fields were perceived as more people oriented and more socially engaged. Careers in these fields were also perceived as allowing a better work-life balance.

**2) Young women do not have a good understanding of what engineering and technology careers entail and therefore cannot aspire to those careers.** A large majority of young women reported that they have very little or only a small amount of knowledge of engineering occupations. However, paradoxically, more knowledge of engineering did not necessarily equate to greater intent to pursue post-secondary studies in these fields.

**3) Young women have negative perceptions of engineering and technology occupations.**

Although some young women perceive engineering and technology as providing opportunities to be creative and to work in teams, most equate engineering and technology (but especially engineering) with construction work, outdoor work, working in a cubicle, and relating primarily to computers and machines, rather than people. Lower status is attributed to engineering and technology occupations in comparison with health and social sciences.

**4) Compared to young men, young women have fewer role models who encourage them to take mathematics and science courses and to consider engineering and technology careers.**

Role models by way of high school teachers and industry professionals were viewed as extremely important by both teachers and young women.

**5) Too few parents encourage their daughters to study mathematics and science and to consider engineering and technology career options.** *Right for Me?* found there was some merit to this statement, but not to the same extent as the previous points. While parental influence is an important factor in the decision to take mathematics and science subjects, the study found that parental influence is not nearly as important in shaping career aspirations, at least as it pertains to engineering and technology.

**6) Beliefs and assumptions that *Right for Me?* did not validate:**

- Young women are streamed out of mathematics and science
- Peers are important influencers
- Male dominance of science and mathematics classes discourages young women from continuing these subjects through to graduation
- There is a subtle, even unconscious, male gender bias in the science and mathematics curriculum that can be a significant deterrent to young women

### ***The United States Experience***

While our principle focus is on the Canadian situation, it is interesting to note that, in the United States, research has demonstrated largely the same issues around awareness and perception as the key factors that contribute to the challenge of attracting more young women to study engineering at the post-secondary level. The Canadian and American situations, therefore, appear quite comparable.

According to Betty Shanahan, executive director and chief executive officer of the Chicago-based Society for Women Engineers, "We need to get kids in by focusing on how rewarding the career is and what we do. We need to talk about how rewarding it is to impact people's health."

In a newspaper article published in March 2009, Maria Larrondo - Petrie, a computer engineer and associate dean of academic and international affairs at the College of Engineering and Computer Science at Florida Atlantic University, said "What is turning girls off is the image of an engineer. They don't see engineering in relation to its impact on the world, on society, on the human condition."

The *Extraordinary Women Engineers Project* – led by a coalition of American engineering associations and the American Association of Engineering Societies, the American Society of Civil Engineers, and WGBH Educational Foundation – took much the same qualitative approach as *Engineer's Canada's Right for Me?* study, with surveys and focus groups of female high school students and faculty. EWEP's final report, released in April 2005, indentified a similar lack of knowledge and negative perceptions about

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### ***Heeding the Canaries in the Coal Mine***

what an engineering career entails as key factors that dissuade young women.

## **College and university**

As noted earlier, Engineers Canada's *Right for Me?* study disproved the notion that young women do not pursue careers in engineering because they lose interest in, or are streamed out of, the math and science curriculums as they progress through high school. In fact, among the female students surveyed for the study, 88.2 percent and 68.5 percent, respectively, were enrolled in Grade 12 mathematics and science courses.

Why then, are more of these young women who have the academic qualifications, not pursuing an engineering degree at the undergrad level? Qualitative and quantitative data suggest a number of factors that either originate with high school and perpetuate through university, or are specific to the university environment.

### **Right for Me? Findings**

Two key conclusions of the *Right for Me?* study that apply throughout the student years were:

#### **1) Negative Perceptions**

"Most young women perceive engineering and technology (but especially engineering) with construction work, outdoor work, working in a cubicle, and relating primarily to computers and machines, rather than to people. Lower status is attributed (by girls) to engineering and technology occupations in comparison with the health and social sciences."

The key insight here is that young women gravitate to career paths they believe will have the greatest positive impact on the welfare of society. Generally speaking, the majority of engineering disciplines, fairly or not, are perceived as less desirable than ones that have a more obvious societal benefit, such as health and social sciences. Alternatively, young women who are drawn to engineering may be more inclined to gravitate toward specific disciplines such as biomedical and life sciences, or environmental engineering, because they can more readily see a direct benefit to *people*, versus electrical or mechanical engineering, which, by contrast, typically have lower female representation.

#### **2) Lack of Female Role Models**

"Compared to young men, young women do not have role models who encourage them to consider engineering and technology careers. Role models, including high school teachers and industry professionals, were viewed as extremely important by both teachers and young women," concluded the authors of *Right for Me?* Obviously, this also applies to a lack of female role models at the post-secondary level.

This conclusion from *Right for Me?* is corroborated by the findings of a separate study undertaken recently in the United States

*Sex and Science: How Professor Gender Perpetuates the Gender Gap*, a joint study by researchers at the University of California-Davis and the United States Air Force Academy, found that "while professor gender has only limited impact on male students, it has a powerful effect on female students' performance in math and science classes, their likelihood of taking future math and science courses, and their likelihood of graduating with a science, technology, engineering or math degree." This despite the

fact that the study also found that many male professors are just as effective at teaching female students as they are at teaching males, if not more so.

This American report emphasized that this phenomenon appears to be more acute in these courses than others, as “the gender of professors teaching humanities courses has, at best, a limited impact on students’ outcomes.”

“The fact that we found the largest effects among high ability women with a predisposition towards math and science is important because this group of women are, arguably, the set of women most suited for entering science and engineering careers,” wrote the authors.

### ***Other Factors***

Considering the negative perceptions and general lack of awareness among young women of the social benefits provided by the various engineering disciplines, it should come as no surprise that those young women who do choose to pursue an engineering degree are invariably top performers.

According to Claude Laguë, professor and dean of the Faculty of Engineering at the University of Ottawa: “When you talk to students of both genders, female students often say that, when they chose engineering, it was something they reflected upon very seriously, while for men, the response is often because a parent, a friend, a family member told them they should go. For male students, it is often less personal and less of a deep thought process.”

Elizabeth Cannon, professor and dean of the Schulich School of Engineering at the University of Calgary, observed that “Women do well in the undergraduate program. They’re overrepresented as leaders; they win major scholarships and so on and so forth.”

Cannon also emphasized that once women are enrolled in an undergrad engineering program, the attrition rate among their number is no greater than that of their male counterparts. However, just as women chose to pursue engineering for different reasons than men, they will also leave for different reasons. While male students are most likely to leave due to poor academic performance, female students most often leave because of a lack of interest or fit.

But what are the contributing factors behind that loss of interest or feelings that one does not fit in, which may also contribute to the negative perceptions that exist among young women about becoming an engineer?

### ***Old School Still in School***

According to the Society of Women Engineers’ Betty Shanahan, women and other under-represented groups encounter in college and university largely the same barrier they will in industry – an environment that is not inclusive and does not foster strong role models for them.

“When you get young women or other under-represented groups into undergrad programs, then they are in an environment that’s been traditionally white male that doesn’t understand how exclusionary they are – students see very few faculty that look like them,” Shanahan said. “There’s all kinds of structures in academic institutions that are set up so it’s assumed that a professor has a stay-at-home wife to manage the rest of their life while the professor advances his career ... female professors trying to get tenure must work crazy hours during their child-bearing years.”

The Schulich School's Elizabeth Cannon, meanwhile, stresses that the prevalent culture can vary widely from school to school. In many cases, the academic environment has become more professional, thanks in no small part to students, of either gender, policing themselves and enforcing more appropriate behaviour. However, in many instances male-dominated traditions and behaviours that are off-putting to female students have become institutionalized. This is particularly evident at schools with residences on campus, versus "commuter schools" where most students live off campus.

"It's much more accepted by our faculty colleagues to have women in the classroom," Cannon said. "It's become a non-issue. As a dean, I don't have to deal with mistreatment of women in the classroom, with a professor saying silly things – that kind of stuff isn't there ... but some of the more residential schools that have longer traditions, some of them are still seen in a light that is negative towards women. I've had complaints from parents with daughters in those schools and they were quite horrified by what they saw during orientation. The faculty there will say they don't condone it, and I agree – they don't, but they don't put a stop to it either because it is so ingrained in their culture."

The degree to which "old boys club" campus cultures and misogynistic attitudes by faculty still prevail at post-secondary institutions across Canada and the United States is open to debate. Nonetheless, these gender biases do persist and can, even at an unconscious level, colour perceptions of what makes a "good engineer" and whether or not women fit this mould.

This persistence of gender bias in the science and engineering professions was amply demonstrated in 2005, when Harvard University president Lawrence Summers, now special economic advisor to United States President Barack Obama, sparked controversy when he made public comments at a conference about "intrinsic aptitude" in science and engineering and whether this might account for the lack of female participation. This fire was further stoked by Harvard psychology professor Steven Pinker who claimed evidence of biological sex differences that pointed to male cognitive superiority.

### **Biased Curriculum**

While the assertion that men are simply better suited than women to science and engineering is widely scorned, it can be argued that most curriculums do not take into account gender-based values and legitimate differences in *how* men and women learn, which subsequently impacts how they behave.

A report released last year by the Information Technology Council of Canada, *The Focus on Information Technology (FIT) Program: Gender-based Analysis*, reviewed the gender differences between young men and women in terms of how they learn, how they are attracted to technology and how a school curriculum must therefore be designed to provide the right "hook" for both genders.

The report found that "the singular and obsessive interest in computing that is common among men is assumed to be the road to success in computing. However, girls are 'connected knowers' and are more interested in knowing how technology can be applied to real world needs than 'how things work.' They don't relate to the study of technology in the abstract."

