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Improving the Working Climate in the Faculty of Science at UBC

Rachel Kuske, Carola Hibsch-Jetter, Simon Peacock and Anne Condon

Abstract

In 2005, an advisory committee was struck to assess the working climate for Science faculty at the University of British Columbia (UBC), with an initial focus on concerns raised by women faculty. This study carefully analyzed both institutional and survey data. It was supported by the Faculty of Science, the Provost and the Vice President, Research, and led by UBC mathematics professor Rachel Kuske. The study found that, while faculty overall reported a general sense of fair treatment and collegiality, several concerns were raised by female faculty about the lack of professional support, issues of workplace equity, and career development needs. In areas where clear policies were applied, such as salaries, there were limited differences by gender. In contrast, significant gender differences were observed, where the data suggested a lack of transparent and equitable procedures and policies. These included differences in time to promotion, in amounts of retention funding, and in awards.

The Dean's Office of the Faculty of Science (FoS) has already acted on several recommendations, but there is much work ahead. Key components of the plan for change will include: new recruiting practices to increase faculty diversity, with oversight by the Dean's office; better support for partner accommodation; policy development and documentation including policies on research support during maternity/parental leave and teaching reductions; better support for mentoring and career feedback; and mechanisms to increase equity in retention, awards and support of leadership.

Following an overview of efforts for institutional change at North American institutions, this paper will report on the findings of the Working Climate Assessment for Science Faculty at UBC, and on progress to date in implementing the recommendations.

Introduction: efforts for institutional change at US American and Canadian institutions

US. Longitudinal data on US PhD production, such as the National Analysis of Diversity[i] on US trends in science and engineering for both women and minorities, show that the slow progress in increasing the representation of underrepresented groups in faculty positions is not just a “pipeline issue” that may correct itself as soon as more science students receive their doctoral degree. A European Molecular Biology Organization (EMBO) study[ii] of women in the biomedical sciences also shows a sharp decrease in the percentage of women from postdoctoral to tenure-track positions. Explanatory factors suggested by the EMBO survey data included family demands, spousal employment status and confidence in obtaining a position. Other studies such as the Do Babies Matter

project[iii] and the Gender Equity project[iv] provide more insight on the challenges faced by women who pursue academic careers.

Several institutions are now working hard to turn these trends around. A landmark report by Nancy Hopkins et al. on the status of women faculty at the Massachusetts Institute of Technology (MIT)[v], together with unusual effort by MIT Dean of Science Robert Birgeneau, led to gains in the percentage of women hired between 1996 and 2000. Elsewhere in the US, a major catalyst of change has been the Advance program[vi], funded by the National Science Foundation. Additionally, the Sloan Foundation has provided significant funding to institutions that are leaders in working towards faculty equity, providing support for UC Berkeley's Faculty Family Friendly Edge[vii] project and University of Washington's Balance@UW[viii] project.

Canada. The Association of Universities and Colleges of Canada's (AUCC's) Trends in Higher Education[ix], as well as Drakich and Stewart's *Academic Matters* article[x], provide historical perspective on the slowly increasing percentage of women in faculty positions at Canadian institutions. By 2006, women accounted for one on three faculty positions, but there are significant differences by discipline, with women filling only 20% of the positions in mathematics and the physical sciences. Unfortunately, data on the number of visible minorities, Aboriginal people, and people with disabilities in the academy is not gathered by Statistics Canada, and so not addressed in these reports.

There have been valuable efforts to help recruit and retain more women in Canadian institutions. NSERC's University Faculty Awards (UFA) program has (partially) funded faculty positions for women and aboriginal researchers in Science and Engineering at Canadian research institutions. Unfortunately, 2007/08 is the last year of this program. A significant advantage of many Canadian institutions, compared with many US institutions, is the availability of paid maternity and parental leave for faculty, and extension of the tenure clock. Some studies at other Canadian institutions, such as that at the University of Calgary[xi], document the status of women faculty and strategies for follow-up have been planned. The University of Toronto has recently completed an Employee Experience Speaking UP survey[xii]; their Family Care Office (see at www.familycare.utoronto.ca) has earned recognition (www.news.utoronto.ca/bin6/061130-2782.asp) for its family-friendly policies. The University of Alberta's Project Catalyst[xiii] aims to "increase the diversity, especially the percentage of women, in faculty positions in the Faculty of Science."

Compared with programs to recruit and retain women, institutional programs with focused attention on recruitment and retention of other underrepresented groups in science are difficult to find, although professional organizations, such as the Canadian Aboriginal Science and Technology Society (www.casts.ca) provide resources and support for networking among minority graduate students and faculty.

UBC. At UBC, attention to and progress on increasing the representation of women on the faculty has been sporadic. Early studies by Day[xiv] and Ledwig-Rigby[xv] provided valuable data on the representation of women faculty (showing, for example, that the

number of female full professors in FoS had doubled – increased from 2 to 4 – in twenty years, from 1973 to 1993), and recommendations for change. In the 1990's, under the leadership of Sharon Kahn, Associate Vice President, Equity Office, FoS Deans Barry McBride and Maria Klawe, and Associate Dean Judy Myers, FoS departments developed hiring plans that addressed diversity goals, and progress was made in increasing the representation of women faculty.

The period of 2003 to 2007 was a time of significant faculty hiring for FoS – and a time of significant turnover in the Dean's office. Women comprised about 16% of the total faculty hired, significantly less than the percentage of female doctoral graduates from Canadian and US institutions. (For example, AUCC's Trends in Higher Education[xvi] shows that the share of women doctoral graduates from Canadian institutions between 2002 and 2004 was over 20% in each scientific discipline and much larger in some, being over 40% in the biological sciences. Donna Nelson's US data are comparable.) In contrast, University of Washington's Advance program reports that 25% of the faculty hires in Science *and* Engineering were women, over roughly the same period; similar gains in hiring were reported by other Advance institutions. At Arizona State University, under the leadership of Divisional Dean Simon Peacock in 2005/06, 43% (21 of 49) of faculty hires in the Natural Sciences and Mathematics were women, and 26% (13 of 49) were minorities. Another cause for concern, given the impending termination of NSERC's UFA program, is that 13 of the 35 women, who were hired as assistant or associate professors since 2000 and are still at UBC, were hired through the UFA program.

Following table shows that the percentages of women, visible minorities, Aboriginal people, and people with disabilities, who were tenure-track faculty in FoS, were all below the respective percentages in the Canadian Labour Force (source: UBC Equity Annual Report[xvii]).

Designated group	**Women**	**Visible minorities**	**Aboriginal people**	**People with disabilities**
Tenure-track faculty at UBC Science (as of May 2006)	19%	10%	<1%	4%
Canadian Labour Force (as of last available census, 2001)	47%	13%	2.5%	5%

Working climate study at UBC's FoS: survey and data collection

In 2005, an advisory committee was struck to assess the working climate for Science faculty at UBC, with an initial focus on concerns raised by women faculty. The study was led by Rachel Kuske (UBC department of Mathematics) and included a faculty survey, a department heads questionnaire[xviii], and collection of quantitative data from various administrative units across the campus. Focus groups were added to provide context for the data collected and to allow for more detailed responses to faculty concerns and issues.

All tenured/tenure-track full-time Science faculty members appointed before July 2005, including instructors, senior instructors, assistant professors, associate professors, and full professors, as well as 119 professors emeriti were asked to complete the on-line survey.

Complementary to the survey results, quantitative data sets were collected by the FoS Dean's Office – with the exception of the data on tenure and promotion of faculty cohorts in FoS and UBC, which were provided courtesy of the UBC Equity Office.

Survey results
A total of 129 completed surveys were returned and used in the faculty survey data analysis, giving response rates of 35% (125 out of 360) for tenured/tenure-track, 3% (4 out of 119) for emeriti, and 27% overall (129 out of 479). Table below shows response rates by gender and rank in comparison to total FoS tenured/tenure-track faculty composition.

	Female faculty	**Male faculty**		**Assistant professors**	**Associate professors**	**Full professors**	**Instructors**
Respondent composition	22%	78%		21%	24%	49%	6%
FoS faculty composition	18%	82%		21%	25%	44%	10%

The Heads Survey was completed separately by each of the nine department heads within the Faculty of Science (Botany, Chemistry, Computer Science, Earth & Ocean Sciences, Mathematics, Microbiology & Immunology, Physics & Astronomy, Statistics, and Zoology).

Of the 44 Focus Group participants, 40% were female and 60% were male. By rank, they were 45% full professors, 23% associate professors, 16% assistant professors, and 16% instructors.

In addition to results based on total respondents, group differences in terms of departmental grouping, gender, rank and years from obtaining PhD were investigated. The departmental groups included the Life Sciences (LS: Botany, Microbiology & Immunology, Zoology), Physical Sciences (PS: Chemistry, Earth & Ocean Sciences, Physics) and Mathematical and Computer Sciences (MCS: Computer Science, Mathematics, Statistics).

Main findings[xix] from the various sources of the assessment were reported by the following topics: resources, tenure/promotion/leadership, hiring, salary/retention, departmental climate/harassment, teaching/mentoring and work–life balance.

Resources. Faculty members were asked to rate their current access to six areas of departmental support and their perception of fairness in the allocation of those resources in their departments. The six areas included technical support, lab equipment, lab space, clerical/administrative assistance, teaching assistants (TAs), and internal special funds (not from start-up funding).

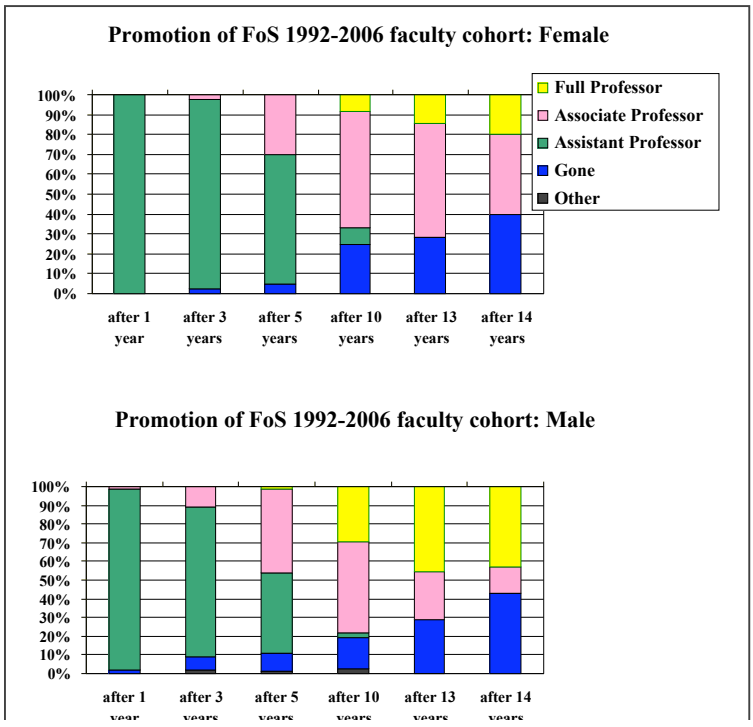
The respondents reported the least amount of support in internal special funds, with only 3% indicating "a lot of access." Most support was reported in lab space and TAs, with 44% and 45% reporting "a lot of access" respectively. Overall perceived fairness was reported the lowest in allocation of special internal funds among the six resources. Male respondents perceived significantly higher levels of fairness in allocation of technical support, clerical/administrative assistance and TAs than female respondents.

MCS faculty members responded more positively than PS and LS faculty members in rating fairness for allocation of resources, technical support, lab equipment and lab space. MCS faculty ratings of fairness in allocation of internal special funds were significantly higher than both PS and LS. There was no significant difference among the three groups in perception of fairness in TA allocation.

Focus Groups noted a perceived gender-based inequity in the way resources were allocated. Their responses highlighted the non-trickle-down and non-transparent use of discretionary funds and noted the challenges of limited administrative and infrastructure support at all levels. Focus Group participants also recommended that the FoS and departments both develop transparent processes/policies for resource allocation and administration cost coverage, and centralize and streamline resource access.

Department heads were asked whether they had a departmental formula on assignment of, or access to, technician support and TAs and, if so, to provide a copy of the formula. One out of the nine departments had a formula on assignment of, or access to, technician support per faculty member. Three departments responded that this question was not applicable to them. Five departments indicated that they did not have a formula. All but one head reported that they had a departmental formula on the assignment of, or access to, TAs per course. Most formulae were based on the number of students enrolled in a course and whether the course had a lab or tutorial.

Tenure, promotion and leadership. Comparison of promotion rates for assistant professor cohorts at UBC and FoS hired between 1992 and 2006 (see figure below for FoS) suggests that there was not much difference in the overall rate of promotion to associate professors for men and women at UBC, but that there was a difference in FoS. Five years after being hired, 31% of women and 33% of men in the UBC cohort were promoted to associate professors, whereas 30% of women and 45% of



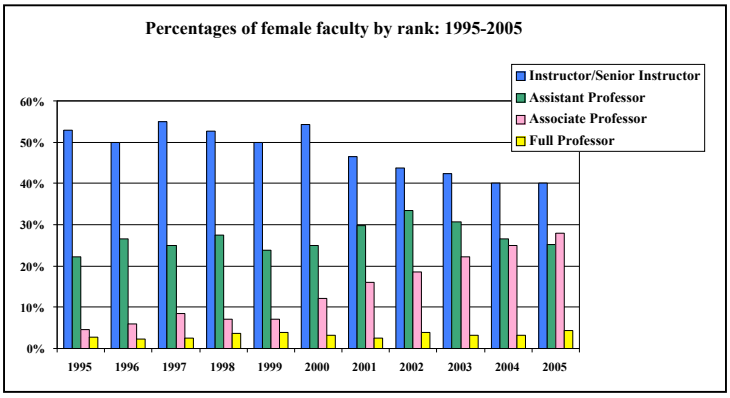
men in the FoS cohort reached associate professor rank. Seven years after being hired, the inequality became greater: 40% of women and 61% of men in the FoS cohort were promoted to associate professors, whereas 51% of both men and women in the UBC cohort became associate professors. When excluding those faculty members who had left UBC or FoS from the calculation, the inequality grew wider: 43% of women and 73% of men in the FoS cohort were promoted to associate professors seven years after they were hired.

Overall at UBC, women were not promoted to full professors as quickly as men. At its largest, a gap of 16% existed between men and women who had become full professors 12 and 14 years after being hired by UBC. In FoS, promotion to full professors came sooner than the UBC average, but women still lagged behind: the largest gap occurred 13 years after being hired: 14% of women and 46% of men in the FoS cohort were promoted to full professors at that stage.

When asked to rate fairness in tenure and promotion policies/procedures in the last five years, faculty members primarily gave a positive response, with full professors reporting a significantly more positive perception of fairness than assistant professors. For 7% of all faculty respondents the policies/procedures were not (quite) clear. In the Focus Groups, both women and men expressed dismay at the lack of clarity as to the tenure review process, with additional comments citing lack of mentors or role models as negatively impacting promotion.

Department heads were asked for their opinions regarding the major hindrances to career advancement that had disproportionately affected women faculty members in their departments over the last five years. Three out of the nine departments reported that women's continued role as the primary caregiver to children, parental leave and higher administrative workload for some female faculty members were found to impact female faculty more than male faculty.

When asked how much time they had spent on committees (or other service) that benefited their careers in the last five years, relative to their departmental peers, a significantly larger proportion of the male faculty respondents (26%) than that of the female respondents (14%) reported more time on beneficial committees/services. Yet, Focus Group participants emphasized the importance of having women represented on committees to help create mechanisms that ensure equity in hiring and nomination decisions. Federal funding agencies and UBC often require one or two women on grant review committees to ensure fairness and compliance with employment equity or anti-discrimination laws. This requirement, however, puts an extra demand on women.



From 1995 to 2005, the percentage of total female faculty increased from 10% to 19%. The proportion of female associate professors in all associate professors increased

steadily from 5% in 1995 to 28% in 2005. In the meantime, the percentages of female full professors in all full professors remained almost static, ranging from 2% to 4% (see figure on the left).