This disparity, the Information Technology Council report stated, has been compounded by the fact that "there has been practically no women's participation in curriculum decision-making about computer science curricula at either the secondary level or at college/university. In computer science classes, assignments and teaching examples often embed male-dominated interests and activities e.g., sports

stats, card and number tricks. Texts tend to focus on technical details with little attention paid to the application and impact of the technology in meaningful, interdisciplinary problem-solving ways.”

## **In the workplace**

As we have explored in this section, there are a number of factors which not only steer a young woman away from an education in engineering, regardless of her aptitudes, but may lead her to drop out and change direction after having embarked on this path at the post-secondary level. These are all factors related to the *attraction* of women to the engineering profession, but what about *retention*?

Having earned an engineering degree does not automatically translate into earning one’s licensure as a professional engineer (P.Eng.). In fact, a certain proportion of men and women with an engineering degree do not, for whatever reason, chose to become a “P. Eng.” Nonetheless, many will still enjoy rewarding careers that draw on their engineering education and may in fact be quite comparable in terms of type of work and salary to that of their peers who have been licensure.

*Changing Roles in Engineering and Technology*, part of the *Engineering and Technology Labour Market Study* undertaken jointly by Engineers Canada and the Canadian Council of Technicians and Technologists, found that “a greater number of engineering technicians and technologists are advancing into “engineering management’ with the result that increasing numbers of working-level professional engineers and engineering technicians and technologists report to technologists.” Data from the 2006 Census indicated that only 25.9 percent of persons who held a university degree in engineering were working in an engineering occupation. Meanwhile, the *Engineering and Technology Labour Market Study’s Survey of Engineers and Engineering Technicians and Technologists*, found that only 49 percent of employers require an engineer to be licensed.

Licensure is in itself a complex topic that we will not delve into here. For the purposes of this paper, our focus is on those women who have become professional engineers, who do embark on a career, but then at some point decide to leave the profession or not renew their professional licence. To a lesser degree, articulating the negative factors that turn women away from the profession may also shed light on why so many women *and men* with an engineering degree are not working in an engineering occupation, as indicated by the 2006 Census data.

A certain level of attrition is common to any profession, and certainly not confined to one gender, but there is hard data that demonstrates this rate of attrition in the engineering profession is greater among women than it is among men. The question is, “Why?” followed by, to be explored in following sections of this paper, “What can be done about it?”

There is significant qualitative and anecdotal evidence from the Canadian experience to support the hypothesis that conditions in the workplace drive female professional engineers to leave their jobs at a greater rate than men. However, to find more comprehensive quantitative data to support this, we must look to in-depth research from the United States. It bears stating that, based on the review of existing research and the interviews with numerous experts on both sides of the border carried out for this paper, it is justifiable to consider the United States experience relevant and comparable to Canada’s.

### ***The United States Experience: The 2005 National Survey about Engineering***

In 2005, the United States Society of Women Engineers commissioned Harris Polls to conduct and perform initial analyses on a “National Survey about Engineering.” The Survey was a follow-up to one

conducted in the early 1990s by the Society in collaboration with a number of other engineering associations. Twenty-one colleges and universities, including one Canadian school, agreed to participate in the 2005 study and facilitated contact between Harris Polls and their alumni.

The study's intent was to determine whether women were more likely to leave engineering than men after graduation and if so, what were the underlying causes? The survey found that men were more likely to be employed as engineers after graduation – 58 percent versus 48 percent of women. Male engineers were also less likely to leave the labour force – 3 percent versus 12 percent of women.

“The data shown here indicate that women often move out of engineering as a result of changing career interests while men do so for better advancement or salary opportunities in other fields,” the survey stated.

However, the survey did not clearly identify whether the majority of these women who left engineering did so because they were “pushed” by negative factors, or “pulled” by positive ones. However, the report did suggest that, “because they operate within a strongly ‘masculine’ culture, both male and female engineers may be reluctant to admit that anyone “pushed” them out of anywhere. So it could be the case that both push and pull forces operate.”

Other results from the survey did suggest those “push” factors persist and that, paradoxically, progress in how women and minorities are treated may have made these factors more difficult to identify and address.

“It is clear that there are still substantial gaps between female and male perceptions of whether engineering is a ‘level playing field’ for women and minorities,” the survey stated. “Despite this persistent gap, all of the data shown here indicate that circumstances appear to have improved somewhat for women and minorities in engineering, based on the differences in women’s responses from 1993 versus 2005. However, the continued gap between men and women is noteworthy. Men are less likely to be aware of discrimination against women or minorities and, subsequently, are more likely to believe that things are generally equitable at their workplaces. This may mean that it is harder now for women and/or minorities to discuss possible cases of discrimination with white men.”

The Society of Women Engineers’ Betty Shanahan said that, after graduation, finding a job is generally not an issue for a young female engineer. The challenge is finding an organization that advances women and understands what they need, despite the fact that there are very simple things management can do to meet these needs.

“There are a spectrum of barriers that are insidious because they are based on unconscious biases by both men and women,” Shanahan said. “They are so engrained in the majority culture – you fix one piece, but that’s not enough.”

### ***The Athena Factor***

But perhaps the most definitive data to come out of the United States in recent years is found in an international report published in June 2008 by the *Harvard Business Review*.

*The Athena Factor: Reversing the Brain Drain in Science, Engineering, and Technology* was the result of four major surveys and 28 focus groups over 18 months that included men and women from around the

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### ***Heeding the Canaries in the Coal Mine***

world, working at 43 global companies. The intent was to examine the career trajectories of women with science, engineering and technology credentials in the private sector on the premise that, “while considerable research has been done on women in the academic sector, women in (science, engineering and technology) in the private sector have been largely ignored and are poorly understood.”

*Athena* concluded that for many women, “attrition rates spike 10 years into a career. Across the climates of science, engineering, and technology, women experience a perfect storm in their mid- to late 30s. They hit serious career hurdles at the same time that family pressures ratchet up. Stepping in with targeted support before this fight-or-flight moment has the potential of lowering the female attrition rate significantly.”

In fact, *Athena* found that 24 percent of women were likely to quit the engineering field, versus 17 percent of men. This rate of attrition was even higher among jobs in the general high tech sector, at 41 percent vs. 17 percent.

The reasons? It begins with a prevalent “hostile macho culture,” with fully 63 percent of female respondents claiming to have been subjected to sexual harassment in the workplace. This is followed by feelings of isolation, difficulty understanding how to advance in this male environment, lack of a supporting peer group and extreme work pressure.

*Athena* concluded that young female scientists, engineers, and technologists embark on their career with enthusiasm and ambition, eager to make a difference and cure the world’s ills, with little understanding of the challenges they will encounter. As time goes on, these “antigens in science, engineering and technology cultures” take hold. Fully 35 percent of junior women surveyed considered themselves to be very ambitious. By age 45, that figure had fallen to 14 percent.

In the *Athena* focus groups, senior women who had made it through the “fight-or-flight” phase of their careers talked about a “great divide” between themselves and younger female colleagues and expressed frustration at not being able to give adequate warning to the next generation of the challenges that lay in store.

However, *Athena* found that the majority of women who leave their science, engineering and technology career are not doing so to raise a family. Roughly half (48 percent) move to a similar job outside the corporate sector. Many become self-employed, while others join the public sector or a startup company. Only one-fifth of the women who left dropped out of the workforce entirely.

Finally, *Athena* concluded that, stemming this flow of talent, even to a small degree, could have profound positive benefits to the size and diversity of a skilled labour force. “Reducing female attrition by one-quarter would add 220,000 people to the highly qualified (science, engineering and technology) labor pool in the United States”

### ***Canada’s Qualitative Validation of these American Findings***

*“I don’t think the main issue is attracting women into the profession; it’s retaining female engineers through better support, more equitable hiring practices, improving work/life balance. I graduated in 2000. Most of my female classmates have left the profession already and I am considering the same.”*

– female respondent to Engineers Canada survey, Aug. 11, 2009

*I would like to see women seen and treated as equal members of the profession, with equal roles and needs for their professional and personal lives as offered to male engineers. This would mean that women see themselves as equally capable, and having equal opportunity. This doesn't mean special treatment for women within the profession or within companies - it means providing equal allowance for people's needs and obligations both at work and outside work."*

– male respondent to Engineers Canada survey, August 17, 2009

*"The old boys club is alive and well within the engineering profession, the companies that employ engineers and the universities that train them. Women need to be given opportunities that will allow them to learn and advance in their careers, either as technical subject matter experts or to rise up through the management ranks. They also need employers to recognize the need for life balance."*

– female respondent to Engineers Canada survey, August 8, 2009

*"I want women to be included when engineers e-mail out job postings to their university friends. I want to stop hearing ridiculous rumours at work that each professional woman supposedly slept her way to that position. When a young female engineer is hired, I want her colleagues to spend more time talking about her degree and experience than about her physical beauty. I want assignments to be given on the basis of competence and resource availability, with no concern for who might hook up with whom."*

– male respondent to Engineers Canada survey, August 9, 2009

As noted in the Introduction, Engineers Canada in June 2009 sent a single qualitative question to professional engineers across Canada: *"What is the vision of success you would like to see for women engineers in Canada?"*

The intent was to capture people's perceptions about their workplace situations to better understand the prevailing cultural conditions in the workplace that influence career decisions. Quantitative data alone cannot capture this. By September 2009, the question had yielded 2,432 responses, 58.8 percent from women and 41.2 percent from men, revealing what professional engineers of both genders deal with on a daily basis – in other words, their current reality. The comments above are representative of the common themes that emerged from the survey results, painting a rather bleak picture of a current reality that, if left unchanged, bodes ill for the future of both Canada's engineering profession and its competitive edge on the global stage.

As illustrated by the respondents' comments above and in the Introduction, the survey results suggest that in most organizations there still exists:

- A "glass ceiling" that prevents the progression of women into more senior roles.
- The persistence of an "old boys club" mentality that fails to extend to women the same degree of professional respect, appreciation and advancement afforded their male counterparts.
- An unwillingness by many employers to provide the flexibility needed by most female engineers to balance work and family in their role as child bearers.
- A common sentiment that work-life balance issues also often apply to men with comparably negative consequences.

When taken together with the findings of the American studies, the results of Engineers Canada's survey paints a consistently grim picture for all of North America.

### ***What Progress has Really Been Made?***

"I am often negatively surprised and disappointed when we get into those discussions about what we can do to change and you have women who tell us, 'here we go again, having the same discussion we did 10 or 15 years ago,'" the University of Ottawa's Claude Laguë said in an interview for this paper. "It appears that things have not changed that much in the workplace or even that much in the schools."

In 1994, visionary activist and writer Felice Schwartz gave a presentation in which she reflected on her 31 years at the helm of Catalyst – the organization she had founded in 1962 to help women make headway in the male-dominated world of work.

"Either corporate leaders will make a bold change in their mindset, which will lead to other kinds of changes in their organizations and ultimately to the release of women's talents, or they will not," she said. "Either women will reach a consensus about the nature of their differences from men and be bold enough to speak about them, or they will continue to try to play by men's rules and will not succeed."

Further, Schwartz remarked that, "if (chief executives) understood how much they need women's talents, they would address the underlying issues such as work schedules for parents, lack of role models and mentors for women, and sexual harassment in a comprehensive manner. If they were committed to promoting the most able individuals, regardless of gender, they would make it possible for women to succeed. As it is, they do not. Changes are small and incremental and do not represent the kind of breakthrough thinking, the change in mindset, that I believe is required."

More than 15 years later, we hear these same themes echoed in the quantitative and qualitative data that has been referenced thus far. It is difficult to find consensus about how much progress has been made since Schwartz gave that speech to address these barriers to women in the engineering context. However, there is no denying that significant progress *remains to be made*.

According to Dan Motyka, president of Engineers Canada, the fundamental challenge remains retaining female professional engineers five to 10 years after they have entered the workforce, and while it is not the only factor in play, family planning is a significant barrier to continuing on the career path.

He also said that some members of the older generation still find it difficult to admit that women are perfectly capable of doing what a man can do, as well or even better. And while it can be argued that both men and women of the younger generation tend to favour a more positive work-life balance, Motyka pointed out that, when it comes to how women are regarded in the workplace, some of the younger people are no more enlightened than some of the older generation.

Christine Plourde, chair of Engineers Canada's Women in Engineering Advisory Group, said it is difficult to pin down specific reasons why women leave engineering, however, she believes that workplace cultures still firmly rooted in the old school mindset is the overarching factor. Ultimately women reach an inflection point in their career where they must choose between family and trying to advance their career.

"The culture of expectations for engineering and a lot of other professions is that you work long hours and don't ask questions and your job should be your number one priority," Plourde said. "That becomes difficult when the parenting and significant portion of looking after the home, still tends to fall on the woman ... so it's difficult for a lot of women to work the long hours without letting things fall about at

home.”

## **The Need for Cultural Change**

### ***A need to change the academic culture***

The aspects of the post-secondary environment that have been explored in this section demonstrate that there remain deeply rooted behaviours and biases, albeit often at an unconscious level, that are not supportive of women and other under-represented groups and contribute to the negative perceptions of the engineering profession that dissuade young women at the high school level from pursuing an engineering degree. Parts III, IV and V will explore where and how change must begin in the academic context to yield a more positive outcome for women at any stage of their career and the profession.

### ***A need to change the workplace culture***

Similarly, the qualitative data from Engineer Canada’s survey of its members undertaken in the summer of 2009, combined with the findings of other research, such as the *Athena Factor*, as well as the anecdotal perspectives of the industry leaders interviewed for this paper, demonstrate a clear and obvious need for cultural change in the workplace.

But before looking at how this change can come about, we will in Part II articulate why the attraction and retention of women in the engineering profession is an issue that merits attention and corrective action.

## Part II: Consequences of the Status Quo

*“The competition internationally is fierce, but we do have many areas of technology where we are world leaders, including wireless and mobile systems, and rapid development of software driven services that build on, and complement, the products of larger strategic partner companies, both domestic and international.*

*“We MUST also play a greater role in the area of content generation in the rapidly evolving world of digital media. Or are we also aiming to be known as the world’s best users of other people’s creative products?”*

*“The online marketplace and rapidly growing use of e-commerce are certainly important aspects of Canada’s ‘Digital Economy’, but do we want to always be buying other people’s music, films, games and software? Keep in mind that even though manufacturing and software development can often be done more cheaply offshore, the creation of cultural content is much harder, if not impossible, to outsource to India or China.*

*“In short, if Canadians want well paying, challenging, knowledge-based jobs for their children, we MUST become an ‘Innovation Nation’. IT & Telecom industries, along with new media and digital content creation, can become the foundation of Canada’s future prosperity ... And no sector of the economy holds greater promise for improving productivity of Canadian companies across all sectors than our R&D intensive ICT sector.”*

– from Sir Terry Mathews’ Keynote, Canada’s Digital Economy: Moving Forward, June 22, 2009, Ottawa

Long before he became the CATA Alliance’s national spokesperson, serial entrepreneur Terry Matthews preached the fundamental economic necessity of Canada finding its place on the global stage as an innovation economy able to grow and prosper despite the emergence of the so called “Chinmerica” – the combination of China, India and America – with its combination of massive investment in technology development and marketing, combined with low-cost R&D and manufacturing.

As part of its Innovation Nation strategy to leverage Canada’s strengths and build a competitive digital economy, CATA has as one of its core agenda items a goal to “develop the IT capacity of women and encouraging women to join the technology market and enrol in technology-related studies.”

But why? Why is it considered so crucial to increase the participation of women in the technology industry? Why is this half of the population singled out for special consideration when there have also been challenges in recent years, albeit less acute, with attracting and retaining *young men* in the ICT sector? For that matter, what about the challenges faced by skilled immigrants to be integrated into the labour force and have their foreign credentials recognized?

### ***The economic argument***

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*Heeding the Canaries in the Coal Mine*

For Engineers Canada, By Janice Calnan and Leo Valiquette – Final, March 31, 2010

While the engineering profession as a whole encompasses much more than Canada's information, communications and technology sector, this question nonetheless remains a relevant one. The issue of gender balance and diversity in the workplace transcends any one profession or industry sector but ultimately has the same impact on productivity, innovation and economic performance. The issue and definition of diversity itself extends beyond men and women to include individuals from varied ethnic and cultural backgrounds. The argument for diversity in favour of women, is, at its root, the same argument for diversity as it pertains to under-represented minorities in general – a varied group, regardless of its makeup, is invariably more creative, innovative and productive than a homogeneous group.

However, women, of whatever ethnic or cultural origin, represent for the engineering profession in any nation a far larger untapped labour pool than any other under-represented group. As the *Athena* report concluded, "Reducing female attrition by one-quarter would add 220,000 people to the highly qualified science, engineering and technology labour pool in the United States"

In its May 2009 report, *Groundbreakers: Using the Strength of Women to Rebuild the World Economy*, Ernst & Young reiterated what numerous studies have previously concluded, "diverse groups of people tend to outperform homogeneous groups if both groups' members have equal abilities. Perhaps more surprisingly, there is now research showing that under the right conditions, a group of intelligent problem solvers chosen completely at random will likely outperform a homogeneous group of even the best problem solvers."

As quoted in *Groundbreakers*, Laura D. Tyson, a professor of business administration and economics at the University of California (Berkeley) and co-author of the World Economic Forum's *Global Competitiveness Index*, said a nation's competitiveness depends significantly on whether and how it educates and utilizes its female talent.

"To maximize its competitiveness and development potential, each country should strive for gender equality — i.e., to give women the same rights, responsibilities and opportunities as men," Tyson said. "In the current global financial and economic crisis, it is more vital than ever that women's economic participation does not shrink, but is in fact seen as an opportunity to make headway."

According to Goldman Sachs's Global Economics Paper No: 154 published in April 2007, *Gender Inequality, Growth and Global Aging*, "Closing the gap between male and female employment rates would have huge implications for the global economy, boosting United States gross domestic product by as much as 9 percent, Eurozone gross domestic product by 13 percent and Japanese gross domestic product by 16 percent ... Encouraging more women into the labour force has been the single biggest driver of the Eurozone's labour market success, much more so than 'conventional' labour market reforms. The United States and Japan, while starting from very different positions, have both made little progress in narrowing the gap between male and female employment in the past 10 years."

A story published in January 2010 by *Canadian Business Magazine*, "Winners & Losers 2010: Big Winner – Women," quoted Michel Ferrary, a professor of management at France's Ceram Business School, who in 2009 made headlines when he published research findings that illustrated that the French companies which had best weathered the global financial crisis – in other words, the ones that saw the smallest drops in their share price – were the ones with the largest proportion of female managers.

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### *Heeding the Canaries in the Coal Mine*

Why? Ferrary pointed to established research into the fundamental differences in how men and women problem solve and manage risk.

“Feminization of management seems to be a protection against financial crisis,” Ferrary told *Canadian Business*. “Several gender studies have pointed out that women behave and manage in a different way than men. They tend to avoid risk and to focus more on long-term perspective. A larger proportion of female managers balance the risk-taking behaviour of their male colleagues.”