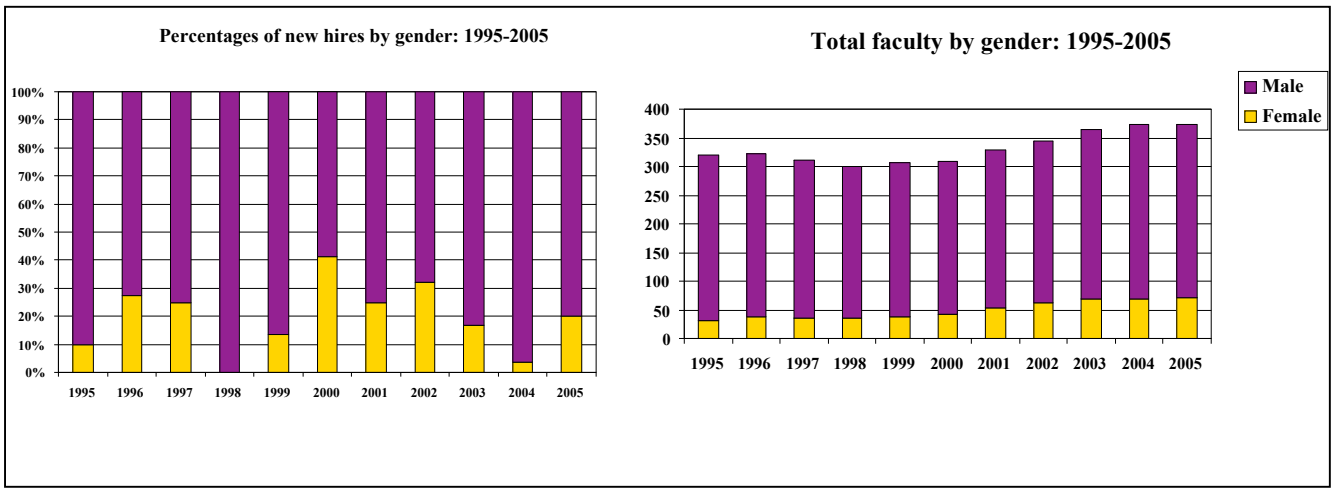
The reasons of the low percentages of senior female faculty members are not yet fully understood. In part, this might be explained by a proportionally smaller number of young female scientists earlier on ("pipeline" problem) and/or a lack of efforts to retain senior female faculty. The low numbers may also be related to the very low proportion of females holding a senior administration position (few senior women available for these positions) and the relatively low percentages of female award winners (depending on seniority requirements and process). It may as well be related to females spending less time than males on committees benefiting their careers (see above) depending on whether appointment to these committees correlates with seniority.

From 1996 to 2006, female faculty members in FoS have won 8% of the five key research and teaching awards at UBC, while the proportion of female faculty in FoS increased from 11% in 1996 to 19% in 2005. Data on CIAR, CIHR and NSERC grant winners and success rates of grant applications over a multi-year period were not available.

Hiring. The extent of clarity of policies and procedures for faculty recruitment and hiring in the various departments was reported as "very clear" by 37% and "very unclear" or "ad hoc" by 4% of all faculty respondents. However, there were significant gender differences, with a perception of "very clear" by 24% of the female and 41% of the male respondents; a total of 10% females indicated "very unclear" or "ad hoc," whereas 3% of males reported "very unclear."

In response to the statement that the hiring and search policies at their departments served to increase diversity, 24% of all faculty respondents agreed "strongly" and 49% agreed "somewhat." Overall, 52% and 46% of the respondents perceived "a lot of effort" and "some effort" on the part of their departments to recruit women faculty. In both questions, a significantly higher percentage of male respondents agreed that departmental policies increase diversity and that efforts are made to recruit female faculty.

From 1996 to 2005, the percentage of female master's students at FoS dropped from 45% to 39%, while female PhD student enrolment increased from 27% to 34% (peaking in 2003 with 37%). At the same time, there was also a trend of increase in the proportion of female postdoctoral fellows in all FoS departmental groupings, with an increase from 20% to 47% in LS, from 13% to 23% (with a peak of 33% in 2001) in PS and from 7% to 28% in MCS (with a peak of 31% in 2001). Shown below are the percentages of female and male faculty hired and the female–male proportions of total faculty per year in FoS, for time period of 1995 to 2005. The average percentage of female new faculty hires at FoS over that period was 20%. Assistant professors constituted over half (ranging from 50% to 88%) of the new hires each year.



Salary and retention. When asked to rate their salary compared to peers in their departments in the last five years, 54% of all faculty respondents perceived their salary as "average," 25% as "below average" and 21% as "above average." Faculty in MCS reported significantly more positively about their salary than PS.

When comparing the average salaries of male and female faculty members by rank and departmental grouping (for 2004), the percentage of the average salaries of their respective departmental group and rank was insignificantly different between female and male faculty. For some departmental group and rank the female average salary was higher than the male, for some about equal and for some lower.

Over the period from 1998 to 2005, the percentages of female faculty members having received retention funding ranged from 0% (in 2004/05) to 17% (in 2002/03 and 2005/06). On average, females received $2,975 less than males. The annual average difference ranged from $739 (in 2005/06) to $7,441 (in 2004/05).

When asked to indicate whether they had ever sought outside positions since joining UBC, 31% of the total respondents reported "yes," with 36% males and 14% females reporting having ever sought outside positions. Low salary was a reason mentioned most often by male respondents. Other repeated reasons were heavy teaching loads, lack of opportunities for career advancement, lack of resources (funding, technical support), departmental climate (inadequate engagement with the university), and the "two body" problem. Female respondents also reported financial issues (salary- and research-wise), teaching loads, department support, unfair prejudice by university administration against work, difficulty in career advancement due to gender and scientific specialization that was different from senior department members, and intentions to be closer to family and go back to their home country.

In the Focus Groups, the cost of housing arose as an issue for retention.

Departmental Climate, Discrimination and Harassment. Faculty members were asked to rate various aspects of departmental climate, which were described by a battery of 11

"polar" adjectives placed on a four-point sliding scale. In nine out of the 11 areas, 75% or more of the respondents reported on the positive side of the scale. Lower than the others were the responses in favour of "diverse" versus "homogeneous" (71%) and those in favour of "collaborative" versus "individualistic" (59%).

Significant differences by departmental grouping were found in seven out of the 11 areas. PS respondents reported a significantly less "diverse" climate than LS respondents and a significantly less "non-sexist" and "supportive" climate than MCS respondents. PS respondents also perceived a significantly less "respectful," "cooperative," "flexible" and "promotes self-confidence" climate than both LS and MCS respondents.

Male respondents agreed more positively (42%) with statement that diversity was often addressed in departmental reviews, versus 25% female respondents agreeing. A significantly higher proportion of the female respondents (36%) "strongly disagreed" as compared to that of the males (15%).

Faculty members were asked to indicate whether they had perceived any discrimination in nine job-related areas within the past five years on the basis of ethnicity, gender, sexual orientation, physical disability, religious affiliation, and age. Between 88% and 94% of the respondents did not perceive discrimination of any kind in access to administrative staff, graduate student and teaching assistant assignments, tenure or promotion, and mentor availability. However, discriminations were reported in the areas of salary, space/equipment/resources, hiring, and leadership opportunities. Reported salary- and leadership-related discriminations were most highly based on gender and resources- and hiring-related discriminations were most highly based on age or a combination of these factors. Across all nine job-related areas, a greater percentage of males than females reported no discrimination.

When asked about their perceptions of harassment in their departments in the past five years, the vast majority of the faculty respondents "somewhat" (27%) or "strongly" (64%) agreed that cases of harassment were rarely experienced, and that reporting harassment was encouraged (60% and 25%, respectively). A majority of respondents "somewhat" (29%) or "strongly" (37%) agreed that cases of harassment were rarely reported. A higher percentage of females than that of males had experienced harassment at UBC, and this was true in both reported and non-reported cases (some respondents may have reported personal harassment, which is not covered by the BC Human Rights Code). Three out of the nine department heads indicated that harassment cases had been reported in the past five years.

Teaching and mentoring. When asked about their teaching loads compared to peers in their departments in the past five years, 68% of the total respondents reported that their teaching loads were "average," 12% indicated "below average" and 19% "above average." Two-thirds of the total respondents indicated that they "always" had reasonable teaching assignments. Perceptions of having reasonable teaching assignments and of fairness in teaching load distribution differed significantly among departmental groupings. MCS respondents perceived having had reasonable teaching assignments

significantly more often than their PS counterparts and rated distribution of teaching loads as significantly fairer than both PS and LS respondents.

The department heads provided percentages of teaching release for administrative service, research or non-administration reasons, and gender for each faculty member who had received releases for more than five of the past 10 years. All the recipients of these releases were male. Focus Group participants reported a lack of transparency on buy-out policies and on decision-making in teaching load allocation.

When asked how the sabbatical leave policy was communicated to faculty, two of the nine department heads responded with "not applicable." One of the departments reported that, each year, eligible faculty members were contacted and provided with a copy of the UBC policy and a checklist of things that would go with their applications. The other departments did not address the question directly, but several of them suggested that faculty members initiated the process.

When asked whether there was a mentoring program/policy in their departments and, if so, to provide a written mentoring policy, all but one department head reported that they had a mentoring policy; however, only five departments attached their mentoring policy to the survey. The provided policies varied in substance and clarity. Faculty were also asked whether their department had a formal mentoring program/policy: 62% of the total respondents reported "yes" and 38% indicated either "don't know" or "no" to this question.

A significantly higher percentage of female respondents than that of males reported having received "some" or "a lot" of mentoring in the areas of teaching, supervising graduate students, and balancing work and family. A higher percentage of female respondents than that of males were dissatisfied with the amount and quality of both informal and formal mentoring provided to them. Males reported having "mentors available but not needed" more frequently than females on all types of mentoring.

Work–Life Balance. Overall, 66% of the faculty respondents (85 out of 129) reported having children; with 52% of females and 70% of males having children. When asked to what degree career considerations had affected their decisions around having children, a significantly higher percentage of females (38%) than that of males (11%) reported that career considerations affected their decisions "a lot." Also, a significantly higher percentage of assistant professors (42%) than that of full professors (13%) reported that career considerations had affected their decisions about having children "a lot." In the Focus Groups, women reported having made conscious choices to put their careers or family on hold. An observation of one department reported 14 out of 15 women were junior tenure-track appointments with no children.

When asked whether they had taken maternity/parental leave, a significantly higher percentage of females (53%) than that of males (11%) reported having taken parental leave (in the previous five years). The length of the most recent family leave for the female respondents was typically four to seven months, whereas the leave for the male

respondents was typically one to three months. While taking the leave, 31% and 38% spent "a lot of the time" on research and graduate student supervision, respectively; 63%, 56% and 44% spent "some time" on administration, research, and graduate student supervision; and 94% spent no time on teaching (total of 16 respondents). In the Focus Groups, it was recognized that while women and men both shared family responsibilities, the societal expectation placed a greater burden on women.

None of the department heads reported having any other policy than UBC policy on maternity/paternity leave. Eight out of the nine heads reported that their departments made efforts to avoid conflicts between departmental events and child care/family care/elder care responsibilities. Seven heads reported procedures that were perceived as helpful in avoiding such conflicts. When asked how many times, in general, departmental events were scheduled to accommodate family care responsibilities, 27% and 31% of the faculty respondents indicated "all the time" and "several times" respectively.

When asked how much effort their department and UBC had made in assisting to find a faculty position or university appointment for their partner, 48% and 13% (out of 40 faculty respondents) indicated that "a lot of effort" and "some effort," respectively, had been made. When asked about extent of assistance to find suitable employment for their partners anywhere in Vancouver, 24% of the respondents relevant to this question perceived "a lot of effort" and 13% indicated "some effort." Of those 89 respondents to whom the question was not applicable, 88% reported that their partners did not need assistance from UBC. Eight out of the nine department heads reported that they assisted candidates/new hires in their departments in finding suitable employment anywhere in Vancouver for their partners. Some department heads were not aware that some university resources were already available.

A higher percentage of male faculty respondents (21%) than female (3%) reported that their partners were not currently employed. A higher percentage of females (62%) than males (51%) indicated that their partners were employed full-time.

Recommendations based on study

The Task Force chaired by Patricia Vertinsky, professor in the UBC Faculty of Education (School of Human Kinetics)[xx], strongly recommended an oversight body to be established in the Faculty of Science with appropriate administrative support to work with the Dean of Science to address the preceding findings. Such a body should consist of representatives from all departments and be led by an Associate Dean of Faculty Affairs, a new position with both a mandate and resources to support the wide range of concerns for Science faculty, from recruitment throughout their career at UBC. Specifically, this body will

- Develop transparent and equitable procedures and policies for hiring, promotion, retention, awards and merit reviews.
- Promote effective leadership and establish effective mentoring programs to maximize faculty potential.
- Review resource distribution in the Faculty of Science and make this knowledge available to faculty members; assist departments in developing clear, equitable allocation schemes for their resources; streamline ways to share resources and provide a centralized infrastructure and administration for appropriate services.
- Work closely with the UBC administration to promote a more supportive environment for work/life balance, with a focus on childcare facilities, financial assistance for rising housing costs, and leave and retirement options.

Plans for implementation of the recommendations

Immediately following release of the report, the dean of the Faculty of Science Simon Peacock expressed his strong commitment to share its findings with faculty members and to go by the recommendations. Effective July 1, 2007, Anne Condon (UBC Computer Science) had agreed to serve as the new Associate Dean, Faculty Affairs and Strategic Initiatives. The goals for this new position are to provide much needed focus on faculty issues across the sciences (and UBC), including faculty recruitment, retention, mentoring, diversity, career advancement, and policies and procedures.

A Faculty Affairs committee including representatives from all nine Science departments has been established. The members of this group are working together with the dean and associate dean and department heads to develop strategies for addressing the recommendations of the assessment. Carola Hibsch-Jetter, Director of Communications and Special Projects in the FoS Dean's office, will play a lead role in executing and evaluating the resulting strategies.

Early on, we realized that, while it was important to ensure that our efforts aim to increase the representation of women on our faculty and to provide a supportive work environment for women, it was also important to broaden the scope of our efforts. A diverse faculty signals that the academy draws from the best talent available, that our students get a well-rounded education, that our research programs are informed by diverse perspectives, and that there is equitable access to the rewards of an academic career. Supporting a diverse faculty means that we must consider not only the issues facing women, but also those facing visible minorities, Aboriginal people, people with disabilities, sexual minorities, and other invisible minority groups. We must ensure that all of our faculty, regardless of background (such as class, country of origin, or religion) are comfortable in expressing their viewpoints, are supported in doing their best work, and know that their accomplishments are valued.

Strategies for achieving these goals have been proposed in "Towards a Diverse Faculty of Science at UBC Vancouver[xxi]." This draft plan has recently been posted, inviting comments by the UBC Science community. Led by Ana Mari Cauce, Executive Vice

Provost and incoming Dean of Arts and Sciences at the University of Washington, and Angela Hildyard, Vice President, Human Resources and Equity, University of Toronto, an external review of the plan has been conducted this March. A written report will be provided to the Faculty of Science. Comments received from our faculty as well as those provided by the reviewers will inform our final plan. Indeed, feedback to date has already made it clear that the current draft needs to go further in acknowledging the many dimensions of a diverse faculty. Until these dimensions are acknowledged, invisible minorities remain just that – invisible – precluding any hope of addressing the issues they may face.

This spring, we started a series of leadership workshops involving department heads and Faculty Affairs committee members, which aim at developing equitable policies for faculty in the various Science departments. Workshop topics to date have focused on ways to support research faculty during maternity and parental leaves, as well as practices pertaining to teaching reduction for individual faculty. In future workshops we will continue to share current practices and to facilitate documentation of these practices, covering topics such as recruiting practices, merit review, awards nominations, space allocation and support for work/life balance within departments.

We recognize the importance of mentorship for faculty at the pre- and post-tenure level. The diversifying plan proposes to strengthen departmental one-on-one mentoring for junior faculty – by ensuring that heads, mentors, and mentees understand the role of mentors, establishing periodic check-in with junior faculty on mentor assignment, assessing whether junior faculty are satisfied with the level of mentoring they are receiving, supporting mentors in their roles and providing on-line documentation of current mentoring practices. We will also work with department heads to develop practices for providing timely career feedback to post-tenure associate professors.

The mentoring support and leadership workshops will address ways to foster a positive climate and to recognize and reward the diverse and often non-traditional contributions of our faculty members. We propose to complement these workshops with peer-led discussions and/or workshops in departments, on topics such as good practices pertaining to hiring, practical tips in minimizing the likelihood of sexual harassment or handling such incidents when they occur, and neutralizing the effects of implicit bias. We also plan to develop short guidelines/checklists for heads and faculty on these topics – availing of expertise on campus, at the Equity office and the Centre for Women and Gender Studies.

The Dean will advocate with the UBC Provost and the senior administration for family and housing support, including a family support office at UBC, a plan for backup emergency care, centralized support for partner accommodation, and support to offset housing costs.

Sustaining good practices needs thorough documentation. We plan for on-line documentation and dissemination of new policies and practices, making them easily accessible to heads and faculty members from a Faculty Affairs page on the FoS website.

Outlook

There is much work ahead, both by individual faculty and by leaders at department, faculty and the upper levels of UBC's administration, to achieve our goals. Fortunately, budget cutbacks notwithstanding, there is much commitment now at UBC to work proactively to increase the number of faculty from underrepresented groups in Science (as well as other disciplines) and better support our faculty. Department heads in the Faculty of Science are all strongly committed to diversity goals. We also appreciate strong support from our colleagues at the Equity Office, and the Centre for Women and Gender Studies, staff in Human Resources, UBC's Academic Leadership Development Program, faculty colleagues across campus, particularly in Engineering and Medicine, and the NSERC Chairs for Women in Science and Engineering.