Ferrary’s findings correlate with previous studies, such as by Catalyst in 2004 and 2007, that examined hundreds of Fortune 500 companies and found that the leaders in terms of fiscal performance boasted the greatest number of women on the board and in senior management positions. The Conference Board of Canada has charted a similar trend among Canadian companies with at least two female board members.

### ***The supply vs. demand argument***

Canada is facing a labour crunch. It is an inevitability driven by a combination of factors common to much of the industrialized world -- a declining birth rate, an aging baby boomer population approaching retirement and intensifying global competition for skilled labour.

In November 2009, the Canadian Coalition of Women in Engineering, Science, Trades and Technology published a report called *Increasing Women in SETT: The Business Case*. This report cited one particular statistic that should give reason for grave concern:

“Over the period 2008 to 2015, Canadian employers will need to recruit around 126,400 to 178,800 ICT workers, an average of 15,795 to 22,345 per year, *with the supply of domestic graduates meeting only 49 percent to 70 percent of net hiring requirements.*”

And this is *before* Canada’s labour supply experiences the years of sharpest loss with the retirement of most baby boomers, which will begin before 2020, according to Statistics Canada. This is a paradigm shift that will impact every facet of Canadian society and every industry sector, a shift further aggravated by a projected decline in the number of young people enrolling in post-secondary programs.

As cited in Part I, data from Engineers Canada and Statistics Canada have charted in recent years a decline in the number of young women enrolling in engineering and applied science programs. According to the most recent data, men in these programs account for about 46 percent of all student enrolments at the college level, while women account for less than 10 percent. At the university level, after rising moderately for several years, the proportion of women enrolled in undergraduate engineering programs has slipped back to about 17.5 percent from 21 percent in 1999.

And after peaking at more than 2.2 million in 2008-2009, the number of high school students in the age 15-19 cohort has now entered a period of steady decline, expected to level off at around 1.95 million by 2020, according to Statistics Canada. Not only is the available supply of experienced professional engineers about to undergo a sharp demographic shift, so too is the pool from which new professional engineers will come.

In its *Outlook for Human Resources in the ICT Labour Market: 2008-2015*, published in October 2008, Canada's Information and Communications Technology Council found that, "Over the forecast period, approximately 80,000 individuals will retire from the ICT labour force. The highest projected retirement rates will be for electrical and electronics engineers and electrical and electronics engineering technologists. Web designers and developers, along with software engineers and developers, will have the lowest retirement rates. With the declining size of the 15-19 cohort, enrolments and graduation rates in (information, communications and technology) fields will be increasingly under pressure."

Faced with this scenario, the 2009 final report of Engineers Canada's *Engineering and Technology Labour Market Study* concluded that, "By far the most attractive strategy to maintain the skill base, without compromising standards, is to increase the number of young women who enter engineering and technology programs."

However, there have been situations over the past decade where a region is suffering a labour shortage *and* a high unemployment rate in the same industry, which raises legitimate questions about how acute the forecast labour crunch will truly be. *Increasing Women in SETT* cited this trend in southwestern Ontario's Technology Triangle in late 2009, in which 1,500 to 2,000 high-tech jobs were unfilled despite a high unemployment rate in the region's general population.

This apparent paradox can perhaps be explained by two factors. The first is a consequence of offshoring – junior people struggle to find an entry level job because employers have found it cheaper to outsource such work. The other factor, much more pertinent to our purposes here and no less acute – is the complaint by employers that many prospective employees have great technical skills, but lack equally important communication and teamwork skills. As articulated by *Increasing Women in SETT*, women are quite often strong in these essential skills.

Retention is another key area cited by *Increasing Women in SETT* that strikes at the heart of established human resources management best practices – it is far more efficient and economical to invest in existing employees and support their advancement through the organization than it is to hire new people.

A separate, though complimentary work on the issue by the Conference Board of Canada, *Workplaces that Work* concluded that "workplace cultures that encourage greater participation by women share many of the same characteristics as those that maximize employee satisfaction and engagement and lessen the costs related to illness, injury, and turnover."

Clearly, in a time of growing labour supply pressures, both at home and abroad, those organizations that strive to create an embracing and supportive workplace environment, not only for women, but for all employees, will emerge the winners as destination employers. These progressive organizations will attract and retain the best and brightest from a diminished pool of talent. Those organizations that fail to exercise the same foresight run the risk of fading away. This of course extends to organizations that employ professional engineers and highlights the importance of reducing the rate of attrition among female professionals and leveraging their full potential.

## ***The global talent race argument***

It only makes sense that leveraging the strengths of as broad and diverse a talent pool as possible yields

significant benefits in terms of productivity, creativity and risk management. Considering that every nation in the industrialized world is attempting in its own way to be globally competitive, the failure to build and leverage *all* of a nation's economic strengths, including a diverse pool of skilled labour, could leave it with a significant competitive disadvantage.

The European Union, in particular, has been actively working to make the most of its existing talent pool to drive an innovation strategy. With the Lisbon Agenda signed in March 2000, heads of state agreed to make the region "the most competitive and dynamic knowledge-driven economy by 2010." Among the goals was increasing the number of people entering science and technology careers.

While the success of the Lisbon Agenda a decade later is open for debate, and the European Union is still struggling with its own challenges to increase the participation of women in science and engineering, it nonetheless demonstrates that this economic powerhouse, much larger and more diverse than Canada in terms of labour supply, is actively looking to leverage its strengths and position itself on the global stage as an innovation economy. Further to this, the European Commission has undertaken numerous conferences, studies and action plans over the past decade to address the issue of attracting and retaining more women in science and technology careers.

As indicated in Part I, the United States is attempting to address similar attraction and retention issues in science and engineering occupations to further its own economic interests. Clearly, the race is on. The question is where on the course is Canada? And what of those Asian juggernauts – India and China?

### ***The India-China Paradox***

While there is a widely held perception that India and China are cranking out engineering graduates by the hundreds of thousands each year, there have been valid questions raised about the quality of these graduates that imply sheer volumes alone will not define economic competitiveness. This suggests that Canada, despite its comparatively miniscule population, may be outnumbered, but not outclassed, provided, of course, that we value and leverage the strengths of both men *and* women.

In 2006, Duke University adjunct professor Vivek Wadhwa testified before the American House of Representatives Committee on Education and the Workforce about a study he had conducted on outsourcing and the competitiveness of American engineering colleges.

His first finding was that, when relying on Indian and Chinese data to tally the number of engineering graduates versus those produced by American schools; it is often not an apples-to-apples comparison. China in particular includes in its headcount graduates of programs that were shorter and more specialized than what passed for an engineering degree in the United States

"This means that the reported number of engineers produced may very well include the equivalent of motor mechanics and industrial technicians," Wadhwa said.

"While it is clear that China is significantly increasing the number of engineers and technology specialists it graduates, the data indicates that there is a factory like approach to turning out graduates," he added. "Duke researcher, Ben Rissing notes that degree quality can't be maintained unless academic staff and facilities grow with student populations."

Wadhwa also testified that "all available data indicates that the vast majority of Indian and Chinese

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### ***Heeding the Canaries in the Coal Mine***

graduates are not close to the standards of United States graduates."

In its August 2007 issue, *Newsweek* explored the challenges of quantity and quality facing India and China in a story titled "The Mythical Million."

"Out of the huge number of engineering and science graduates that India produces, only 25 to 30 percent can be regarded as suitable," Kiran Karnik, head of India's National Association of Software and Services Companies, told *Newsweek*.

Prof. Mao Shoulong of China's Renmin University told *Newsweek* that an ambitious effort to rebuild the country's educational institutions following the punitive years of China's Cultural Revolution had led standards to slip. "Once you get in, it's (too) easy to graduate," he said.

*Newsweek's* report concluded that "To sustain their breakneck growth, the countries will need lots of high-quality engineers and scientists. Yet neither have enough reliable universities to produce them."

Of course, this lack of quality domestic talent does yield additional pressures for industrialized western nations to make the most of their home-grown talent pool – before someone else does. India, for example, has fostered the growth of companies such as Wipro, Tata Consultancy Services and Infosys. These enterprises have grown from being offshore sweatshops doing the drudge IT work for North American and European companies, to competitive multinationals in their own right that have expanded overseas and set up their own offshore operations in Europe and North America to take advantage of local skilled labour and market experience.

Meanwhile, Duke's Wadhwa and his research team have charted a growing trend of immigrants educated in the United States taking their expertise back to their home country.

"Why should we care?" Wadhwa mused in a column published in the March 2009 issue of *BusinessWeek*. "Because immigrants are critical to the country's long-term economic health. Despite the fact that they constitute only 12 percent of the American population, immigrants have started 52 percent of Silicon Valley's technology companies and contributed to more than 25 percent of our global patents. They make up 24 percent of the American science and engineering workforce holding bachelor's degrees and 47 percent of science and engineering workers who have PhDs."

So while China and India may not be the competitive threat they were feared to be a few years ago in terms of the sheer number of engineers they produce, their economic growing pains nonetheless intensify the pressures on Canada and other western nations to build as large and diverse a pool of talented professional engineers as possible and to create the conditions that actively serve to attract and retain both men and women to the profession. And while women have been attracted to the profession in greater numbers over the past two decades, there has been, as explored in Part I, a decline in female enrolment in undergraduate engineering programs in recent years, compounded by a rate of attrition in the workplace that is much higher among women than it is among men.