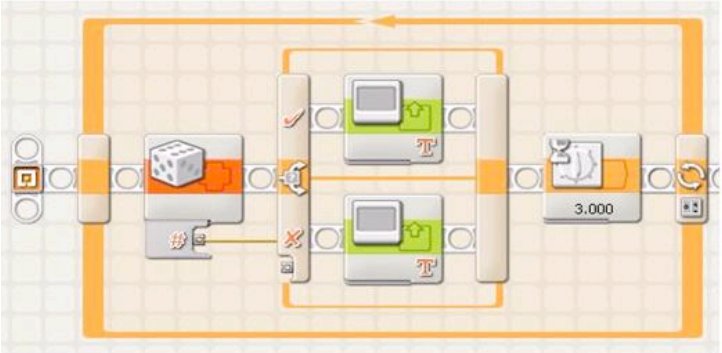
We are optimistic that we will take positive steps forward, while learning from our inevitable mistakes, to further develop more effective practices in the coming years. On the journey ahead, we look forward to continued collaboration with our colleagues, and to the many opportunities to build a more diverse workplace with deeper appreciation for its diversity in our faculty.

References

Sparking the Mind: Techniques for introducing CS to Young Girls

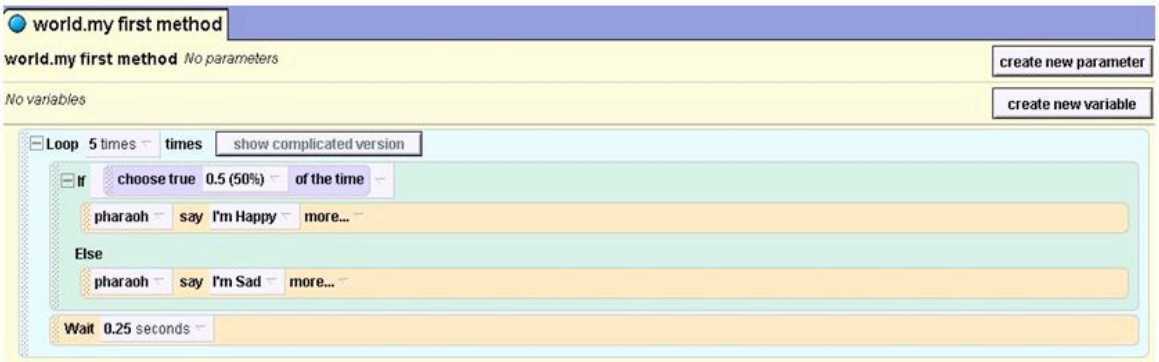
Katherine Gunion, Celina Gibbs, and Yvonne Coady

A student's journey through education starts when they walk into their first kindergarten class. They see what resources are available to them, and through these early years begin to discover which aspects of school they enjoy, and which ones they do not. It is during these pivotal years that we must spark interest in Computer Science and Technology in young girls. At The University of Victoria and The University of British Columbia, we have implemented computing programs targeting grade and high school students. We have been experimenting with various tools to engage the students and foster creativity. Three of these tools are Scratch[1], Lego Mindstorms[2] and Alice[3].



Lego Blocks

Scratch Puzzle Pieces



Alice Approach

In this paper we will explore the curriculum which we have implemented using these tools. We will describe how they have helped to teach students key Computer Science concepts along with building team and leadership skills in a fun and engaging environment.

We have seen impressive results from very young students, surpassing our initial expectations by how much they were invested in the exercises. Grade school students have demonstrated understanding looping, conditionals and basic problem solving. The students were also able to express themselves very uniquely with these creative mediums

(Eg. cow and 'broken heart' games of Pong), and had the opportunity to exercise skills involving communication with their peers.

Our goal is to share our information and experiences to hopefully promote education to young female and minority students. We would like to spread awareness regarding the impressive ability of young students when they are given the opportunity to succeed. We would also like to exchange resources, experiences, successes and challenges of Computer Science Education.

Curriculum which we have implemented

This past summer we had a group of adolescents, ages 12 through 17, from a neighbouring aboriginal community Tsawout. This group of students were brought to the University for three weeks of science outreach funded by the national group *Let's Talk Science!*[4]. This group of students was 50% female, but none of the students had any previous exposure to the types of exercises we were attempting. As these students were in a foreign environment and uncharted territory in terms of the material, it was not surprising that they exhibited shorter attention spans and focus than traditional students. For this reason many of our typical techniques needed to be altered slightly to be more accommodating. Many of the handouts had very detailed instructions so that the students had the option of following along, we also ensured that the students were able to reach small goals and complete short tasks that built upon one another. This helped to give the students a sense of accomplishment.

The first two weeks revolved around this group of students' community and heritage. Our team was responsible for the Computer Science component of the workshop. We decided to teach the students about The Neptune Project[5]. The Neptune Project is a system of underwater cabling that is going to be used for Marine research over the next thirty years. This project is important to this group of students, because the cabling runs along the San Juan Tectonic plate right beside some heritage sites important to their community.

We learned through working with this group that they were very passionate about their culture and heritage. They would gladly correct us with mispronunciations of words and tell us about what they mean and how they are important to their culture.

On our first day with these students, we had someone come in and show the students about some of the technology that is being used on their heritage sites. From then we introduced them to Lego Mindstorms. We told them they were going to build their own Neptune rover to explore the classroom. The students were broken into groups of three, given Lego kits and put to work. This mix of students did not seem to be familiar with this type of working dynamic. For this reason, we had an instructor or helper passively with each group of students to ensure that they were on track and that all of the students got a fair chance to participate. For the remainder of the time, the students worked together to build a rover. Not all the students completed their rover, but we took the liberty of finishing the incomplete robots so that all the students would begin at the same starting point when we rejoined for another session.

The following week, we introduced the students to the Mindstorms programming language. We split the day up in to three 'Stations'. For the first station the students were instructed to have their robot go towards a line and stop when a light sensor detects it. The second station asked the students to emulate the robot taking samples from the environment, the same as the Neptune rover. To do this we used the sound sensor and had them display the sound level in the room on the screen. The third station we had the students train their robot follow a line that we had drawn in tape around the class room. At each station we had bonuses that the students were able to complete if they wanted, either between stations or after they completed all the stations. Bonuses included, a fun "dance" when they hit the line at station one, or mixing station two and station three to collect sound samples every 10 seconds.

The third week of the program we diverted from teaching the students about their culture, and had them work with a program called Scratch. We had the students make a game of Pong (the old arcade game)[6]. This is in response to popular demands of "are we going to build our own video games?". The students were able to work individually with hand outs and instructions from the instructors. This week was also sectioned into tasks: (1) make a ball, (2) make a paddle and, (3) have the ball react with the paddle, and the floor of the playing field. We also had bonuses for the students who were moving quickly: lives within the game, game over sign, and keeping track of points.

<u>Key concepts that we witnessed the students learning</u>:

The students were able to learn about the Neptune project, which is being developed of the coast near their community. The students were also able to learn many key computer science concepts and structures. Common programming structures like loops, variables, conditionals and event handling are programmed as drag and drop blocks in both the Mindstorms and the Scratch programming environments. The students were able to use these constructs to program the various activities that are outlined above.

The students were also tested in their ability to follow directions closely. Firstly, the instructions to build the robots were very detailed and step by step. The instructions told them which pieces to find from the box, and precisely where to place them. All of the activities also had handouts with basic instructions that gave the students detailed hints and guidance on how to execute the activity.

The Scratch environment is also highly dependent on basic mathematical geometry. Items start at X and Y co-ordinates, they move in accordance with these axis. Items are also able to point at different degrees and bounce off walls at varying angles. Scratch's blocks are all labelled to describe their function. Many of these labels facilitate logical thinking. The *Logic* blocks come complete with arithmetic (+ - * /) and logical operations(logical-OR, logical-AND). The students learn what these constructs mean, and how to use them in this simple intuitive graphical environment

<u>Additional skills</u>

In addition to learning many technical skills, our students were able to develop some of their leadership and creative skills. While working with the robots the students were required to work in groups of two or three. This dynamic fostered teamwork and leadership skills.

Scratch allowed the students to paint their own characters and be creative with their games of pong. We had many interesting paddles, balls and obstacles. One student made a Cow the ball and a car the paddle. One girl had a broken heart bouncing around on the screen, and another made a very colourful and eccentric background for his game.

The students were also given some creative freedom in the bonus exercises while doing the Neptune activity. The students` robots made different sounds and dances when they hit the lines or check points.

We saw many positive interactions with the robot building and designing among group members. Some groups found a leader to organize the other members, and delegate tasks. Other groups each had an assigned role, instructions reader, piece finder and assembler. And, other groups simply worked well at focusing on the task all together.

Conclusion

By using interesting tools and relating the students' work to their culture, we were able to create an interest in computer science among our young minority group. At the end of the workshop, we had two of the girls approach us and ask what was required for them to continue with computer science. When many of our students came in, they thought computers were about YouTube[7] and MySpace[8]. After seeing Mindstorms and Scratch, we believe the students were able to appreciate computer science and technology for something much more exciting---enabling them to be producers of technology, not just consumers of it!

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Building Communities Symposium '07: Designing A networkING Event for women in Engineering in BC

Anja Lanz, Elizabeth Croft, Jennifer Pelletier, Bernadette Currie and Erin Biddlecombe

Abstract

Current research shows that building a supportive environment for women within the engineering community, where women can achieve personal and career satisfaction, will lead to an increase in the number of women attracted to engineering as a career, and reduce the number of women leaving the profession[1]. The Building Communities Symposium '07 (BCS) was a two day event for 120 women in engineering in British Columbia from all levels of the profession; approximately 60 students, 20 new immigrant engineers/women returning to work and 20 established industry professionals were targeted to attend.

The vision of the Building Communities Symposium was to develop a network of women in engineering in BC, where students, new immigrant engineers, women returning to work and established industry professionals alike could have the opportunity to build and participate in a supportive and inclusive community. The number of women in engineering in any school or workplace in BC is so small that women often feel alone and isolated. This feeling of isolation tends to increase as women progress through their career and often leads to attrition[2]. The symposium aimed to address this issue and to strengthen the number of women in the field, by bringing women together to achieve a sense of "critical mass".

The Building Communities Symposium programming was intentionally designed to provide a catalyst for network establishment of women across engineering workplaces, industries, and university faculties. Sessions held on the first day of the event focused on such topics as: a) leadership skill development, b) mentoring relationships creation, c) outreach and advocacy work required to bring women into the profession, and d) the need to develop support networks that allow more women to advance to senior positions in their industries. On the second day of the symposium, participants self organized, planned, and developed action plans for their respective network, established through previous programming on the first day, via online websites.

In this paper, we report on the logistical planning, program design and implementation of this event, the results of the attendee survey, and make recommendations for future events of this nature. The authors hope that by reporting on their experiences' outcomes

that this will serve as a helpful guide to others who wish to take on a similar exciting and worthwhile challenge.

Index Terms – Women in Engineering, Networking, Symposium for women in engineering.

Planning the Event

The planning for the symposium started approximately 18 months before the event, through the writing of a proposal for seed funding from the Jade Bridges Program, sponsored by the NSERC Chair for Women in Science and Engineering, BC/Yukon. This seed funding, matched with funding from the student Work Study program at UBC, was used to fund a 4th year undergraduate student, supervised by a volunteer faculty member, to develop the event. Appendix A lists the committees that were established to implement various phases of the planning. Figure 1 shows a timeline for the planning of the event.

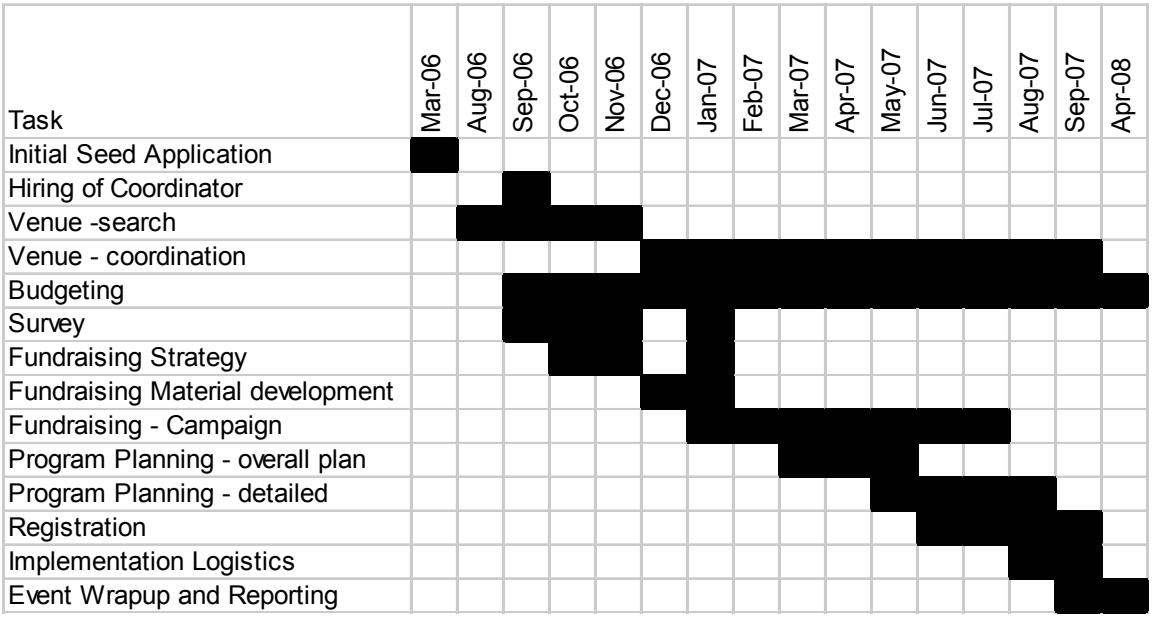


Figure 1: Planning Timeline

Early Phase Planning – Venue, Budget, and Awareness

One of the keys to this early phase of planning was the securing of an appropriate venue for the event. A second important step was the establishment of a set of three budgets for multiple funding scenarios for the event. One budget was based on what was felt to be a realistic amount of revenue, one included extras that would only be possible if the fundraising targets were exceeded, and one was a contingency budget based on receiving

no sponsorship and relying solely on registration fees. These options provided some security to the planning committee that the event could be successfully implemented.

The third important step was to establish a combined advertising/awareness and fundraising strategy targeting agencies, organizations, and companies to support the event. Great care was taken in developing a clear message about what the event was about, and the value that would be provided to both the sponsors and the participants. A website was developed to support this effort. As much as possible, personal contacts were utilized to forward the fundraising requests to key decision makers at companies and agencies. This effort was well rewarded by a successful fundraising campaign supported by both industry and government agencies. Finally in the early stages of the planning, a survey of women in engineering at the undergraduate, graduate and industry stages of their career was conducted to identify desirable locations, time frames, programming content and personal goals for such a networking symposium. This survey had the consequence of building expectations for the event and helped to identify potential volunteers and participants.

Mid-phase Planning – Fundraising

In the second phase of the planning process, fundraising switched into high gear. A letter writing campaign with follow up contacts was implemented to attract funding. A smaller campaign was implemented to attract giveaway prizes (pens, keylights, etc) as well as door prizes for the event. At the same time, the program planning got underway based on survey information obtained in the first phase of the planning stages. Based on the strength of the fundraising campaign, the moderate level budget was adopted, with the plan to partially reimburse registration fees to volunteers if fundraising was more successful. The final budget is given in Appendix B. As it turned out, a large amount of the funding arrived after the event was implemented. These moneys were used to fund spinoff events from the symposium. Sponsors are listed in Appendix C.

Final phase Planning – Program planning and Logistics

In the final phase, detailed planning of the event and program was undertaken. This was a very intense time for the planning committee and program chair. At this stage, assistance with registration from the professional association group (DAWEG - The Division for the Advancement of Women in Engineering and Geoscience) was very much appreciated, and the countless hours of work by volunteers was invaluable. The online payment system allowed the committee to keep the handling of fees and cheques to a minimum and process the lump sum of attendee fees after the registration process.

The program planning started with brainstorming topics by grouped ideas into themes. Effort was made to select a variety of speakers, workshops and panelists to represent the diverse interests of women in engineering. The goal was to offer sessions that were sure to inform, energize and inspire the many wonderful women attending the symposium. The program overview and planning guide was designed to allow for "streamed"

networking opportunities with and for women at all levels of their career path in engineering under the categories of:

- Leadership (L)
- Career Advancement (CA)
- Transition (TR)
- Work / Life Balance (WLB)

A condensed version of the program is shown in Appendix D.

In canvassing for speakers, the program planning coordinator relied on an establish network of women in industry and academia. As an interesting note, only one out of all selected speakers was male. And only two of the more than two dozen presenters, panelists and keynote speakers were paid for their sessions. The organizers offered to cover travel costs for these individuals and invited them to join the group for meals in those cases that they were only attending for part of the day.

Symposium Implementation

On September 15 and 16, 2007 approximately 120 women engineers, engineering students and faculty gathered at the Loon Lake Research and Education Centre in Maple Ridge, British Columbia to participate in the Building Communities Symposium. The registration data for the event is shown in Table 1 and includes volunteers and speakers.

Figure 2: Symposium Group Photo

Numerous volunteers were needed to implement this event. Overall, the program chair was able to draw from about 37 women that indicated willingness to assist with the planning of this event and about 10 of these women were involved with the crucial core implementations. It should be mentioned that not all volunteers were available throughout the duration of the 18 months planning and especially during the intense planning in the summer months leading up to the September event, the majority of volunteers were only sporadically available, which put an additional burden on the planning committee to continue to recruit new volunteers to oversee sections of the work.

Table 1: Symposium Registration by Category

Symposium Registration by Category

Undergraduate Students	Graduate Students	Engineers in Training	Faculty	Professional Engineers	Seeking Employ ment	Others
56	29	10	8	4	9	16

The symposium had an information booth set up with two staff support volunteers from the University of British Columbia, however, in hindsight, there could have easily been 3 or 4 full-time help to relieve the volunteers from their stressful duties. Setup on the day of the event was organized by 10 volunteers as well as 4 out-of-town early participants who spent the night before the symposium at the Loon Lake Venue. The setup preparation was way into the night in order to have all the rooms ready for the early arrival of the buses with the participants to start the symposium at 9am.

Figure 3: Participants network in the Loon Lake Dining Hall

The event featured a number of keynotes speakers. On the first day, Anne Condon, NSERC/GM Chair for Women in Science and Engineering opened the event with a discussion on the Art of Networking, and Ms. Janet Benjamin, recently elected President of the Association of Professional Engineers and Geoscientists of BC, closed the day with a directed and empowering talk on marketing and engineering. On day two, Ann English, Director of the 2010 Olympic Initiative at BC Hydro, gave a very compelling personal account of her career path and management experience within several engineering companies, and Elizabeth Croft, Associate Professor of Mechanical Engineering, UBC challenged the attendees to Believe, Calculate and Succeed in their engineering endeavors and career paths.

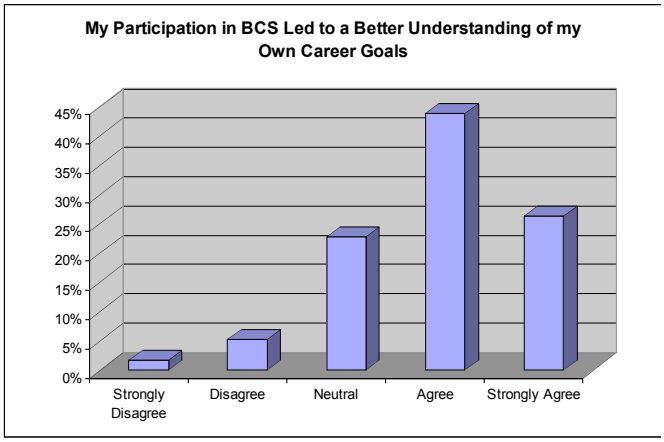
Participants took part in a wide variety of breakout workshops and panel discussions designed to meet the needs of women engineering professionals at all stages of their career. The closing session of the symposium provided an engaging opportunity for further networking: new and established groups were formed and expanded around

various communities including DAWEG (Division for the Advancement of Women in Engineering and Geoscience), Women in Engineering UBC, Women in Academia, Internationally Trained Engineers, GEERing Up! UBC Engineering & Science for Kids, etc. This activity provided a venue for these women to envision and plan community activities, with access to supporting funding from remaining funds of the Building Communities Symposium.

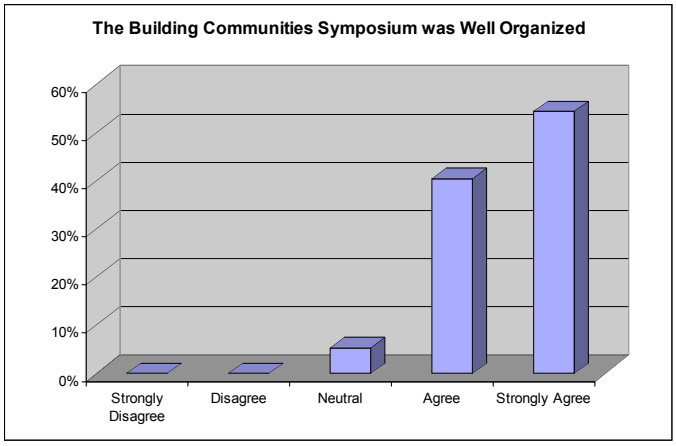
Figure 4: Speaker Sally Halliday listens while young women engineers navigate change

Outcomes

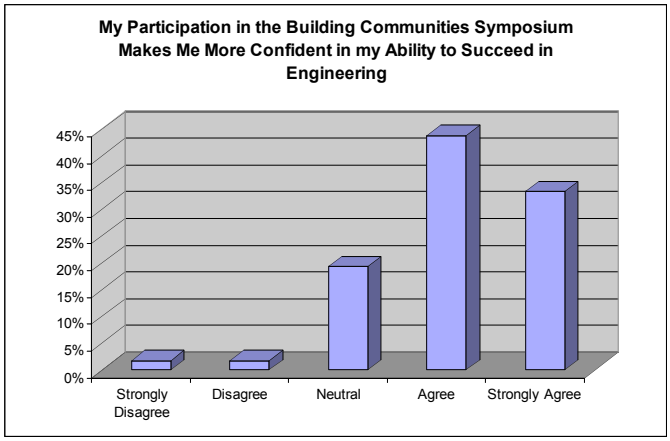
Building Communities was a resounding success, due to the hard work of the organizing committee as well as a large number of volunteers. An anonymous web survey was run the week following the event. Almost 50% (57) of the registrants responded to this survey (a very high voluntary response rate) and the results were overwhelmingly positive. In our post event survey, 98% of respondents felt that the event should be repeated, over 90% of respondents agreed that they had strengthened their engineering network, and almost 80 % were more confident in their ability to succeed. Graphs of responses are compiled in Figure 5 below. Of the many anonymous comments received, the following statement is representative.
"This was a wonderful weekend. Having the opportunity to meet with women of all different backgrounds and places in their career helped me to feel less isolated in my own life. I appreciated that there were workshop options for both those in school and out of it."



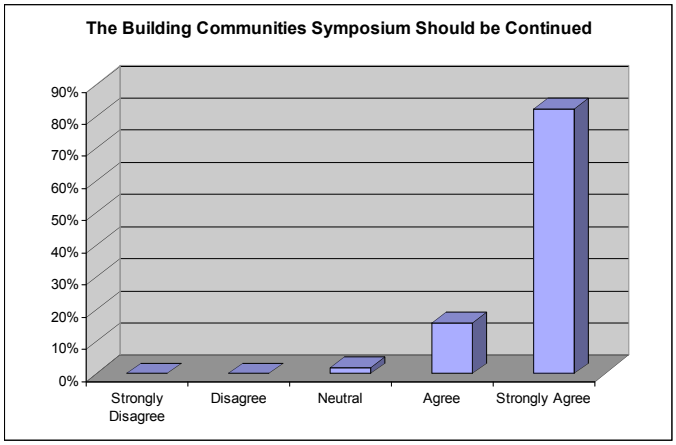
(a) Symposium led to better understanding of career goals.



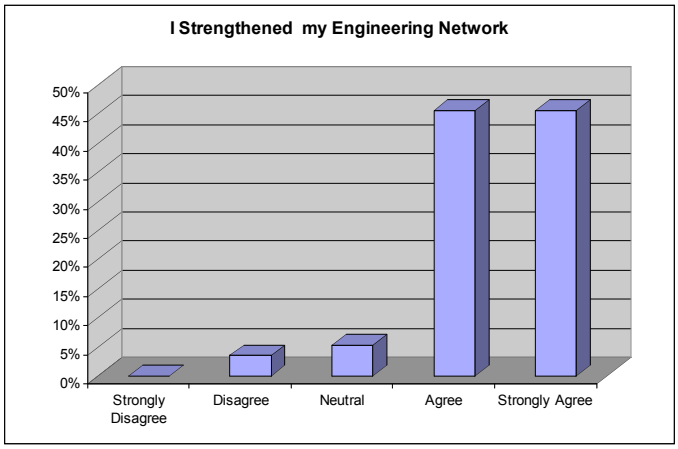
(b) Symposium was well organized



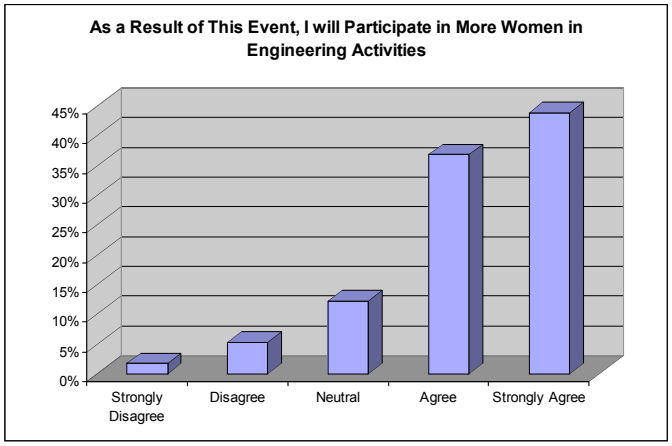
(c) Participation lead to higher confidence.



(d) The symposium should be continued



(e) I strengthened my engineering network



(f) I will participate in more WIE activities

Figure 5. Post event survey outcomes.

Next steps

Due to the overwhelming success of the Building Communities Symposium, and the proof that more opportunities for networking and learning for women in engineering of all levels are needed, the symposium chair together with some planning committee members created a new group that will organize networking as well as professional development events for women in engineering in the Vancouver region - WIE (VR).

The aim of this initiative is to give women in engineering from various institutions and engineering industry in the Vancouver region the opportunity to come together, network, and share ideas through both fun events and professional development workshops.

The program is divided into two main categories: a) social networking and b) professional development. The social networking part of this initiative covers fun events which will include board game nights themed as educational and a fun way to network, potlucks, movie nights which will show documentaries of women in engineering or science who have become accomplished in both their careers and community activities or other documentary or educational topics of interest to the women in engineering community, and BBQs.

The plan is also to hold workshops and speaker sessions for the professional development category of programming. The workshop topics will range from project management, team building, leadership, motivation, conflict resolution, to career related topics. Further to this, previous anecdotal information tells us that many women are interested in holding seminars that are related to financial management. In order to cater to this interest, there will also be an investment workshop or workshops. The topics of the workshops could be real estate, early retirement, budgeting, and other such financial topics. Speakers from the engineering community or academia will also be invited to speak on such topics as entrepreneurship, technical expertise, and their experiences which will be of interest to the women. As part of the goals, the group tries to recruit female speakers and workshop facilitators as much as possible in order to promote the successes of women and to inspire the women engineering community.

These workshops and events will give an opportunity for leadership, networking, and mentorship activity for all participants and team building and organizational training for the committee members. Additional workshops to the ones listed above will be considered as the program develops.

Recommendations

After the event, valuable insight was gained into the planning of a first-ever grass roots event such as the Building Communities Symposium. As planning progressed, the organizing committee realized very quickly that planning this huge undertaking would have benefited from more staff support from other BC universities as well as industry or other organizations in order to not “burn out” its volunteers. Since this type of event had never been attempted on such a large scale in British Columbia before, and because

women in engineering initiatives were lacking the exposure, support, and expertise at the university level as well as in industry, the organizing committee undertook an incredible risk in this initiative which, however, has paid off by establishing a solid reputation for any future event of this caliber. The goal is to gain institutional support at the major universities in the region. More specifically, the key to sustaining a program like BCS requires university support in the form of personnel and finances. We are happy to report that, by building upon the success of the Symposium, this support is slowly unfolding.

In addition, building a committed, responsible volunteer base is crucial for events of this type. Working mainly with initially untrained volunteers, much time was spent on training. Due to the short time frame of the final planning stages and the demographics of women's work locations over the summer, the volunteers and chair often had only email as a means of training, which was very time consuming. Building a volunteer base in advance and providing training at earlier stages would have alleviated this problem. However, the training of these newly recruited volunteers paid off as many of them have now moved on to volunteering with new or established women in engineering committees and organizations.

In an ideal world, the organization for this enormous event would have begun earlier. However, it can be concluded, and backed up by the participant's responses, that the symposium was well organized and that the planning went as smoothly as it could under the circumstances. Since the core organizing committee drew from key members who had previous experience in specific areas of planning, attention could be focused to areas that needed to be planned early and moved ahead quickly. It is recommended that the initial planning of events of this nature should start at least 12 – 18 months in advance. In addition, it is crucial to have the venue and core committee members established at a very early stage and ensure the core committee can commit time and energy for this long-term project.

Lastly, not enough can be said about staying optimistic, focused, and well supported both financially and emotionally with such a new ambition. The experience through this event has shown that, even though carefully crafting supporting and promotional materials, fundraising initiatives can sometimes take a long time, but by staying positive and persistent, funding may come through at a later date or even after the event has taken place.

The Organizing Committee would like to thank all volunteers, sponsors, British Columbia universities, and organizations for their support and trust, and would like to add that a well networked and mentored 'women in engineering' group, can and will put together such a successful event.

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Appendix A – Planning Committees

Pre-Symposium Committees	Responsibilities
Venue / Food	• Identify venues • Establish suitability and costs • Select best venue candidates • Conduct site visits to venues • Select final venue • Make arrangement for venue bookings • Liaison between chosen venue and committee • Select food menu • Book equipment and extra activity rooms with venue
Outreach	• Conduct online survey for initial symposium planning inquiring about desirable locations, time frames, programming content (ie. activities, workshops) and personal goals • Liaison with engineering groups and organizations and schools for raising awareness of symposium
Sponsorship/ Fundraising	• Create sponsorship levels • Apply to government grants • Write sponsorship letters and develop sponsorship information packages • Create mailing list with details on companies (including contact information, contact person, etc.) • Print and mail out letters • Correspond with potential sponsors • Promote symposium to organizations • Record sponsorship received and make copies of each cheque that comes in for later reference • Write thank you letters • Follow up regarding tax receipts
Budget/ Accounting	• Create budgets for multiple revenue scenarios • Monitor expenses • Advise committees about appropriate expenditures • Liaise with sponsorship committee to track donations and sponsorship • Adjusting budget to account for unexpected revenue or expenses • Handle reimbursements and invoices • Report on final spending
Speaker Selection	• Recruit and collaborate with speakers • Book speakers • Negotiate remuneration of speakers • Select speaker gifts • Liaison between speakers and committee
Program Planning	• Organize A/V equipment and materials for workshops • Create layout of program (number of concurrent sessions, session timeslots during the day)

	• Collaborate on planned activities and workshops with committee • Propose topics to perspective presenters • Allocate sessions into rooms • Seek out minimum of three keynote speakers • Discuss goals and target audience with confirmed keynote speakers • Liaison with speakers and venue • Write final program • Prepare program agendas for posting at venue
Advertisement/ Promotion	• Create brochures, posters, and electronic materials for advertisement • Develop list of advertising contacts • Circulate material for promotion
Website	• Create and update website • Update online program and sponsor list • Obtain logos from sponsors for website
Registration	• Create registration guidelines • Organize online registration • Track payment of registration fees • Obtain updated registration information • Correspond to inquiries about registration • Accommodate special needs registration (such as meals, transportation, accommodation, etc.)
Name Badges	• Create name badges layout • Obtain all information to be printed onto badges • Colour code badges by groups (such as organizers, volunteers, and presenters) • Print badges • Collect badges at end of event
Giveaway Items	• Create letters for giveaway sponsors • Visit potential stores that might like to donate items for giveaways • Tabulate all items collected • Write thank you letters • Follow up with tax receipts if applicable
Volunteer Coordination	• Collect volunteer information • Advertise openings for volunteering • Train volunteers • Correspond with volunteers as needed • Thank volunteers for their time and energy

Symposium Committees	Responsibilities
Bus Helper	• Assist with organization of participants for bus transportation to venue • Display signs at bus stop locations for pick up on day of event • Assist with questions regarding traveling
Photographer	• Obtain photo release form from all participants • Organize indication on name badges for participant that don't like their photo taken • Take as many photos as possible during event • Transfer photos to central file folder for use in reports, promotional materials, and website
Workshop Session Assistance	• Assist speakers with workshop sessions • Ensure workshop materials being printed out ahead of time • Circulate materials as needed • Present speaker with thank you gift
Accommodation Assistance	• Assist participants with room location • Act as contact person for any accommodation need
Greeter/Floater	• Greet participants • Be available to assist either organizing committee or speakers during event.
Set-up/Cleaning	• Arrive early to set up venues and workshop areas • Clean up during and after meals • Clean up accommodation and workshop rooms after event, if needed
First Aid	• Collect medical forms for participants (in sealed envelopes) • Make first aid assistance available in case of emergencies
Logistics	• Coordinate the efforts of event volunteers • Maintain a central information booth • Distribute schedules • Coordinate materials and supplies • Greet late arrivals • Provide support and troubleshooting.