## Part III: Making a Difference

In Part I of this paper, we established and defined the issue that women make up only a small minority of professional engineers in Canada and United States and in fact, of the general science, engineering and technology labour pool. We explored the factors that serve as negative influencers for women at various stages of their academic and professional careers that dissuade them from pursuing, or continuing, a career as a professional engineer. We focused on what have been proven, through both qualitative and quantitative research, to be the negative influencers at the elementary/high school level, the post-secondary level and in the workplace.

In Part II, we asked why this status quo is a relevant issue worthy of study and redress. We answered this question by reviewing respected research into the economic importance of diversity in the workplace, an increasingly fierce global competition for talent, and impending labour shortages that will be driven by the retirement of the baby boomer generation, declining birthrates and a shrinking cohort of young people to enrol in post-secondary studies. For the most part, these arguments are relevant to all industrialized nations.

Having presented the problem and articulated why it must be addressed brings us to the solution. Just as there has been extensive research into why more women are not attracted to science, engineering and technology careers or retained in them, there have been numerous recommendations as to *what* must be done to address the root causes and increase the participation of women in these career fields.

But as stated in the Introduction, our primary focus in this paper is to go beyond the *what* to the *how*. It is one thing to recommend a solution to a problem, quite another to define and instigate an effective process that yields positive and long-term change.

Drawing on the philosophies and methodologies of the LeaderSHIFT© Practicum developed by the Calnan Group, parts IV and V of this paper will apply principles of planned organizational change to define the role and characteristics of the Green Light Leader, a crucial champion in effective organizational and cultural change, and create a road map for how Engineers Canada and other stakeholders can turn a positive vision for the future into reality for *all* professional engineers, regardless of gender, age or ethnicity.

Before we can dive into the *how*, we must first review the *what*: among all the diverse research that has been done into identifying the root causes that dissuade women from the engineering profession, what are the common recommendations that have been made to tackle the problem at the root?

As we will see in the review that follows, there is no shortage of sage advice to address the negative influencers at the high school and university levels, but considerably less when it comes to tackling the negative influencers that exist in the workplace.

## ***Taking action: What must be done?***

### ***Elementary and High School***

In Part I: The Root Causes, we referenced two specific reports, one Canadian and one American, both of which used qualitative research to understand why more young women in high school are not attracted to science, engineering and technology careers in general and the engineering profession in particular.

*Right for Me? A Study of Factors that Shape the Attitudes of Young Women Towards Mathematics and Science and Towards Careers in Engineering and Technology* was part of the *Engineering and Technology Labour Market Study* undertaken by Engineers Canada and the Canadian Council of Technicians and Technologists between 2007 and 2009.

The *Extraordinary Women Engineers Project* took much the same qualitative approach as Engineer's Canada's *Right for Me?* study several years earlier, with surveys and focus groups of female high school students and faculty across the United States

Both reports made similar recommendations to overcome the lack of knowledge about, and discouraging perceptions of, post-secondary engineering studies and engineering careers. These included:

- **Messaging.** There is a need for concerted efforts between industry, post-secondary institutions and professional organizations to develop and provide career information materials geared toward young women that emphasize those attributes young women seek more strongly in a career, such as social engagement, “making a difference,” creativity and working in teams. Fundamentally, women learn differently than men and have different interests. These differences must be taken into account when programs and information materials are being developed to include those key messages that will have the greatest resonance with young women.
- **Mentorship.** The fundamental importance of providing role models for young women is an oft-repeated theme at every stage of the career path. At the high school level, *Right for Me?* recommends “a program that will bring young women in high school in contact with women in engineering and technology.”
- **Mindshare.** Those individuals who have the greatest influence on a young woman's career choices – parents, teachers and guidance counsellors – must themselves be educated about the societal benefits and personal rewards of an engineering career and encouraged to effectively convey these messages to young women. They can play an important role in overcoming the perception that engineering is nothing more than a science and math-intensive slog that demands long work hours in an isolating environment.

The overall message is that effective communication is key. The engineering professional as a whole, however, has significant progress to make in effectively promoting itself not only to young women, but to young people in general.

According to Dan Motyka, president of Engineers Canada, there is a failure within the profession itself to recognize the importance of committing the resources necessary to spread the message about the merits of engineering as a profession concerned with human welfare and environmental conditions. Engineers by nature tend to keep their head down instead of standing up and saying “this is what we do for you. This is why we need qualified, educated engineers in our society.”

“We’re not doing a very good job of communicating to the world at large why this is an honourable profession with equal opportunity for the future,” said Motyka.

### ***College and University***

Part I of this paper argued that there remains on many university and college campuses across North America an “old boys club” culture that is unsupportive of female students as well as female faculty. This still manifests, albeit to a lesser degree than was typical in the past, as outright misogyny and discrimination. More often, however, it exists as subtle, even unconscious, gender biases that are reflected in course material and colour perceptions of what makes a “good engineer” – a definition that often does not encompass the values, strengths and priorities of women.

The catch-22 is that such engrained cultural behaviours not only dissuade young women from studying engineering, they discourage women from joining the engineering faculty, thus depriving female students of the role models considered so crucial to success.

As *Sex and Science: How Professor Gender Perpetuates the Gender Gap* found, “while professor gender has only limited impact on male students, it has a powerful effect on female students' performance in math and science classes, their likelihood of taking future math and science courses, and their likelihood of graduating with a science, technology, engineering or math degree.”

How can this engrained culture be overcome to make for an environment that is more welcoming to both female students and faculty? Clearly there is a need to sensitize the male faculty who are in the majority to how attitudes about the value of women (and men) grow, are institutionalized and become unwritten norms that perpetuate subtle discrimination in the educational and workplace environments. This education must begin with both faculty and first-year engineering students, led by those who fit the profile of Green Light Leader, and provide clear evidence of how negative behaviours and norms develop.

### ***Achieving Diversity: Strategies that Work***

*Achieving Diversity: Strategies that Work*, another report that was part of the larger *Engineering and Technology Labour Market Study*, took a case study approach to examine 10 different programs undertaken in Canada to attract and retain women, skilled immigrants and other under-represented minorities to engineering and technology occupations.

Its conclusions inextricably tie together *all* phases of the educational path and highlight four elements that define a successful program for increasing post-secondary enrolments in engineering and technology:

- Programs should start in *elementary* school at least by grade 5 or 6.
- Programs should *continue through secondary school*.
- Support needs to carry through *into post-secondary years in the form of mentorship and support*

networks.

- Outreach programs at the grade school and high school level need to be *activity focused*. Maths and sciences only become exciting when they are seen as the keys that unlock the door to do things that are truly exciting.

Initiating and driving forward this kind of focused, long-term effort to increase the percentage of young women pursuing an engineering degree requires sweeping organizational and cultural change at a high level. It is the kind of shift in thinking that can only be accomplished through Green Light Leadership.

### ***In the Workplace***

*“There is definitely more pressure for women even now to work much harder than men, to achieve the same level of recognition. I decided to delay my family to further my career ... reached supervisor level and waited again, and then again. Now I am on the verge of being too old to have a family.”*

– female respondent to Engineers Canada survey, August 10, 2009

*“Female engineers bring different collaborative skills to group design and this must be enhanced in organizational behavioural training. Most North American business models seek aggression and dominance to perpetuate ideas – I find women do not participate willingly in this environment.”*

– male respondent to Engineers Canada survey, August 8, 2009

*“Let’s face it – there are differences between men and women, even in brain function, but there is nothing about that which makes women less capable than men in engineering, as problems have more than one approach for a solution. But we are definitely made unwelcome in the ‘you may have to take time off for a baby’ stage.”*

– female respondent to Engineers Canada survey, August 8, 2009

*“Women bring a different perspective to the table. We should not expect or even encourage women to behave in the same way as men do but rather value their views and diversity. Women make up close to half the population, so they certainly should be heard.”*

– male respondent to Engineers Canada survey, August 9, 2009

To reiterate the observation made by the *Athena Factor*, young female scientists, professional engineers, and technologists who have overcome the negative influencers of high school and university often embark on their career with enthusiasm and ambition, eager to make a difference and cure the world’s ills, with little understanding of the challenges they will encounter.

### ***But what is the point of bringing talented and ambitious young women to this stage if only to have them slam into the proverbial glass ceiling in the workplace?***

Many organizations recognize the value of diversity in the workplace and are eager to leverage the unique strengths and perspectives of women. Engineering firms and companies that employ professional engineers are no different. When it comes to ensuring a professional, fair and equitable workplace, there are employers who have succeeded, employers with the best of intentions but little result to show for it, and employers who are mired in the past and could care less.

Unfortunately, the cultural conditions that drive women to abandon an engineering career after 10 to 15 years at a far faster rate than men are still widespread in the workplace. Putting out the welcome

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### ***Heeding the Canaries in the Coal Mine***

mat to female graduates accomplishes little if the workplace culture they encounter suffers from the “antigens” cited in the *Athena Factor* and by hundreds of respondents to Engineers Canada’s qualitative survey – antigens that, at the very least, inhibit women from advancing to more senior roles and making as significant a contribution as they could.

What must be done about this? The published literature is surprisingly quiet on the subject. While numerous research reports and studies expound at great length on what must be done to encourage more young women to study science and math in high school and make an informed decision about whether or not to study science, engineering or technology at college or university, little attention, it seems, has been devoted to examining the other end of the problem -- not the *attraction*, but the *retention* of women who are already working in the field.

The *Athena Factor* featured 14 new company initiatives— from Cisco’s “Executive Talent Insertion Program,” which breaks down female isolation, to Johnson & Johnson’s “Crossing the Finish Line,” which helps young female multicultural employees make it into senior management, as examples of positive action to overcome the “antigens” in the workplace and provide women with the support they need to balance family and career and surpass their “fight or flight” moment.