Appendix B – Budget

Revenue			
Registration			
	Students @ $35		
	Back to work/Immigrant @ $45		
	Industry @ $75		
	Subtotal	**2,420.00**	
Grants			
	NSERC	7,000.00	
	JADE	3,000.00	
	Subtotal	**10,000.00**	
Sponsors			
	Industry Sponsorship	13,100.00	
	DAWEG - APEGBC	1,500.00	$ 500 in-kind advertising
	UBC Dept. of Mechanical Engineering	1,500.00	
	UBC Engineering Physics Program	200.00	
	UBC Applied Science Professional Fund	1,000.00	
	UBC Walter Gage Fund	2,000.00	
	SFU Faculty of Applied Science	500.00	
	Private Donor	200.00	
	Subtotal	**20,000.00**	
Total Revenue	***All Sources***	***32,420.00***	
Expenses			
Accommodations and Meals			
	Friday Night Stayover for Volunteers	$ 540.00	
	Overnight with meals - 100@ $68	$ 6,800.00	
	Snack Catering	$ 1,000.00	
	Food for stayover and extra snacks	$ 228.09	
	Subtotal	**$ 8,568.09**	
Facilities	AV costs	**$ -**	Equipment loaned by UBC Mechanical Engineering
Travel	Ferry Costs	$ 202.35	
	Bus Charter, return	$ 1,224.30	
		1,224.30	
Administrative Expense			
	Stationary and printing	$ 75.00	
	Web survey hosting	$ 62.30	
	Miscellaneous	$ 102.75	
	Subtotal	**$ 240.05**	
Advertising			
	Brochures and posters	$ -	Photocopying provided in-kind
	Ads	$ 500.00	Provided in-kind by DAWEG
	Website Hosting	$ -	Provided in-kind by UBC Mechanical Engineering
	Subtotal	**$ 500.00**	
Speakers/Workshops			
	Presentation Fee	$ 482.21	
	Speaker Gifts	$ 160.19	
	General logistics supplies	$ 41.42	
	Workshop Materials and Programs	$ 540.67	
	Tote Bags	$ 706.68	
	Subtotal	**1,931.17**	
Coordinator Funding	Sept 06-Sept07	**$ 6,809.00**	
Volunteer Reimbursements		**$ 430.00**	
Spinoff Activities		**$ 5,917.39**	
Carry-over Funding	To fund coordinator for next Symposium	**$ 6,800.00**	
Total Expenses		***$ 32,420.00***	
Revenue - Expenses		***$ -***	

Appendix C – Sponsors

Building Communities Symposium Sponsors

Diamond
NSERC/CRSNG Pacific

Platinum
The Jade Project

Gold

Teleflex Canada
Toyota CAPTIN
UBC Mechanical Engineering
BC Hydro
JV Driver
UBC Walter Gage Memorial Fund

Silver

Faculty of Applied Science Professional Activities Fund
UMA/AECOM
Stantec
Klohn Crippen Berger
SFU Faculty of Applied Science
Associated Engineering
Glotman Simpson
The Langley Concrete Group
Robert Allan Ltd.
Read Jones Christoffersen
Convergent
MMM Group
FortisBC
YVR
Penticton Foundry

Bronze

UBC Engineering Physics
Sandwell

Appendix D - Program Session Overview

Saturday Sessions

Timeslot	Workshop Title	Theme	Location
11:00 - 12:15 pm	Path to success through real world experience.	CA	Student Centre Lounge
	Mentoring 101- What it is and how it can help you!	CA	Staff House
	Your interview: The 5 Minute Impression	CA	Dinning Hall
LUNCH			
2:00 – 3:00 pm	Dressing for Professional Success—Make the Right First Impression	CA	Staff House
	Making a Difference – Engineering Opportunities in Developing Countries	L	Student Centre Lounge
	Making Life Shaping Decisions – Navigating Change	TR	Dinning Hall
BREAK			
3:15 – 4:15 pm	Making Life Shaping Decisions – Navigating Change Cont…	TR	Dinning Hall
	It is possible to have the life and career you dreamed of?	WLB	Staff House

Saturday Afternoon Activities

Time	Theme	Activity	Meeting Location
4:30 - 5:30 pm	Rest	Lie down for an hour	Your Room
		Sit on dock for a chat	Dock 1
	Relax	Write a biographical story for self or others or read.	Student Centre Lounge
		Make centerpieces for dinner tables	Dinning Hall
	Recreate	Swim in lake	Dock 2
		Hike along forest trail - _5km	Ferry

Sunday Morning Sessions

Timeslot	Workshop Title	Theme	Location
9:15 – 10:15 am	Genuine Self Confidence	L	Dinning Hall
	Navigating the journey from school to work … and from work back to school again	TR	Staff House

	Entering the workforce; new to the region or county	TR	Student Centre Lounge

Networking Break Out Groups

10:30 - 11:30 am	**"Networking Group Name"** *Meeting Location*		**APEGBC** *Student Centre South*
	Future BCS Planning Committee *Staff House*	**Engineers Without Borders** *Student Center Lounge*	**DAWEG** *Student Center Deck*
	Internationally Trained EIT or P. Eng *Student Center North*	**GEERing-Up!** *Amphitheatre*	**Academia / Faculty** *Friends & Alumni Cabin*
	Graduate Students *Dinning Hall*	**Looking For Work** *Dinning Hall Patio*	**NEW@UBC** *Gymnasium*

CA – Career Advancement
WLB – Work / Life Balance
L - Leadership
TR –Transistions

E

Gendered Organisational Cultures for women engineers researcher's success: EU-project PROMETEA

Felizitas Sagebiel

Abstract

The issue of the paper is the European Commission Project PROMETEA "Empowering Women Engineers in Industrial and Academic Research" (website: www.prometa.info) (2005-2007). Aim is to give an overview about state of the art, hypotheses, methodology and results of work package four, dealing with effects of gendered organisational cultures on careers in engineering research.

The question was in what ways and to what amount social structures and cultures of engineering research organisations are traditionally male oriented dominated by hegemonic masculinity and men's networks. The qualitative methodological design included interviewing women engineers and doing focus discussion groups with men and women engineers separately.

Results focus first on genderedness of organisational cultures, analysed by gendered division of labour, gender stereotypes and gender awareness. Second, networks will be described from the perception of women and men engineers in research. Genderedness of networks are analysed by definition, functions, processes, activities and evaluation and women's integration or exclusion in different engineering research organisations (industrial, academic and governmental). Characterisation and function of men's networks will be presented in the perception of women and men engineers in research, especially how they influence careers of women engineers.

Key words: gender, women's career, engineering, organisational culture, men's networks

1 State of the art, methodology[1], hypotheses and definition of concepts

Based on empirical and theoretical research six social science research fields can be differentiated which are relevant for gendered organisational cultures and networks of engineering, and which the author has combined for interpretation of empirical results of the former European project Womeng (www.womeng.net).[2]

Qualitative data on gendered organisational cultures and networks in academic and industrial settings of engineering and technological research have been gathered through semi-structured interviews with women and focus groups with men and women separately. Focus group discussion was the privileged method to get known the more tacit

[1] Methodology in more detail is described by Anne-Sophie Godroy-Genin 2008.
[2] First concentrated on four research fields (Sagebiel 2005c), later on, based on critical discussions, Field were extended to six relevant theoretical areas (see Sagebiel 2007, 2006a).

elements and was taken from Womeng project (Godfroy-Genin and Sagebiel 2007; Sagebiel 2005a).

Hypotheses from the former European project Womeng (European Commission 2006) about gendered organisational cultures and networks in professional sphere of engineering (Sagebiel 2005b; 2006a; 2006c) were transferred to the field of engineering research. Further hypotheses were taken from research literature about investigations of genderedness of science and career (Sagebiel 2006b). Three main factors namely access to resources, successful research steps and cooperation possibilities determine career in science. The question is if and how these are gendered in the field of engineering research and what role gendered organisational culture and networks play. For issue of this paper the following hypotheses[3] were taken:

1) Organisational culture in engineering research is traditional masculine with gendered networks as central element.
2) Women engineers in research are excluded from men's networks and cannot rely on a powerful women's network to compensate the exclusion from men's networks.

The concept of gendered organisations (Acker 1990; Wilz 2004, 446) describes organisational characteristics as not gender neutral at all. *"To say that an organization, or any other analytic unit, is gendered means that advantage and disadvantage, exploitation and control, action and emotion, meaning and identity, are patterned through and in terms of a distinction between male and female, masculine and feminine. Gender is not an addition to ongoing processes, conceived as gender neutral. Rather, it is an integral part of those processes, which cannot be understood without an analysis of gender."* (Acker 1990: 164, qtd. in Wimbauer 1999: 44)

Gendered networks refer to exchange of information, feedback and help, formal and informal, inside and outside the organisation as they are influenced by gender. Networks have manifest and latent functions. A prerequisite is knowledge and awareness of networks, especially the informal ones. For inclusion and exclusion most of all informal networks with so called *tacit knowledge* are important, because of less transparency. Exclusionary processes are central especially in networks of a male domain, and even more so in a male bonding (Doppler 2005). Being a kind of informal men's network it serves for construction and reproduction of male identity, power and privileges which are a traditional characteristic of management networks.

Men and women were asked in focus groups separately. Questions had been, what role networking played for job and career, especially for getting relevant information, what benefits and barriers informants experience (lack of time, restricted access), and if gender differences exist. Women were asked too individually about their experiences with networking and networks (importance, time, access, benefits and gender differences) regarding their career progression and career hindering factors (work culture, mobility, lack of information, networks access, gender differences).

[3] For more hypotheses used in this work package see PROMETEA final report (www.prometea.info).

For analysis of data for this paper, national reports on basis of the national findings in each partner country were taken together with summaries of interviews and focus groups.

2 Gendered organisational cultures in society and in engineering research[4]

2.1 Gendered division of labour in society

Gendered division of labour in society could be found in all countries, but extreme traditional gender role embedded thinking exists especially within Eastern European countries, but, it is also existent in other partner countries, even though it is not talked about so frankly.

In the opinion of female focus group members in the business sector in Slovakia (B_NT_FGW_K)[5] the man is regarded as "head" of the family by the traditional opinion in the Slovak Republic and that is why women are predominantly taking care of children. Men know about their career advantages by gender division of labour. Slovak men in a group discussion agreed that their female counterparts lose approximately 5 years devoting time to children.

A good example for gendered labour division is how women engineers in Spain describe their situation in the BUS sector. They call themselves "ants" because they "*do the work of ants*" e.g. they make sure that a meeting organized by their boss is acceptable to all the participants and they do not consider this as a normal part of heir job. "*Men give orders but never worry about them being carried out; we are the ones who run around doing that"*. They work as 'ants' "*because it is not visible but it is indispensable for everything to work smoothly*" (B_FGW).

Also in Austrian women focus groups women engineers complain that they have more organisational (administrative) tasks (like booking flights, writing minutes) in comparison to men.

In France gendered role expectations in society showed more indirectly. One male discussant from higher education thinks "*We have to promote the women models that did succeed to manage both of it*", the women who "*brightly managed both their scientific career, and their family life*" (ENS-H_FGM_N).

2.2 Gender stereotypes in engineering research organisations

Gender stereotypes in society and their reflection in engineering research organisations were found nearly everywhere, but the most extreme positions and traditional attitudes

[4] For this section not all partner countries provided data because the upcoming points were partly not directly asked in interviews and focus group discussion. But while looking at the gathered material of colleagues in all PROMETEA countries and reading their national reports some specific differences became visible.

[5] The abbreviation is the code for characterizing the country, instrument and anonymized interviewee.

had shown in the same countries where a very traditional role and labour division existed. All stereotypes define men as predominant and more apt for leadership roles.

Strong traditional stereotypes exist in Lithuania, where men's thinking is determined by traditional gender dichotomies. Men engineers believe they are more self-confident and therefore naturally occupy highest positions. One informant thinks: "*Attitudes towards women differ from the ones towards me; woman's nature is different; ... in technological sciences, there is a stereotype stating that "the strong" sex must predominate*" (H_FGM_I1). Even Lithuanian women in a focus group agreed that men are more qualified as leader: "*Men are rough, have more features characteristic to leaders"* (H_FGW_I1) or another statement: "*Their competence is higher, that is why they take the lead*" (H_FGW_I1).

Russian women in engineering face complex and really discriminating stereotypes such as "*Engineering is men's business*" and "*Men are smarter then women*" or "*A man is a generator of ideas, a creator and a woman is a good executor*".

2.3 Gender awareness and gender denial in engineering research

In a male domain like engineering research men's gender awareness is an important indicator for organisational culture. Gender awareness was measured by the focus group answers to the question if interviewees ever discuss issues related to gender in their work environment.

The results showed that men engineers in research overall did not have any gender awareness. What they have in common, they never discussed gender as their genuine own problem. And even women hesitate often times to discuss gender issues at work as seen in the focus groups. They partly are not aware of gender differences like in Russia or Serbia, feeling equal in numbers or referring to friendship feelings towards male colleagues. Being in minority they joke about gender issues "as a fun-factor" (like in Austria, Germany). Some women asked in UK and France were sensitive to their worse situation; partly they talked about sexist beliefs and prejudices, but, at the same time they fear to be over sensitive to gender issues. In Sweden and Finland with better equal opportunity programs in society they talked about differences in division of labour at work and salaries (Finland) as well as reasons for the low number of women managers (Sweden). In both countries gender is a regular issue in yearly talks about personal development.

3 Gendered networks and networking in engineering research organisations

Even though women were asked individually and in focus groups men talked much more about networks, so they produced as much material.

3.1 Understanding of networks and networking

Understanding of networks differs depending on awareness and perception of networks and networking. Some interviewees have only a vague impression and can't really tell their definitions, others refuse to talk about informal networks and only refer to professional formal ones. Overall men could describe different kinds of networks with different functions.

Male discussion members in Sweden talked about three kinds of networks: networks with former fellow students, networks with people one has worked together with (in different projects) and external networks with people with the same (technical) area of interest. Respondents of other countries also referred to this kind of differentiation. Swedish academic informants also talked about the researcher networks which are built up in conferences and, increasingly, by international research projects.

There was a general opinion of women engineers and of men engineers that becoming a network member is gender independent.

3.2 Manifest and latent functions of networks and networking

Getting to know people generally or relevant people, fresh information exchange, sharing material, acting collectively and getting job perspectives, these are manifest functions of networking in summary. External networks have manifest functions as initiating projects, especially international ones. Publication is another manifest function, but at the same time the information channels for publication are most of all not very transparent. In higher education networks are seen as necessary for career at a certain point of qualification with the aim to selling oneself and enforcing one's visibility. Internal networks build the unofficial organigram of the organisation which allows information exchange. In some countries networks are depending on hierarchical structure and decision of superior about the amount of restriction of information. From men focus group participants some take advantage from tacit knowledge they get by networking, others think it is not always career relevant.

A male Austrian engineer at university explained in detail how he networks and how it supports his work: "*If you take a look, you need networking to initiate projects. You need external partners, you have international partners and without networks this doesn't work. And yes, if you do your PhD you can also use the network of a colleague. If you know someone who works at the institute who works with specific equipment some things work out much easier. Getting any analyses, getting any chemicals, borrowing equipment, all that works much easier if you walk over and say hello*" (H_NT_FGM_Y1).

Even if the Finnish saying goes that "*good work always sells itself*", it's just not enough, because actually the knowledge and information "*between the book covers*" is silent. One of the men said that the network helps you to "'*peel the cream of the top' before anyone else gets the chance to do it. That is not necessarily always fair but it helps you to know that if you had not done it, somebody else would have*" (H_FGM_J1).

3. 3 Process of networking – from initiation to patronisation

Networks work with sympathy, personality, good performance, same professional and private interests, fraternisation after getting drunk together and luck. Several interviewees told that networking would start with common education in school or later during study time or even later during in service training in companies for example. Commitment often would go back to these roots.

In a German discussion round at a governmental institute men explained that first personal links would be already made during study time and can sometimes last a long period in someone's professional live. "*Networking starts already during study time and continues on conferences or while preparing together a project proposal.*" Additionally this institute was a good example for prolonged commitment within a specific community. When the institute was founded by some professors (mostly coming from a certain university nearby), they supported their close research assistants and offered jobs at the institute to them. The connections to this university would be still strong nowadays, and the new personnel were likely to be recruited out of the university department of the current institute's leader. "*You always can see where the institute leader has his connections; there is a commitment which obliges him to some kind of patronisation of his roots!"* (G_GP_NT_FGM1_M1).

3. 4 Evaluation and devaluation of network and networking

Male interviewees are aware of the importance networks have for daily work life and particularly career advancement. Difficulties for becoming a member of networks were not reported. Some respondents stated that network's impact might be overvalued, because at least professional performance counts for climbing up the career ladder and not connections. But some male discussants see this totally different, for them network contacts are highly influencing organisational cultures and decision makers; for career progress knowing the right people in decisive positions is essentially.

Women engineers perceived that they were not part of powerful networks, even though many of them felt or knew the importance of networks. Some of them under evaluated the importance of networks and networking for their careers. They spent too less time for informal opportunities to contact these networks outside the narrow defined work environment. Men in contrast, even though they told that becoming a member was seen as something not being reflected, what just happened by meeting and knowing the right people at the right time and place, they realised that these opportunities to take advantage of were worthwhile.

British men engineers in a focus group discussion in business sector (B_FGM_O) saw networking as vital: "*I think it's the hardest part of the scientists job*" and his colleague adds: "*I think you ignore it at your peril, I would say*!" A woman engineer in Germany consciously stated: *"Networks are the nuts and bolts - privately and professionally. Without (private) networks I could not have worked in that way." (*G_NT_WR2_M2*).*

On the contrary male researchers in France and Slovakia show a distant approach towards informal networks, *"I prefer the term: "scientific community", that is very different from those influence networks, very insane, chaotic and perverse*" (male engineer France - H_FGM_N1c). And one Austrian engineer from university personally feels "*that scientists are more defined by their performance than, like a strategic lawyer who can tell you anything and you can tell a lot, but here we have numbers, data and facts. Here you can't sugar-coat anything*" (H_NT_FGM_Y1).

3.5 Rituals and activities of networking

Many rituals and activities especially of informal networking take place without women. Networks are knitted and tightened after work. In most of the partner countries women engineers feeling more responsible for family duties and life will not join these activities as much. Besides for joining special sports (extreme) and sauna meetings the sex difference counts and, even if women are not excluded in these activities and rituals, men don't seem to look for alternatives not so excluding for women.

In a German men focus group discussion in governmental research it was clear for all that important contacts to other people are mostly made after work, while going out for dinner or some drinks. "*My first superior told me, if you want to be successful in raising funds or getting project partners, you have to get once drunken with your future cooperation partner*!" More experienced participants agreed on this story. "*Inhibitions get weak and you can talk more frank and free about cooperation structures*." (G_GP_NT_FGM1_M1)

3.6 Women's exclusion from or integration in men's networks

For answering hypotheses about women's lower integration in men's networks, two questions were analysed on basis of interviews with women engineers and of men and women focus groups. Women were asked about access to men's network (extent, areas). Men and women were asked about barriers against networking (lack of time, restricted access) and gender differences.

Men asked about exclusion of women generally answer that they see no access barriers for women in joining networks. On the other hand in some situations having women included could damage reputation of men's network, men and women realised. One interviewed German female engineer, working in industry, had a very clear opinion about how male networks work, but this was outstanding: *"Networks function due to the fact that they exchange information and informally a "non-aggression pact" exist and also supports itself maybe. The men are maybe afraid to damage their reputation with a woman as a network partner. And men probably see there more common characteristics among themselves. Are women defined as the "others"?* (B_T_WR4_M4). Another male German engineer in industry argued „*Fostering networks with women is more inhibited*", because it easily gets a kind of sexual touch … (B_FGM_M2).

A special phenomenon found in PROMETEA results was that partly women did not perceive being excluded from men's networks. For women engineers in research non perception of gender differences and discrimination seems to be a general problem because Matthies found a parallel result for women scientists (Matthies et al 2001, p 19).

Family responsibilities are often used arguments or prejudices of women themselves and moreover of men against women joining men's networks. But, partly women didn't realise the usefulness of networking for their careers and this might have influenced their time argument. Less time resources (except in Sweden, where only one woman saw problems in timing) and less mobility are factors, besides special activities and rituals by men, in which women engineers are not interested in.

One of the Chilean respondents said: *"Networks are hard to get in since it often implies going for drinks someplace you don't particularly care about…*" (H_FGM_2). When asking Swedish informants in academic research about networking with men, one informant said in a humorous manner: "*No, you can't network with them" [everybody laughed]*. And she continued explaining what it takes to network with men: "*Then you have to play football with them and I have no desire to do that*". (H_GP_FGW_W2). One other female discussant from Sweden said: "*I was never invited to the sauna evenings. One of the other women with a management position higher up in the hierarchy was invited but I think she turned down the invitation because it did not feel right for her*" (H_GP_FGW_W2).

The hypothesis focussed too on women's networks, but about these PROMETEA results showed hardly any engagement of women engineers in research. Moreover these *women's networks* overall were not estimated as helpful[6].

4 Summary and conclusion

The results referring to the importance of gender, organisational culture and networking differ from country to country and in a country from case to case and from individual woman to another. So, even though for example in a country like Sweden there is more gender equality existing in society that influences organisational culture in engineering research, nevertheless there are gendered differences in networking. On the other hand, if a country has a very traditional culture according to gender stereotypes and gendered division of labour this is defining the organisational culture of engineering research too. Discrimination and excluding processes are more open (manifest). That does not mean that evoking gendered career barriers in the more equal national societies does not exist.

The concepts of gendered organisational culture and of gendered networks offer a variety

[6] Only some Swedish female focus group discussants referred to networks with other women, when asked about networks. "They are starting up a women's network at the technical faculty here at our university. However, I think that you have to be an Associate Professor to be a member of this network, but I was invited to it anyway. We'll have to see what will come out of it" (H_GP_FGW_W2). Networking between female engineers in Slovakia is not highly recognized as an important factor and male discussants think women's networks are less influential and almost not existing in their field of research (H_FGM_K2).

of possibilities for investigation of research in engineering organisations as can be seen in this analysis. Nevertheless both concepts have to be further developed in the future. Typologies to differentiate kinds of gendered organisational cultures and networks in engineering in combination with multiple professional masculinities (Collinson, Hearn 2000) could be developed by using empirical studies in the field. Moreover men's networks as instrument for social regulation in societies and engineering professional organisations today should be focussed in theoretical research. Interrelationship between particular men's networks combined with different gender awareness and power should be more investigated.

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Increasing the Participation and Advancement of Women in Academic Science and Engineering in the Central US

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Abstract

Since 2001 the National Science Foundation has shifted the nature of their targeted programs for women, switching from a focus on the individual to institutions. This new thrust, embodied in the NSF ADVANCE program, seeks to transform the culture within academic institutions to improve the recruitment, retention and leadership potential for women in science, technology, engineering and mathematics (STEM). This article will discuss the specifics of the ADVANCE project at the University of Oklahoma (OU) in the context of the nationwide ADVANCE program. The OU ADVANCE project is a multifaceted one addressing: intercollegiate dialogue on the promotion of diversity within the faculty body; the on-campus adoption of best practices for hiring, promotion and work-life balance; and outreach to promote science and engineering careers with underrepresented groups in the community.

Introduction

While the numbers of American white males pursuing and earning doctoral degrees in science and engineering are declining, the influx of traditionally underrepresented students, foreign, female and minority, is rising[1]. This shift in the doctoral science and engineering workforce has speared on new programs to change institutional culture at US universities and colleges to improve the "chilly climate"[2] and practices experienced by these traditionally underrepresented groups, at both the graduate level and, more recently, at the faculty member level. Without such intervention, it is doubtful that the glacial pace of change in culture for the acceptance and advancement of women would have accelerated on its own.

From 1982 to 1995, the US National Science Foundation (NSF)'s programs targeted specifically for women were concentrated on the Visiting Professorship award[3] that allowed "women scientists and engineers experienced in independent research and employed in a field of science or engineering to serve as visiting professors at academic institutions in the US". The 1995 NSF investment is this program was US$3M, benefiting 25 women[3]. Evaluation of the program showed that awardees reported spending "nearly twice as much time on research [….], and that their professional careers had benefited greatly"[4]. Still, these women found themselves struggling to overcome barriers that they did not understand.

From 1995 to 2001, NSF shifted to a more institution-focused approach with the

ADVANCE program[5] for increasing the participation and advancement of women in academic science and engineering careers appearing in 2001. In the first round, US$19M was allocated to a three-tiered initiative: large Institutional Transformation (IT) awards ($3M/5yrs); moderate-sized Leadership awards ($300K/3yrs); and smaller Fellows awards. The program has since evolved and now includes a new category, Partnerships for Adaptation, Implementation and Dissemination (PAID) ($500K/3yrs). The Fellows program no longer exists. For the 2007 program $13M was been allocated for IT and PAID. Overall, NSF is investing over $50M in the period 2001-2008[5].

Largely as a result of this generous NSF commitment, there have been a number of new initiatives in the US to increase the participation and advancement of women in science and engineering academia[5]. Many universities are now adopting and adapting elements of these programs or developing their own. While comprehensive coverage of the ADVANCE initiatives exceeds the intent of this paper, the OU ADVANCE project incorporates a number of the more successful and common activities at these institutions. A good snapshot of the early ADVANCE projects is given in Ref[6].

Overview

The University of Oklahoma (OU) is the flagship PhD granting and research university of the state of Oklahoma. Enrollment was 19000 undergraduates and 3600 graduate students in Fall 2007. The 1400 full-time faculty members are approximately 16% minority and 34% female: in particular representation from Native American groups is strong (2.8%) relative to that of other American universities. Nevertheless, Oklahoma and the central or plains states remain much less ethnically diverse in comparison to coastal states due underdeveloped economies, particularly high technology. The region is also more politically conservative, contributing to less gender diversity in employment. In such an environment, we set out to start a program for advancing women and increasing diversity in general at the university.

Our starting point was to gather interested parties on campus. A small group of women professors (*e.g.* Ref.[7]) had already established themselves as active researchers in gender and racial equity in STEM (Science, Engineering, Technology and Mathematics) fields and was therefore the natural launching pad for a new project in the area. Furthermore, an especially proactive college, the College of Arts and Sciences, had already established a Dean's Advisory Committee on the Status of Women[8], who had previously laid important groundwork in surveying faculty members about work/life balance. With these assets, we proposed and were granted a NSF PAID ADVANCE award[5].

The project would be housed in the proactive College of Arts and Sciences with strong support from the dean. From this position, we would be able to pilot our activities and optimize them in the college and then use our successes as lures for other parts of the university. Furthermore, we estimated that institutional peer pressure from without would be more effective than a grass-roots cry from within for change; hence the centerpiece of the project would be a regional workshop inviting the other regional universities to participate in a Big 12 Workshop on Faculty Recruitment, Retention and Leadership.

Lastly, work in the community is necessary to educate future participants and groom a new generation with less bias. Hence, the proposed project included three main thrusts: work on campus ("at home"), in the region ("with our neighbours") and in the community ("in town"). These three initiatives are described below as they were proposed and successfully implemented under a NSF ADVANCE PAID grant (0620102)[9].

Engaging the Neighbours

Our Workshop on Faculty Recruitment, Retention and Leadership was targeted towards a regional coalition of universities, the Big 12. While initially established as a league of intercollegiate athletics, the Big 12 affiliation has grown to include cross-institutional comparisons of faculty member salaries, endowments, library size, research funding *etc*. Our goal was to establish gender and racial diversity of the faculty body as a new point of comparison. Our fellow Big 12 institutions share many of the same characteristics as OU, and are, in general, large, public, plains states institutions. The central states share the characteristics of economies based mostly on manufacturing and natural resources (farming/ranching, petroleum extraction and, in some cases mining)[10]. These states tend towards low population density, and citizens less likely to move away from their native areas. With the exception of Colorado and Texas, these states also tend to less developed high technology industries. All of these factors point to a lower potential success rate for women: the industries are traditionally male-dominated, employ few people in relation to their revenue and are conservative in their technology development, so there is little room for entry even with an advanced education. Additionally the states suffer from lower rates of employment, hence making it a difficult region for a spouse of a faculty member to find a job; for women who want to be close to their families and often have responsibilities to take care of aging parents, moving away is not a desirable option; for Native Americans, staying close to their communities is also important, especially in terms of being role models and helping their communities to develop. All these factors point to a lower success rate for women in STEM fields for the central states when compared with other regions of the country[11].

We therefore deemed it productive to engage the Big 12 institutions: Baylor U., U. of Colorado, Iowa State U., Kansas U., Kansas State U., U. of Missouri, U. of Nebraska, U. of Oklahoma, Oklahoma State U., U. of Texas, Texas A&M U. and Texas Tech U. in a project aimed at improving the climate and opportunities for advancement and leadership for STEM women on these campuses. By working together with common goals and backgrounds, we can better jumpstart the advancement of women. Two of these institutions, Colorado and Kansas State, hold or have held ADVANCE Institutional Transformation (IT) Awards and have established credible programs[12,13]. By showcasing their efforts and by bringing the best practices of other national ADVANCE programs to the Big 12 administrators' attention, we would most effectively bring about change in the region.

The centerpiece of our activity is a biennial Big 12 Workshop on Faculty Recruitment, Retention and Leadership. The first Big 12 Workshop on Faculty Recruitment, Retention

and Leadership was held January 10-11, 2008, at OU: it brought together 13 formulated teams from 10 of the Big 12 schools, with participation from 8 Associate Provosts for diversity, 5 STEM deans, 11 STEM department chairs, and 4 Women's Studies program directors; 30% of the participants were male. We plan to run a second workshop in January 2010 and work collaboratively with these institutions in the interim period.

Figure 1: The Big 12 Workshop on Faculty Recruitment, Retention and Leadership successfully recruited 13 teams from 10 of the Big 12 institutions to convene for 1.5 days of exposure to and discussion of NSF ADVANCE IT initiatives to be adapted to the Big 12. Team leaders, such as Roger Worthington, Chief Diversity Officer at U. Missouri, and Maurice Bryan, Associate Vice Provost for Diversity and Equity at Kansas U., both on far right, outlined plans to collaborate in the Big 12 as an outcome of this workshop.

We feel that cultural change is best achieved and received when undertaken by a team of stakeholders. Indeed, the past ADVANCE IT awards have confirmed this observation *e.g.* Ref.[14]. We therefore structured the workshop around team participation. A similar process has been used by the American Mathematical Society's Mathematicians and Education Reform Forum workshops[15]. Each of the Big 12 schools was invited to the inaugural event in 2008, asking them to bring a team to OU to work on faculty member recruitment, retention and leadership for their own campus. Prospective participants were told that ideally the team would have one administrator (*e.g.* dean), a STEM discipline chairperson, center or institute leader, STEM faculty members and an evaluator or social sciences researcher. We expected that some schools would have a well-developed team and activities to report on, but that many schools would not have such a team or project already in place and would feel the impetus to build one and to initiate some activity. The second workshop two years later would then showcase the fruits these teams' labors and reinforce the collaboration between the Big 12 schools to address the issues of faculty member recruitment, retention and leadership with a specific focus on the advancement of STEM women in academia.

The 2008 workshop activities centered around diversifying the faculty body and building teams and strategies to promote women and other members of underrepresented groups in the faculty body and to positions of leadership. In some of the activities the special focus was on women in STEM disciplines, but we made an effort to keep discussions gender-neutral and to emphasize that best practices benefit all disciplines of these comprehensive universities. The workshop made use of the best practices culled from current NSF ADVANCE IT sites, in particular those that have worked well at large public institutions with strong faculty governance. We chose activities from the IT programs of the universities of Michigan[16], Wisconsin[17], and Washington[14]. As members of the Big 12, we also invited representatives of the Colorado IT program and the Kansas State IT program to report on their activities and share effective practices with the group.

The application process allowed us to communicate with the teams ahead of the workshop and to require that they do some "homework" before they arrived at the

workshop. We requested a summary of their institutional data on underrepresented STEM faculty members on their campus, their institution's policies relating to the climate for underrepresented STEM faculty members, for example whether a spousal hiring program exists or not, or drafting a brief plan of initiatives for increasing the participation of women in STEM leadership positions. Based on experience the second author had with her FORWARD workshops[18,19] (skills for transitioning from PhD to faculty member), we recognized that workshop participants appreciate the impetus provided to kick-start efforts before the event. The products of this activity can be used for instance to pair-share with participants from other institutions, thereby enhancing cross-institution sharing of ideas and methods, and promoting lasting working relationships. FORWARD participants found the pair-share activity very useful and the Big 12 teams did report on their final day of the workshop some cross-institutional plans to collaborate on initiatives.