The initiatives profiled in the *Athena Factor* reveal that the underlying issue lies with engrained workplace cultures that must be changed. But a new corporate HR policy or niche program targeted at a select group of employees, will not change the broader negative influencers that persist in the workplace, they will only allow a chosen few to succeed *in spite* of them.

Instead, men and women must work together at *every level* throughout an organization to describe and understand each other’s differences and expand their unique ways of thinking and doing. And when it comes to male-driven corporate and organizational cultures, men must take action against other men. Change must come from within and be driven from the top down by Green Light Leaders who actively solicit, and *listen*, to the creative input of all their employees.

“Because engineers work in teams and we know that diversity can increase creative output, it is important for there to be open lines of communication amongst engineers to keep the profession an attractive and worthwhile pursuit for everyone regardless of gender and/or ethnicity,” concluded the Society of Women Engineers in its 2005 *National Survey About Engineering*.

### ***What all these recommendations have in common***

Simply put, the status quo must change. The negative inertia that sees only marginal progress year after year in the battle to attract and retain more women to engineering and technology careers will not be overcome by yet another report that restates the same old problems in an attractive new cover. Recommendations, no matter how sound, will not effect change, unless they are accompanied by a clear and co-ordinated process that is focused, explicit and driven by strong leadership, *Green Light Leadership*.

This applies equally to changing the curriculum and the career guidance activities at the high school level, changing the “old boys club” mentality on the university campus and changing the toxic male-dominated culture that exists in many workplaces.

But to bring about meaningful organizational change, we need to step out of our comfort zone and stop accepting that “it’s always been this way.” It hasn’t. Change happens all the time. The negative influencers and gender biases that discourage more women from enjoying a rewarding engineering or technology career are weaker than they once were. The challenge is to understand what must be done to make positive change happen faster and on a broader scale. As we explored in Part II: The Consequences of the Status Quo, we can’t afford to tarry.

But making a conscious effort to effect change is the hardest thing to do. It’s much easier to work longer, harder and stronger than it is to work differently. But, as Albert Einstein said, “The definition of insanity is doing the same thing over and over again and expecting different results.”

In parts IV and V we will explore how we respond to change, a process for effective organizational change and the Green Light methodology that can guide the process to a positive outcome.

## **Part IV: The Shaping of a Culture**

### ***Shift from Root Cause to a Vision of Success***

#### ***Focusing on a root cause is important ... up to a point***

We began this project for Engineers Canada by looking at the 2,432 'qualitative' survey responses collected in August 2009 from the question "What would be a perfect future for women engineers?" In our culture as a whole and especially in the engineering and high tech world, there is a tendency to focus on the root cause of a situation with the intention of correcting problems. W. Edwards Deming, one of three pioneers in Total Quality often said of this, "Serves you right!"

Uncovering the root cause is a common practice and a good one, yet it has some serious drawbacks. In the larger picture it detracts a team from focusing on the vision. They can easily get stuck in dealing with problems and more problems. Metaphorically speaking, a focus on a root cause should be used initially to stop the bleeding – in other words, the financial drain. This is a critical point. In the long run, to focus heavily on the root cause is counter-productive to the growth of a team and the profit of a company. Egos get in the way. People become mired in the past with their head down when they need to be looking to the future for expansion and new ideas.

#### ***A new focus is needed***

We learned over many years working with engineers that when they focus on a problem or the source of a problem, they tend to find more problems. A director at the height of Nortel's success noted that, "Engineers are paid to find problems. We have more problems than we can ever solve. Do we really want to keep doing this?" He then asked "How can we get out of this? It's costing us money. How can we turn this tendency around?"

Several groups of Nortel staff learned that the best way to bring about consistent and positive change was to focus on the vision that they wanted to create. When they did this the root cause didn't disappear; it simply took on less importance as the team focused on the vision they wanted to create. As their vision expanded their energy became more positive. They shifted their thinking about how they wanted to proceed. Problems or root causes begin to shrink. The engineering teams watched their collective vision grow. They began to see positive outcomes as they focused on their vision. They worked harder, faster and smarter. Excitement and enthusiasm grew as the team expanded their view of the possible.

#### ***Human beings are creatures of habit***

Shifting from a focus on "root cause" to one of "visioning" takes discipline and new thinking. However, human beings are creatures of habit. They learn something, they like it and soon it becomes the way they want to approach other things. While it's expedient to follow routines, this tendency has implications for how people treat each other in the workplace.

For example, routines are established. Policies are developed. Who is in charge is decided on. Who is not allowed in certain areas is established. How practices should, must and ought to happen become the norm. As these beliefs and practices fall into place a workplace culture emerges. Rules are developed, often unspoken, to make sure things happen “the way they are supposed to” or “the way things have happened to date.” There may be a better way, but the culture is now formed and managers and employees alike tend to want to follow “the way things are.”

### ***Developing a culture happens over time***

Men and women are socialized differently from infancy. As a result they think differently, their behaviour is different from each other, as is the way they talk with each other and the way they approach problems.

Think about this for a minute! Most of you have young children somewhere in your lives. Have you noticed some of these differences between the genders? Beyond the baby’s innate tendencies and character, its personality is being shaped by its environment. Prior to birth, parents, knowing the gender of their baby, buy pink for girls or blue for boys along with other gender-specific clothes and toys. And if parents and relatives don’t treat boys and girls differently, then teachers, bosses, physicians, coaches and many other professionals in our culture do.

You can probably think of many ways you or family members treated your daughters or sons differently just because of their gender. And yes, we know that this is not true for everyone. It is, however, a tendency in our culture. Children grow up through this culture and arrive in adulthood with life long patterns of thinking and doing that are different due to their socialization, education, religion and culture training during their formative years.

### ***We live in multiple cultures***

Every organization, department, family and group has a culture. Developing that culture happens over a lifetime and it’s incorporated during the first weeks of employment in a new job. Engineers have their own culture. Changing the culture from “root cause,” for example, to “visioning” requires new thinking, new learning, new language and ultimately new behaviour.

However, human beings are creatures of habit. They tend to hold on to what they have been taught and have become used to. It’s expedient. They can work faster using a common framework and common language. When they find themselves doing the same things repeatedly in a similar manner they begin to act as if that is “the right way” that this must be done. These practices about the right way to do things become cultural norms and it’s the norms that guide the beliefs and behaviours in a culture, often at a subconscious level. A manager might say to a new recruit “We just do it because this is how it’s done here.”

Cultural norms guide the actions of how that culture treats “outsiders.” Differences of beliefs and behaviours show up that may have nothing to do with what the newcomer believes in. Conflict arises. Those involved in the conflict often have little idea about what’s going on in the mind of the other. Here is where the differences in the socialization and belief systems of men and women show up. While they each may have the same result in mind, how they approach the situation and how they talk with others about the situation is quite different. And who is right? Answer: most often the folks that have grown the culture in the first place are seen to be “right.” If it were a male culture, women would be at a disadvantage. The reverse is also true.

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### ***Heeding the Canaries in the Coal Mine***

### ***Whose culture is it, anyway?***

Engineering has been a male bastion for many years with women being the newcomers. If the tendency for human beings is to lean on their beliefs as true, then the belief that “we have always done this in a certain way” leaves women, who are more recent arrivals, vulnerable in a culture created and perpetuated by men.

Women and men have been socialized to think and to do in different ways. See some of the examples in the qualitative data from Engineer Canada’s 2009 survey. The invisible critic exists. In our culture and often unintentionally, we each make automatic and invisible assumptions that “different” equates to “wrong.”

In engineering, women are the minority. How does this affect their ability to be promoted, to work on choice projects, to be heard? And exactly what would a perfect future for women in engineering look like? How do we envision women and men working together in the future that’s different from today? This is where work needs to be done. It’s called shifting the culture by expanding the cultural mindset. While this is doable, it’s important to remember human beings are creatures of habit and change brings resistance.

## Part V: Putting Theory into Practice

### ***The pyramid, the hierarchical structure of most large companies, isolates.***

It keeps people from speaking with those who can make a difference in the work that must be done on a daily basis. In the hierarchy, there are unwritten rules that say, “I can’t go to my boss’s boss to deal with this,” and yet, that is the person who could be most helpful.

The place to begin is neither with the boss’s boss nor with the boss, but within oneself. The process of change always begins with an ending followed by a new beginning. The leader discovers a new and deeply personal shift in how s/he views the current reality. There is an end to old ways of thinking and a beginning of new thought processes. Our language, and then our behaviour, follows our thinking.

### ***The best leaders are first, and foremost, fully functioning human beings***

A senior engineer challenged this stating, “I leave my personal self at home or in the car when I enter my workplace.” When he finished his explanation we reminded him gently, “Hold on to your chair, Hank. You’re about to discover a whole new concept!”

People have one basic personality, even though they may temper it according to whether they are at work or at home. Taught to suppress feelings in the workplace, they think they are “being different.” However, those who work with them experience one person; the same one who is at home is also at work. If you are prone to think of yourself as a completely different person at home from the one you bring to work, you’re suppressing a rich and living part of yourself. Those around you can see this and it may be dangerous for them to say so.

### ***Putting theory into practice requires engagement at all levels***

This means that effective and lasting change cannot be forced from the top down – it must be embraced by people from all levels of the organization from the outset. *How* change happens is more important than *what* actually happens.

When we talk about “how” we mean “how you the leader include your management and your employees” and “how they, your entire workforce, receives your invitation.” We are talking about the process of how things happen and how people become engaged in a system-wide change.

Let’s take a look at “how” a change in culture often happens in an organization. A new process is about to be introduced or rolled out. It’s identified and initiated by executives at the top. Because it starts at the top with little input from the various lower levels that must implement this process, it’s seen throughout the organization to be owned and driven from the top. Consequently, the passion and ownership for change required to create a sustainable shift in the culture at lower levels is often weak.

### ***Employees and mid-level managers recognize that the power is above them. They find themselves***

***feeling powerless. And how can any individual support meaningful, innovative, productive and cost effective change when they see themselves as powerless in the process?***

The biggest need for change in organizations is **how** change is managed. This cannot be understated. When top management understands the human dynamics of the need for involvement in **how change works**, buy-in for that change increases on the spot. We're talking about **trust**. When employees, all employees, know themselves to be an important part of the process of change, they begin to own the process. Change happens. The need to include people from the beginning is the most important step in any kind of major change. As Frederick Taylor from the auto industry said at the turn of the last century, "It's not the best way. It's the only way."

So the question becomes:

"Where and how do we begin to help people (leaders, managers, subject matter experts, HR and front line professionals and more) throughout an organization understand and adopt methods of including their *entire* workforce in the process from the get go?"

The leader sets the tone and people throughout the organization follow this style. How leaders communicate has the powerful effect of either drawing people toward them or inadvertently pushing them away. And if these leaders unknowingly push people away by their attitude and their language, the team may stay in the presence of that leader but they will leave their passion behind. The dedicated team begins to dissolve and become a team in name only. The leader begins to wonder why s/he is working so hard to have people be productive, innovative and motivated. He or she needs to look in the mirror – the answers are right there.

***If you are the leader, and this could be at any level in your organization, the biggest factor in how to create a positive vision for your company is to change yourself and to change how you are with your people. If you don't have time to do this then by default you have time to fail.***

Where and how does one begin to change a structure and the thinking of a culture so that people work together more effectively and communicate honestly and directly with each other? Our focus here will be on concrete and actionable steps, with an emphasis on the individual leader's responsibility to recognize the impact of his or hers perceptions.

### ***Our thoughts, perceptions and beliefs are the key to all change***

They drive our behavior, and it's these that hold us back and create barriers to progress. It's also our thinking and perception that opens the door for success and advancement. Those of you who have wives, daughters and female friends in your lives have probably noticed that women think, speak and do things differently than their male counterparts. They may use the same processes, yet how they implement and how they work with people is different than their male colleagues.

The qualitative data collected by Engineers Canada in August of 2009 about female professional engineers in the workplace suggests that women are penalized for these differences. Whether or not this is true, we have found that the following steps are crucial in **how** to bring about significant changes in your organizational culture. When integrated they show you **how** to change your culture.

# ***First Steps to bring about whole system organizational change***

## ***I. Tell the truth and start with you***

The work of creating change is simple. Most of us complicate it with our thoughts. It's not unusual that we ask a client leader before beginning the work "Why did you call us to work with your team?" One leader said it perfectly. "We are already a highly effective team and we want greater and different results. We know if we continue working the way we do now, we'll get the same results we always have. How can we change when we are already using our wisdom and our technical knowledge in the best ways we know how?"

He was wise – he knew something different needed to happen with his team. They were ending their individual search for answers and beginning their collective journey. And for that journey, wisdom, not intelligence, was required. The difference would be found in their thinking and in their intention. For this group the task was unusual. While they were about to change their behaviour, they would first address their thinking. They had to look inward, examine their thoughts about their own expectations and suspend their ideas about how things "should, must and ought to happen."

This is a difficult task for technical leaders, many of whom are professional engineers. Steeped in the engineering/high-tech culture, they are trained to find the right answers. Their methods, while state of the art for engineers and scientists, do not apply to the technology of human change. When you start with your own truth you create a level playing field.

## ***II. Find and use Green Light Leaders in your organization***

Green Light Leaders are formal and informal leaders who:

- Are in positions where they are doing well and want to do even better
- Value their people and are responsible for the development of people as a key component of organizational sustainability
- Understand that how people are managed has a huge impact on productivity, innovation, quality, commitment and ultimately on profit
- Are curious about new ways of thinking and leading. They seek creative approaches to sustained change, rather than a quick fix
- Have the courage to challenge cherished beliefs, behaviors and assumptions and to push back when needed
- Lead others, regardless of their level, to be more innovative, productive and profitable

Compare the Green Light Leader to the Yellow and Red Light Leaders. Yellow Light Leaders will wait to see how successful the Green Light Leaders are with implementing change before jumping on board. Red Light Leaders cannot be convinced. They know that the best way is the way things have always been done.

Green Light Leaders are found at *every level* within an organization. Management must work with them to develop their skills and their voice and to invite the ideas of the people around them. Together they will discover how to best implement change. This collaborative process requires the voice of women from day one of the change process.

### ***III. Use management and employees from all levels of your organization who know the culture – they will lead the process of change.***

Your people know how your system operates. They learned about this during the first month that they were on board. They want to and can help to create the changes that will improve productivity, innovation, quality, human interaction and, ultimately, profit.

When you involve your people, politics and power plays diminish. Old cultural patterns and practices fall away in lieu of what is current more applicable. When leaders and their people understand how a system and its people work to keep change from happening, they also begin to see where to start to make change. Change happens.

But the change process is different in every organization. The starting point becomes visible after bringing people together to hear their stories. Hearing people's stories is *very* significant. When their stories change, their behaviors change. At this point the shift in direction has begun.

### ***IV. Use a specialist in human change from outside your system.***

Most organizations are steeped in doing things a certain way, they need "fresh eyes" to proceed. Total Quality pioneer W. Edwards Deming was prone to remind organizational leaders that, "systems cannot see themselves." They need people from inside their organization and from outside their organization – there are no exceptions to this.

The greatest gift here is that an outside specialist doesn't know what can't be done according to the beliefs of your people. An outside specialist brings fresh eyes and will challenge the current behaviours and beliefs. This person isn't vested in protecting sacred cows. In the process of revealing commonly held beliefs and practices, these sacred cows begin to fall away in favour of healthier workplace practices.

This is the magic. This outside specialist spots them, speaks of them and a hush fills the space. Your people begin to question how practices happen; they become open to new ideas; they begin to have the courage to say what they really think needs to happen. And the leaders need to have the courage to listen and ask questions so they understand what's needed, not just what they *think* is needed. It's simple but it's not easy. As a matter of fact it takes a great deal of courage to hear the truth of others when it isn't the norm in your department or organization.

You won't get the benefit of these fresh eyes, or reveal the sacred cows, when you use people who have been part of your organization. They are steeped in the culture and may find it difficult to see and then to challenge the norms and beliefs that exists. Translated, this means that constant attention from outside qualified sources (and from those who "know what's needed" from inside your system) on how to implement whole system change is required to keep an organization moving forward.

### ***V. Learn how your culture really functions and let your people know you're grateful.***

Discover its formal and informal norm. *Every* employee, manager and supplier understands your system through their own perspective. After a few months on the job they know well who are the informal and formal power brokers above and below them. They know the rules (formal and informal), who has more power and how to get things done above and below them. They know how the system works, who to ignore, how to risk breaking rules and who to call on when there is trouble. This means that pockets of power need some light. An outside specialist can shine the light easier than those who are steeped in

the culture. When knowledge is open and power is shared, employees at all levels become more efficient. The system improves.

### ***VI. Personally ask people to be part of the vision you want. Notice it happening.***

Stay clear of problem solving. See Part IV on shifting from root cause to visioning. When your teams begin to shift focus to a vision of success, that vision comes to life. For this reason alone it's critical to shift the focus of change for engineering toward the vision rather than the root cause. Our beliefs, language and actions show up as a result of what we focus on. And what we focus on is what we think about. *Everything starts with our thinking.* There are no exceptions.

## ***Guiding Lights***

For organizations and leaders looking to embark on a process of positive change, there are no shortage of examples to look to for guidance, insight and inspiration – examples in Canada and United States that speak directly to the challenges faced by the engineering profession as well as the broader science, engineering and technology sector.

### ***Achieving Diversity: Strategies that Work***

This report, part of Engineers Canada's larger *Labour Market Study*, profiled 10 examples of positive change in action to help address the challenges faced by the profession to attract, integrate and retain, women as well as other under-represented minorities, such as Aboriginals and skilled immigrants.

### ***Women in Scholarship, Engineering, Science and Technology (WISEST, Alberta)***

This program began in 1982 out of the University of Alberta to help attract, retain and advance women in SET careers. It has since expanded its mandate to include support for other under-represented populations. Its programs include a number of outreach and awareness building activities that begin at the elementary school level and have been replicated elsewhere in Canada.

How did this program begin? In 1982 Dr. Gordin Kaplan, at the time the University of Alberta's Vice President of Research, saw that at a seminar on microprocessors, there was only one woman among the 150 participants. Demonstrating the characteristics of Green Light Leadership, he decided to find out why and to do something about it.

Other meritorious programs profiled in *Achieving Diversity* that focus on the female equation include:

- **Ryerson University's Discover Engineering program**, begun in 1991 by a group called Women in Engineering to offer engineering career information to female high school and university students. Again, the catalyst was a small group of leaders committed to challenging the status quo.
- **Canadian Association for Girls in Science (CAGIS)**, a non-profit dedicated to promoting science, technology, engineering and mathematics interests to girls aged 7-16 with various programs that have consistently focused on being "for girls, by girls." Who was the Green Light Leader, here? Larissa Vingilis-Jarenko, who was only *nine years old* when she founded the non-profit in 1992.
- **Wardrop Engineering**, a Manitoba-based engineering firm with national and international

operations. Wardrop adopted a number of diversity programs out of the sheer necessity of increasing the representation of visible minorities and women on its payroll in order to bid on Government of Canada Industrial Security Program contracts. The company instituted an Employment Equity Committee in 2005 and has increased the participation of visible minorities to now account for one third of core engineering and design staff, with representation at all levels, including the board of directors. Wardrop has come to realize the value of employee engagement and open communication, as well as diversity, to drive company growth and success around the globe.