The program for the inaugural workshop centered on:

1. making the teams aware of issues for women and underrepresented minorities (and others) involving job satisfaction and performance, career/life balance, and advancement in the academic STEM environment,
2. showcasing best practices from ADVANCE IT sites and other initiatives, and
3. encouraging the teams to take action on their campus and in the Big 12 community to improve the climate and diversify the faculty body.

The program is sketched out below. The full 1½ day program for the 2008 Big 12 workshop is available on our website[20].

1st evening:

- General information session about the goals of the workshop and an overview of current problems including: gender bias social science research; and advances in faculty body diversity, recruitment, retention, leadership, climate and satisfaction (including career/life balance); and an overview of the ADVANCE program. Self-introduction of each Big 12 institution team and report on the status of faculty body diversity and initiatives on their home campus as well as their objectives for their workshop participation.

Figure 2: The University of Michigan CRLT players acting a faculty search candidate selection meeting. Characters and scripts are developed based on social science research in the current climate in STEM departments across the US.

- Performance of *The Faculty Meeting*, an interactive play by the University of Michigan CRLT ADVANCE players[16]. This interactive theatre performance exposes, without laying blame, subtle behaviors and attitudes that contribute to a poor climate for women in STEM academia. The plays include sketches that focus on a borderline tenure case, faculty member hiring and faculty member mentoring. We believe that the CRLT ADVANCE plays are a most expeditious way of transmitting the message about the climate for women in STEM academia, in particular at the start of the workshop to get conversations flowing.
- Dinner with a keynote speaker.

2nd day:

- ***1st session:*** More tailored session outlining ADVANCE IT site initiatives with results.
- ***2nd session:*** Parallel sessions attended by different team members (teams split up and rejoin later). 1) Search committee training based on WISELI workshop[17] (see details in next section). 2) Department chair and leadership training based on U. Washington workshop[14].
- ***Lunch:*** Teams reconvene and/or individuals network with other universities.
- ***3rd session:*** Reports of outcomes from existing ADVANCE projects: a) from the overall project coordination side and 2) from the point of view of the effect on an individual's career.
- ***4th session:*** Teams work on formulating initiatives for progress on their own campuses. Teams report to the whole group.
- ***Closing networking dinner.***

The purpose of the three parallel morning sessions was to address each of the three topics: recruitment, retention and leadership within the framework of diversifying the body of STEM faculty. By splitting up the teams, we aimed for maximum information transmittal and networking between like-minded parties at the Big 12 institutions. The slate of speakers was chosen for their expertise and their collective gender, ethnic/racial, disciplinary and position (administrators as well as regular faculty members) diversity.

We expect that, through joint participation and discussion at the workshop and in the interim year, a core set of objectives for the Big 12 will emerge and that initiatives for joint Big 12 efforts will be undertaken. As an example, a possible outcome could be a Big 12 consortium for faculty member hiring similar to the existing ones in California[21,22] and New England[23] that list all the open positions and facilitate faculty member job searches for dual-career couples or persons with geographical restrictions. A stronger collaboration of sharing of information and cooperation on dual-career hiring will be sought. In the final reporting of the teams, we heard several instances of plans to collaborate in the coming year.

The participants evaluated the various sessions of the workshop highly (on average higher than 4 on a 1 (very dissatisfied) – 5 (very satisfied) scale). 100% of the respondents deemed the emphasis on team attendance a positive aspect of the workshop. They expressed the opinion that it would facilitate buy-in and implementation at their home campuses, and in some cases that "[the discussion] wouldn't have happened back at our university". The participants were asked to evaluate their proficiency (*i.e.* experience and level of knowledge) in areas relating to recruiting, retention, and leadership promotion both before and after the workshop. Largest increases in ratings were for 1) "developing strategies for bringing about cultural change in your institution", 2) "reducing the impact of implicit bias in recruitment", and 3) "encouraging members of underrepresented groups at your institution to seek out leadership roles".

The second workshop planned for 2010 will intensify the activities surrounding the advancement of women in STEM disciplines. First, we will expect the teams from the participating institutions to give formal oral reports of their initiatives and the outcomes.

Second, we will continue to expose them to the latest developments and best practices in the field. Third, we will run sessions to help them plan their continued efforts at their campuses. The topics for these sessions will be chosen based on their one year (post-workshop) reports and other communications, such as the "Intent to Return" form, submitted prior to the workshop. Lastly, we will ask them to jointly develop an action plan for the Big 12 group of schools.

What's Cooking at Home?

In addition to our regional focus, our PAID proposal also outlined activities focused on our home campus alone. Given the paramount importance of search committees in the academic hiring process, the OU Advance team decided to focus on search committee training as a principal initial objective. In December 2006, two team members visited the University of Wisconsin-Madison and observed a search training session run by the NSF-funded ADVANCE Women In Science & Engineering Leadership Institute (WISELI)[17]. The following fall under the auspices of the OU College of Arts and Sciences (CAS), the team piloted their "Recruiting for Excellence and Diversity Search Committee Workshop". All search committee chairs, members and chairs of searching departments in CAS were invited to attend the 3½ hour midweek workshop in October. The timing of the workshop was planned after departments had been officially authorized to search and had formed search committees, but before advertisements or any substantive searching had started. Invitations were sent out from the Deans' office and the attendance of the university Provost was made clear to potential participants, greatly increasing the positive responses.

In order to convey the administration's support of diversity, the workshop opened with an official welcome by the Dean who made brief remarks on the value of diversity and its import to the college. The organizers take care at this juncture to emphasize the workshop nature of the session. Many participants were senior faculty members with extensive previous search committee experience. The organizers made it clear that they valued this expertise and arranged the workshop with sufficient discussion time to allow the participants to share their insights in regards to their previous search successes and failures. These discussion periods were interwoven with 15-20 minute presentations by the organizers covering: search committee basics; organization of searches and time commitments; research on factors impacting the impartiality of searches; and methods to diversify the applicant pool. The team made extensive use of resources developed by WISELI.[24] The organizers also supplemented their own expertise by arranging presentations from other members of the university community. These included a joint presentation by a representative of the university legal counsel and the University Equal Opportunity Officer who discussed prohibited hiring practices; most notable was a discussion of unlawful interview questions *(i.e.* those related to marital and parental status, ethnicity and religion *etc*.) A faculty member from a traditionally underrepresented group discussed her perceptions of the interview process both as a candidate and more recently as a search chair. She focused on methods to optimize the on-campus interview and how to present the university in the best light. Finally a chair of a department with a highly successful track record in landing their first choice candidate

spoke on "closing the deal": how to negotiate with the chosen candidate and the upper administration to put together the best offer; how to deal with spousal hire issues; and how to manage the timetable for a response while keeping other desirable candidates viable. The workshop closed with a lunch allowing additional discussion time for participants.

Confidential surveys from participants rated the workshop from good to excellent. The majority of respondents indicated that they had not been previously exposed to the literature on bias in hiring practices and that they learned a great deal from hearing about hiring practices in other disciplines. Most related that they were likely to use some of the covered material in their own upcoming searches.

Upon the successful implementation of a search committee training workshop, the team has identified a few key items, critical to success. Observation of a search training session organized by an established group gave us tremendous headstart. Use of tested materials from other universities also made more efficient use of the team's limited time. Working under the auspices of a College of Arts and Sciences, we found it essential to extend the training session to encompass the humanities rather than restrict ourselves exclusively to STEM fields. Indeed while women may well be the majority of faculty members in some humanities departments, they can still be underutilized relative to the fraction of women amongst recent PhD graduates in the discipline. The team also extended their reach by inviting additional faculty members and staff with targeted expertise to present. The workshop was organized to solicit the expertise of the participants and encourage dialogue between them, nevertheless we made sure to present something new that they had not encountered before (*i.e.* research on implicit bias). The team fully intends to continue these annual workshops and extend them to other colleges, particularly the College of Engineering, in subsequent years.

In addition to the development of resources for better hiring practices, the team has also initiated efforts geared towards improving working conditions for existing women faculty members. Utilizing the social science expertise of the team and drawing from other ADVANCE project climate surveys[6], we developed and administered a survey for faculty members in the colleges of Arts and Sciences, Earth and Energy, Engineering, and Atmospheric and Geographic Sciences. The survey was designed to assess the campus climate by focusing on workloads, access to resources, observations of discrimination *etc*. broken down by race and gender. Analysis of the survey is ongoing, but preliminary evaluation reveals significant job satisfaction in those faculty members who experience positive campus climate, have input into decision making, and are satisfied with university policies. Alternatively, severely decreased job satisfaction is found in faculty members who have experienced/observed subtle and/or overt discrimination.

On a more intimate level, we have also started a distinguished speakers series with an event each semester featuring a renowned expert, and more frequent brown bag lunches for more casual discussion between faculty members. Speakers have included Dr. Ruth Okediji, from the University of Minnesota Law School who spoke on "Negotiating Success: Gender, Leadership and the Academic Culture", Dr. Margaret Rossiter of

Cornell who spoke on "Women Scientists in a Historical Perspective - An Alternative Universe?", Dr. Alice Agogino from the University of California, Berkeley who was one of the authors of the National Academy study on gender in academia[25] and Dr. Aihua Xie from Oklahoma State University who spoke about lessons learned from worldwide efforts to advance women in physics. Recognizing that many female faculty members, particularly in STEM, have partners who are also academics we have also held year-end holiday receptions for dual career couples. Our mailing list surprisingly includes over 60 such couples. During these receptions, which are mostly social events, we have been able to solicit information about specific challenges faced by dual academic career couples even after finding dual employment.

What's Happening in Town?

Figure 3: High school girls at the Oklahoma EPSCoR Women in Science Conference of 2007 listen to a panel of women scientists and engineers.

To supplement our on campus activities, we also have outreach programs expanding beyond the university setting. In February 2007, we organized the scientific panels for a one day conference for pre-collegiate girls/women in grades 7-12. The event held at a local hands-on science museum was enormously successful and attracted over 600 students and their teachers. This conference format and audience has been adopted by a state organization and will be continued on an annual basis. Our university is also home to the National Weather Center, a cooperative enterprise of the University of Oklahoma and the National Oceanic and Atmospheric Administration (NOAA). The ADVANCE team has organized roundtable discussions for female employees of this federal center. We have also presented at the 2007 Conference for the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)[26] in order to reach a more diverse audience and to alert future professionals to the programs for change that are in progress, that they should be on the lookout for as they start their academic careers. In particular, if new candidates start asking institutions if they participate in such programs, the peer pressure effect should be felt and promote a more widespread institutional change for the profession. Lastly, we have also presented our findings in Europe at the PROMETEA International Conference on Women in Engineering and Technology Research[27], in order to exchange ideas and methodologies that work in a number of different cultures and systems. Forthcoming from these exchanges are new collaborations to promote institutional change.

Conclusion

As the numbers of women attaining doctoral degrees in science and engineering increases, it is important to implement practices and policies to ensure that this investment in training women researchers is not lost. Over the last six years a cadre of projects, mostly funded by the US NSF ADVANCE program, have started to change the institutional culture at many US universities. A data-based approach as well as a multi-

pronged approach aimed at individuals, search committees, department chairs and higher level administrators appears to be key to initiating change. Adoption and adaptation of existing ADVANCE initiatives, using research results and proven data, can jumpstart the process. In particular, we found that addressing diversity in general, rather than gender diversity alone, as well as addressing issues for all (men and women, minorities and majorities) is helpful to depoliticize the conversations.

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Acknowledgments

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E

Women in engineering at UBC: A case for support of networking activities

Anja Lanz, Elizabeth Croft and Susana Zoghbi

Abstract

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

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

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

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

Introduction

In March 2006, a web based survey of engineering students at the University of British Columbia was conducted[7]. The aim of this survey was to gather data that can be used to direct research and programs for supporting women in engineering, as well as to advocate for, and inform the development of, programs for all engineering students.

The survey was conducted by the "grassroots" Networking Engineering Women organization at UBC (NEW@UBC)[8]. This survey attempted to investigate a variety of issues that challenge university students in engineering, including support for engineering students in general and women students in particular. Behavioural Research Ethics Board approval was obtained for the survey, and the Faculty of Applied Science, UBC, assisted by emailing the survey invitation to all registered undergraduate engineering students. Graduate students were contacted through their departmental graduate secretaries. Students were also contacted through mailing lists which were set up by NEW@UBC. The complete survey is included in Appendix 1. Since very limited resources were available to complete the survey and no professional statistical consulting services were affordable to the group to set up or refine the questions, or analyze the data, further professional study would be necessary to confirm the results of this work.

Background

The Faculty of Applied Science at UBC comprises the School of Architecture and Landscape Architecture, the School of Nursing, and Engineering. Engineering offers 11 different undergraduate programs leading to the Bachelor of Applied Science degree in chemical and biological, civil, electrical, computer, materials, mechanical, mining, geological, integrated, and environmental engineering as well as engineering physics. The Faculty offers graduate programs leading to the Master of Engineering, Master of Applied Science, and Doctor of Philosophy degrees. Applied Science also comprises the School of Engineering at UBC Okanagan, which offers degree programs in civil, electrical, and mechanical engineering; however these programs commenced after the time of this survey and are not included in this report. The undergraduate program in Vancouver has a common first year after which students apply to join one of the 11 programs listed above.

In 2005, there were 3259 students registered in engineering, of which 600 (18%) were women[1]. Table 1 shows the breakdown of participation of women in the various programs by discipline. Comparison of the numbers reported by the Canadian Council of

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[7] Funding for this survey was provided by the JADE Bridges Programme, NSERC Chair for Women in Science and Engineering, BC/Yukon.

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

Professional Engineers[2] indicates that these numbers are in-line with the national average, which shows a downtrend in the enrollment of women in engineering.

Survey Participation

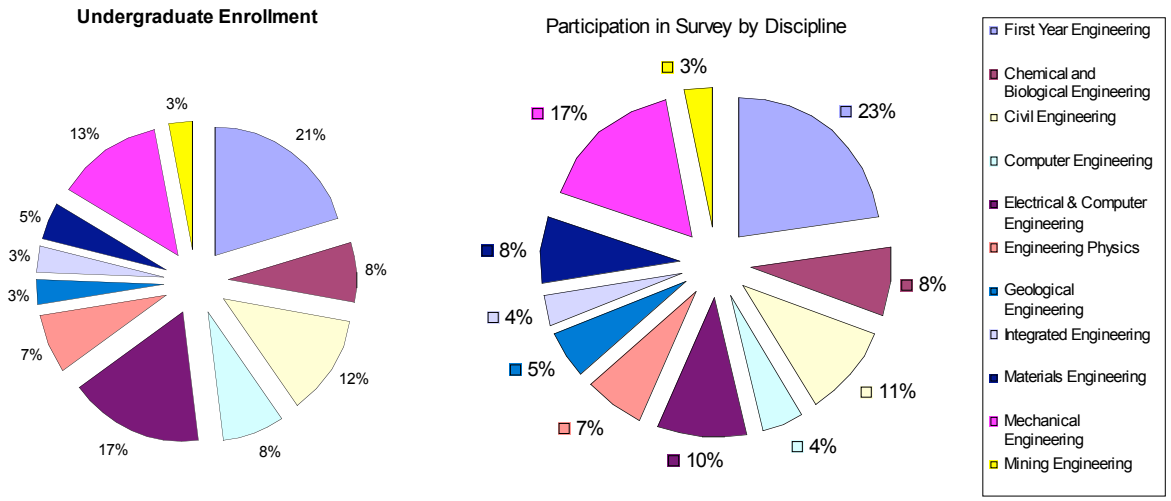
As shown in Table 2, 264 students participated in the survey. Although more men participated than women, the participation rate by women represents 18% of the female student population versus an only ~6% participation rate by men. A small number of graduate students participated in the survey, totaling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

Table 1: Percentage women in Engineering programs at UBC, 2005[1].

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

Table 2: Survey participants by gender.

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



(a) (b)

Figure 5: Undergraduate Participants. (a) Undergraduate enrolment in departments at UBC. (b) Percentage of *undergraduate* student survey respondents by discipline. In both graphs, the largest pie slice represents first year engineering, and from there, the legend is read clockwise.

Table 3: Work environment experience of survey participants.

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

Survey Results

Beyond general demographic information, the survey questions covered the following areas that were hypothesized as being important to the participation and support of students in engineering: departmental climate, student group project involvement, career development, and extra curricular participation. Student views on gender balance within

engineering and whether or not gender barriers exist in engineering were also requested. On these questions, the analysis was performed using a two-tailed t-test against the null hypothesis that there existed no difference between the views of male and female students. The significance level (α) was 0.05.