- **Career Trek**, a registered charity based in Manitoba, strives to “fight poverty through career development.” Social worker Darrell Cole founded the organization in 1996 on the grounds that career fairs are ineffective and only hands-on experience provides young people with the insight they need to make an informed decision about their career path. Career Trek works in partnership with a number of public schools and post-secondary institutions to develop and offer hands-on programs to young people.

### ***The Athena Factor***

This American report that looked at dozens of international companies noted a number of corporate initiatives, some new and unproven, that illustrate steps toward addressing the so called “antigens” it identified in many workplace cultures that discourage women from continuing with a science, engineering or technology career.

The report summarized its findings as follows to demonstrate with real-world examples the kind of actions that must be taken:

- **Expanding recruitment:** Pfizer’s Student Mentoring Program looks to stem losses among science, engineering or technology female graduate students. Google is striving to “widen the filters” to attract top-notch individuals who may not have technical credentials.
- **Targeting line and technical roles:** Alcoa’s WOVEN and Manufacturing Manager Development Program encourage women to stay in line positions. Intel’s Technical Leadership Pipelines Program for Women helps retain female professional engineers and position them for advancement. Cisco’s Global Telepresence Coaching program supports mentoring of key female talent.
- **Tackling the fight-or-flight moment:** Johnson & Johnson’s Crossing the Finish Line helps to promote female multicultural employees to senior management. Microsoft offers a Mentoring Rings program to retain junior women, while IBM offers a Flexible Leave of Absence program.
- **Creating on-ramps:** GE in India has developed Restart, to attract highly qualified science, engineering or technology women who have been out of the workforce for a period of time. Both Johnson & Johnson’s ReConnections program and MIT’s Midcareer Acceleration professional development program attempt to ensure a seamless return to work for SET workers.
- **Fighting isolation:** Cisco’s ETIP/ETAP program attempts to boost the number of senior women at the VP level and above.

### ***What these examples tell us***

All of these examples illustrate the adage that the leadership of a small group, even a single individual, is the only thing that can, and ever has, made a difference. Nonetheless, despite these efforts, the

representation and retention of women in the engineering profession remains problematic. Clearly, much work remains to be done to duplicate such efforts on a scale that will have a more significant, and deeper, impact on the cultures where positive change is needed most to address the attraction and retention conundrum.

And with many of the corporate initiatives cited by the *Athena Factor*, it should be cautioned that there is a distinct difference between efforts to change the dominant workplace culture for the better, as opposed to simply instituting programs that help a small group of individuals advance and succeed in spite of it. To achieve lasting, positive change at every level of an organization, the negative aspects of the dominant culture must be addressed in a holistic fashion. For, as the Society of Women Engineers' Betty Shanahan said in Part I, "There are a spectrum of barriers that are insidious because they are based on unconscious biases by both men and women. They are so engrained in the majority culture – you fix one piece, but that's not enough."

## In Conclusion

*Women engineers, it could be said, are akin to canaries in the coal mine; their plight warns of a greater threat that extends far beyond the immediate and obvious issue of equity and fair play in the workplace.*

### ***In summary***

In the course of this paper, we have explored the challenges faced by the engineering profession, as well as the broader science, engineering and technology sector, to attract and retain women. Citing extensive third-party research, we articulated the root causes that discourage women from pursuing engineering at college and university or from remaining in the profession after a certain number of years in the workforce.

In reviewing this volume of research, and heeding the warning cries found in Engineers Canada's qualitative survey from the summer of 2009, we identified a number of negative influencers that point to broader issues within institutional and workplace cultures that can be off-putting, even toxic, to women, other under-represented groups and even to men eager for work-life balance and concerned about a lack of workplace diversity and equality.

Against the backdrop of this status quo, we painted the perfect storm that is brewing on the horizon – a storm that demands Canada and other industrialized nations make the most of their labour pools to drive innovation if they want to remain relevant and competitive on a 21<sup>st</sup> century global stage. Faced with a fierce global competition for talent and impending labour shortages driven by the retirement of the baby boomer generation, declining birthrates and a shrinking cohort of young people to enroll in post-secondary studies, the poorly tapped female labour pool, more than any other under-represented group, offers Canada's engineering profession the human capital it needs to drive Canada's innovation agenda.

But if the ingrained status quo – whether it be defined by poor guidance and outreach at the high school level, gender biased campus cultures and curricula at the post-secondary level, or male-driven mindsets in the workplace – discourages women from pursuing or continuing with an engineering career, what hope is there?

Fortunately, the case studies cited by *Achieving Diversity: Strategies that Work* and the *Athena Factor* report demonstrate there is a will and a desire to change. There are Green Light Leaders who will not settle for the old excuse that “this is the way things are” and will fight to bring such counter-productive complacency to heel.

The challenge is to understand, recognize, and leverage Green Light Leadership to effect the positive change that will see “the way things are” become “the way things should be” at every level – from how young girls are introduced to engineering and science, to when a 35-year-old female engineer faces that

“fight or flight” moment, to quote the *Athena Factor*, trying to balance the demands of work and family with personal aspiration.

It also bears stating that women in the profession have a critical role to play. They must speak out against the obstacles that exist in the academic and workplace settings and provide the leadership and inspiration for the younger women who will follow. Female professional engineers can make a difference to drive change and overcome the barriers and stereotypes that discourage others by refusing to accept the status quo.

Drawing on the philosophies and methodologies of the LeaderSHIFT© Practicum developed by the Calnan Group, we applied the principles of planned organizational change to understand how change happens, how it must begin and how to find the Green Light Leader who will drive it forward.

### ***Where do we go from here?***

Of course, effecting positive change can only happen when there is a *desire* for change. Engineers Canada has started the ball rolling by casting a spotlight on the issue and soliciting the input of external experts who possess some part of the answer. Now it is up to industry as a whole to embrace the idea that a long-term, collaborative effort is required among *all* stakeholders, from public school boards, to post-secondary faculty, employers and others who are committed to furthering Canada’s innovation agenda.

As noted at the end of Part V, there has been no shortage of initiatives undertaken to draw women toward the engineering profession and help them achieve career success. However, few have tackled the daunting task of changing an *entire* workplace culture that we know drives women to quit the profession and creates barriers for other under-represented groups.

So where to begin? The next step is twofold.

### ***The First Step***

Engineers Canada must instigate the process of culture change in the workplace and set the example by progressing from defining the *what* to demonstrating the *how*. It can do this by inviting a group of about 30 women and men from across Canada (three each from 10 different organizations), who are already steeped in the engineering culture, to attend a culture change program in Ottawa through Engineers Canada. These must be people who fit the profile of a Green Light Leader and want to work collaboratively, share knowledge, communicate effectively and grow professionally to effect real and positive change in their organizations. This first group must have a majority of women.

The culture change process works best when participants represent various levels within an organization (within a department or directorate, for example), rather than just peers at the same level. This fosters the cross-level communication that is so vital to sustainable change.

The return on investment of this process can be significant. However, we all know that new learning, unless it is implemented immediately, is often wasted because people return to their overloaded desks and get sidetracked from their intentions to change. And change takes time. There is no such thing as a quick fix for creating and managing change. To be effective, this culture change program requires a commitment over several months, reinforced with facilitated learning

sessions in the form of small, common-interest group interactions and individual coaching, focused on implementation.

Once this first group has completed the program through Engineers Canada and begun to plant and implement the process of change within their individual organizations, it will be time to support their efforts by bringing the culture change program from Engineers Canada into their workplace. This will help them to expand and entrench the process among a large number of co-workers. These Green Light Leaders are invited to be heavily involved in the process of changing their organization's culture, to help guide it and pass on what they have learned to their colleagues. In this way we begin to build a viral community of people committed to positive change who share knowledge and develop and exchange best practices that can be replicated and applied across their organization and elsewhere.

### ***The Second Step***

"We have had clear indications from women in engineering that the culture of the profession is unwelcoming to them, and in some cases it can be hostile," said Marie Carter, chief operating officer of Engineers Canada. "This culture is, to a large extent, learned in university during the undergraduate degree program. Frosh week activities and ongoing pressure to develop particular attitudes contribute greatly toward reinforcing the unwelcoming culture. It is imperative that the engineering faculties take this problem seriously and work toward effecting positive change."

But how? The same program described above to effect culture change in the workplace can be applied in the academic setting. It begins with one post-secondary engineering department that can serve as the trailblazer – a department where there is a dean who fits the profile of Green Light Leader. This individual is one who is looking for change, a pacesetter passionate about leading the charge and willing to take the flack, especially from the Red Light Leaders who resist change and cling to the status quo.

For the academic program, the first group should include mainly Green Light Leaders from among faculty and students of every year, perhaps too, a Yellow Light Leader who embodies some of the status quo and the sacred cows that must be overcome. In addition, this program should be a collaborative effort with the businesses with which engineering students typically undertake internships.

It is recommended that Engineers Canada actively seek out and work with a Green Light Dean at a Canadian university school of engineering to create a model program that can be duplicated at other institutions.

The bottom line is this – there is no shortage of evidence that female professional engineers leave the profession at a greater rate than men. On the other hand, there are a multitude of excellent programs intended to help girls and young women make informed decisions and choose engineering on the expectation of a rewarding career that will allow them to make a difference. The next step is to ensure that what these young women encounter in the classroom and the office fulfills their expectations and supports their personal and career development. This requires a change in culture in both the university and in the workplace. It needs to start small and mushroom. Engineers Canada is in an excellent position to start the process and be the catalyst for change.