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

Departmental Climate

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

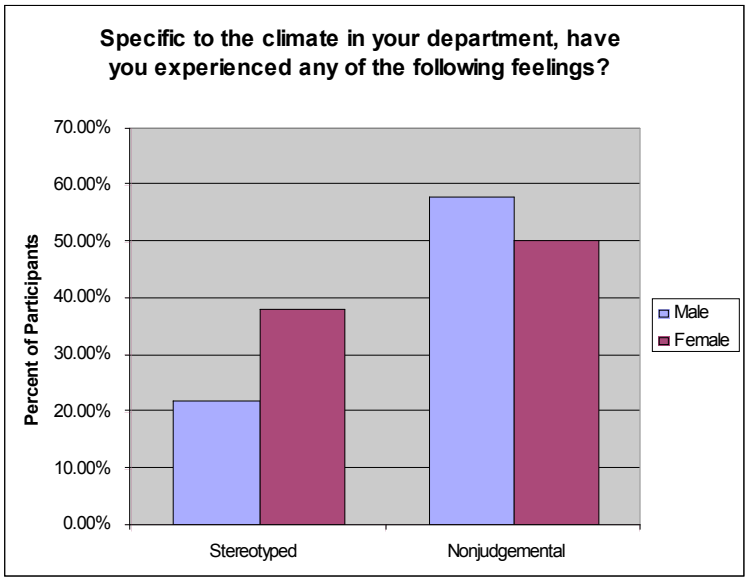


Figure 6: Significant response to feeling of being stereotyped.

Student group project involvement

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

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

Career development

Questions (9) and (10) inquired about skills and support that students felt were necessary to their career, and whether they felt they had sufficient opportunity to obtain such skills

and support. Question (11) inquired about the most effective ways to provide career skills. While there was no significant difference between men and women in terms of the opportunities to obtain skills and support, or the modes of providing desired skills, women found the following career development activities to be more necessary to their education than men:

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

Extra curricular activities

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

Gender Barriers in Engineering

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

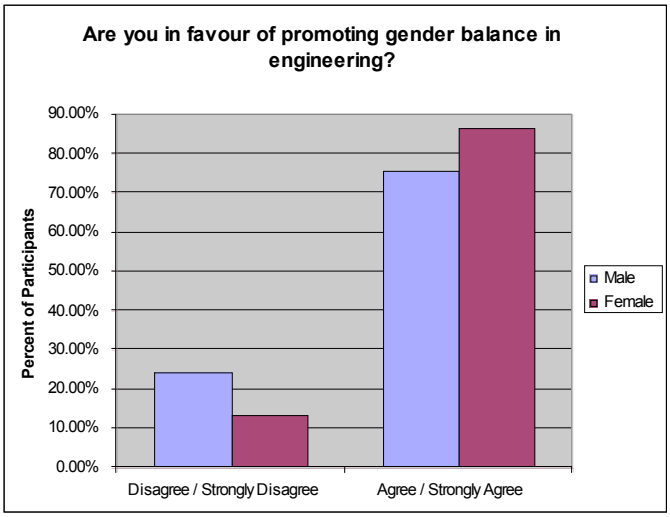
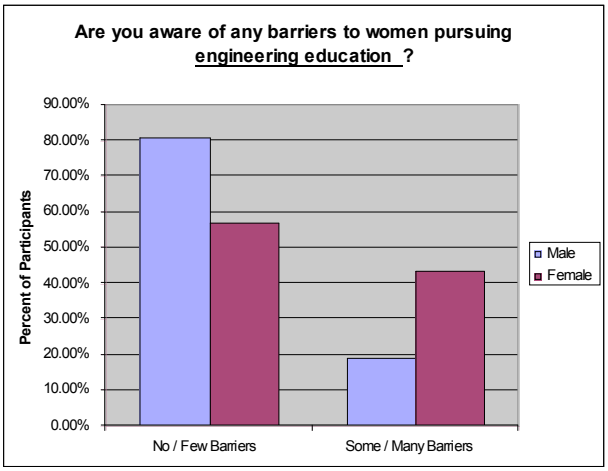


Figure 7: Approximately 80% of students were in favour of promoting gender balance in engineering.



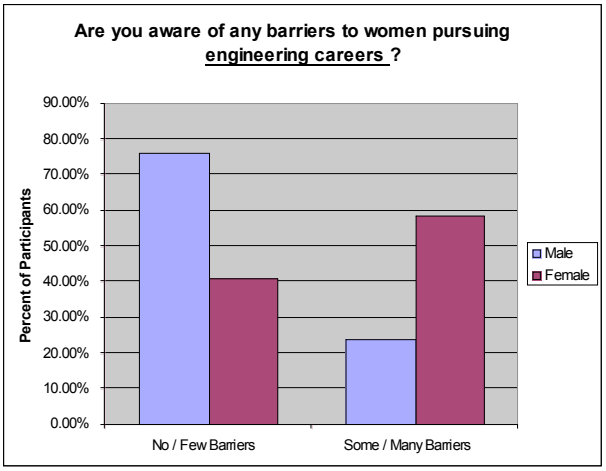


Figure 8: Perception of barriers to women pursuing engineering education and careers.

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

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

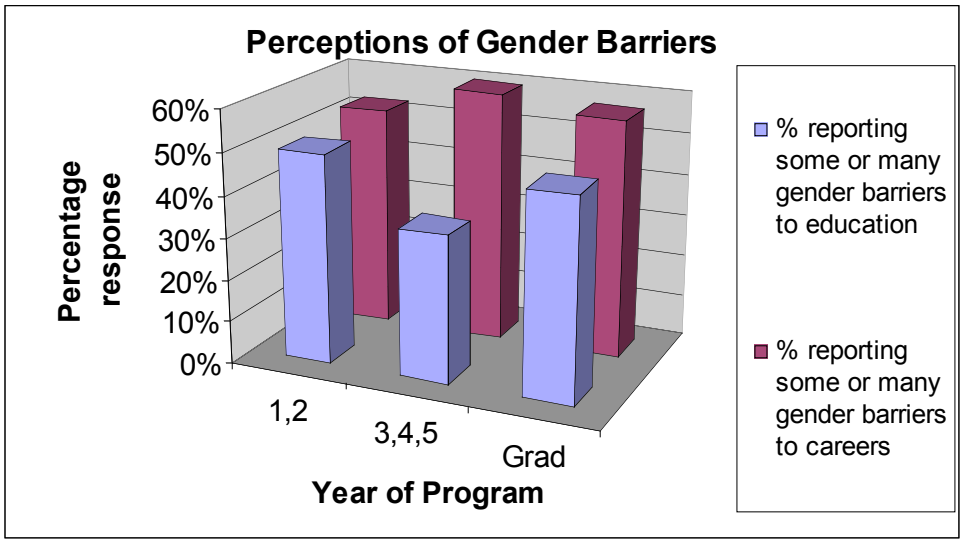


Figure 9: Perception by women students of gender barriers to engineering education and careers.

Women in Engineering Support programs

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

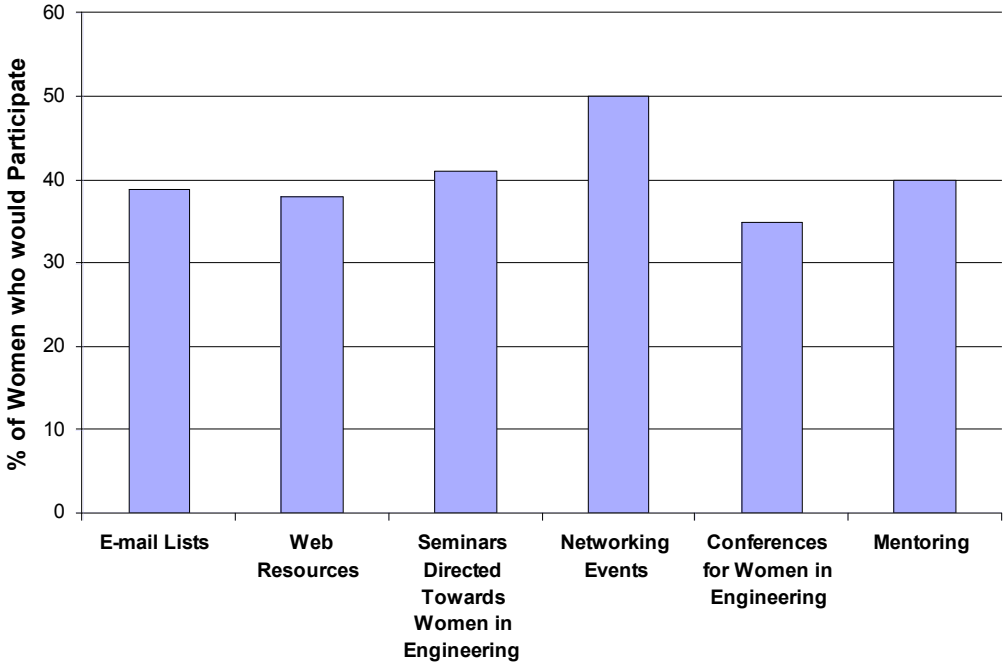


Figure 10: Percentage of women students that indicated they would participate in proposed women-in-engineering support programs.

Outcomes and Recommendations

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

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

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

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

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

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

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

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The authors would like to acknowledge the work of the original NEW@ubc group: Nicole Bennett, Donna Dykeman, Monica Dannon-Schaffer, Kim Bogan, and Dana Kulic who worked on various aspects of

developing and implementing the survey. The support of the JADE Bridges Progamme, NSERC Chair for Women in Science and Engineering, BC/Yukon is also gratefully acknowledged.

F

F

Graduate Students Striking a Balance: Finding the Time and Space for Outreach Initiatives

Celina Gibbs

Abstract

The journey of a doctoral student navigating her way through a PhD program is one of learning, about research as well as of herself and her academic surroundings. A student's research accomplishments are publicly praised and rewarded, but what of service achievements that are so important in the preparation for a chosen academic career and a sense of balance?

As a Computer Science doctoral student, an NSERC-CGS scholarship holder, wife and mother of two I have been in search of a balance between research, teaching and family. Time seems to always be the critical factor, and so when introduced to the opportunity to contribute to outreach initiatives within our department I did not see where it fit in. The question that arises is: Where exactly does outreach fit into the many priorities of a graduate student?

Introduction

For myself, I have used my outreach initiatives to make my two daughters aware of the need for community involvement including them as helpers and participant in outreach activities that I am involved with. I have proposed a panel/workshop in which participants can share experiences with respect to the impact of outreach in terms of their families, supervisors, department and faculties, universities and communities. This could serve as a forum for sharing strategies for managing and incorporating these activities into a lifestyle. This paper outlines some of my experiences in terms of academic research and outreach initiatives and attempt to manage and integrate the two. Section 1 begins by over viewing my past and present academic research, Section 2 overviews the outreach initiatives I am involved in and Section 3 overviews my intent to combine both research and outreach initiatives.

Academic Research

My research focus has been in the combined areas of systems and software engineering. Specifically, my MSc research investigated the impact of Aspect-Oriented Software Development (AOSD) on the evolution of a memory management subsystem within a Java Virtual Machine (JVM). This work was based on the premise that many rapidly evolving systems eventually require extensive restructuring in order to effectively support further evolution where, these overhauls reverberate throughout the system.

The success of this initial project led to the ability to partner with international researchers in a project proposing a programming model to support the real-time systems development and the memory management complexities that come along with this complex environment. Specifically, this project integrated my expertise in AOSD in the systems domain with my colleagues' expertise in real-time systems to provide a disciplined approach to real-time design and implementation.

Current Reseach Initiatives

Ideal incarnations of composite-services that rely heavily on underlying systems infrastructure and middleware are increasingly difficult to achieve due to unanticipated external environmental conditions. Considering application logic in static isolation from infrastructure that supports it does not yield a clear dynamic understanding of the dependencies that impact adaptation. Further, complications associated with the context sensitive nature of these dependencies is amplified in web applications which are further subject to dynamic factors such as server load and network traffic.

The ensuing unpredictability makes system-wide tuning particularly difficult to accomplish from a static context alone. My research proposes tool support to enable system-wide diagnosis and adaptation that allows developers to apply and reconcile system monitoring globally across operating systems, virtual machines and applications.

Identifying the best fit, both in terms of structure and dynamic interactions, requires more than monitoring and detection of anomalies. It is necessary to provide a means for comparison of one structure, service, or adaptation, against another in a way that considers dynamic interactions. Again, tool support is proposed for the comparison of multiple competing structural representations of a system. Applying this model of customizable and systematic observation, detection, comparison and adaptation, reveals the optimal organizations of system infrastructures.

Outreach Initiatives

I have been heavily involved in many avenues of outreach initiatives as part of the SPARCS group [4] at the University of Victoria. In my initial contributions in this area, I was the founder and initial organizer of the After School Club Children's Programming group which introduced students ranging from ages 7 to 13 years to computer science. Each session was centered on an activity to be performed individually or in small groups. After establishing a model for these sessions, I mentored undergraduate students to take on the offering and development of these sessions. The success of this model has lead to it growth and expansion to be a full registered program sponsored and run by SPARCS and Women in Engineering and Computer Science at the University of Victoria.

Since this original participation in outreach initiatives, I have moved my focus to concentrate more exclusively in the area of Aboriginal outreach. In growing up in a small town in close proximity to three First Nations communities I was cognizant of the struggles many First Nation's students faced in the education system, but it was not until

recently that I saw an opportunity to contribute to addressing these educational issues. In the summer of 2007 through a small NSERC Pacific grant and support from the Jade Project Brides Programme [2], the ACCESS (Aboriginal Connections with Computing, Engineering, and Software Systems) Project was conceived.

The June 1, 2007 Globe and Mail article, "Aboriginal Academics Breathing New Life into Canada's Ivory Tower", tells the story of successful First Nations graduate students from Indigenous communities across Canada. The article indicates a disconnect may exist between typical academic offerings and the resulting ability for these students to use education to give back to and strengthen their own communities. Specifically, the story of Michelle Hogan beginning as a Computer Science student but switching to a major in Indigenous studies after an elective in Native History includes the candid observation that, "suddenly all the computer stuff I was studying didn't feel useful any more". Observations such as this raise the question as to how we might better facilitate a connection to areas such as Computer Science within these communities. This connection is the focal point of the ACCESS project.

Though the issue of under representation of Indigenous peoples in the field of Computer Science is a key motivator for this project, more specifically the project's goal is to investigate the ways in which Computer Science and Engineering education connections can be better established, maintained and nurtured in these largely remote communities.

An essential part of the success of this project has been the support and co-ordination of the UVic's Office of Indigenous Affairs which is focused on supporting UVic's strong commitment to Indigenous education. The connections made through Fran Hunt-Jinnouchi , the Director of UVic's Office of Indigenous Affairs has allowed us to reach both remote and local Victoria First Nations communities. Through Fran, communication with local Indigenous communities was established, including Tseycum, Tsawout and the Esquimalt Nation as well as allowing us to contribute along with Let's Talk Science [5] to a three week Indigenous youth camp organized by the Tsawout Nation.

During the three days spent in UVic's Computer Science Department, students were given the opportunity to explore their environmental surroundings using new technology: Google Maps and Google Earth; CRD camera on Race Rocks; and images from the Venus/Neptune project off of Cordova Spit located on Tsawout land. They also participated in unplugged activities, a robotics workshop, group problem solving activities, and had an opportunity to write a program to create their own version of the game of Pong using the SCRATCH programming environment.

Through these initial connections a request for a multi-level technical training program for both youth and adults was requested from First Nations Communities. A pilot program for youth partially funded by a BC government was developed and offered in November 2007 within the Tsawout First Nation community. This twenty-hour workshop was run over ten evenings and covered six core computer science topics with a main focus on core computer knowledge, programming and problem solving skills. For

example, in the hardware and file systems component we hoped to familiarize students with some of the essential pieces of hardware that make up the computer. Our goal was to prepare the students to be able to do basic troubleshooting within the community and feel confident in the purchase of their own computer. The programming component introduced general concepts of conditionals, looping, and branching using the graphical programming language called Scratch, developed at MIT. With this component, students were not only introduced to programming concepts that first university students encounter, but they exercised their problem solving and math skills in the process.

In terms of redeployment of this workshop, a meeting was held with the Tsawout and Tseycum First Nations in December 2007 with regard to offering a version of this workshop tailored to Elders in the community. The idea is to have some of the youth attend this workshop as mentors to the elders learning this material. This program is still in the development stages.

Since these initial offerings, ACCESS has begun to work on initiatives in remote regions. A meeting was held in January 2008 on Northern Vancouver Island to investigate the offering of a similar technical workshop in Port Hardy in the spring of 2008 to support distance education on the North Island. This meeting and workshop offering comes as a request from the communities in support of a distance education module that is being set up in the North Island over the coming year. Since that meeting the workshop outline has been developed and is awaiting feedback from the community.

Further, the importance of family within these communities as well as my relationship with my daughters has inspired a sub-program of ACCESS called AWAKE: Aboriginal Women Acquiring Knowledge through Engineering. This program, through partial funding by the Jade Bridges Project will specifically target aboriginal women and their children from both local and remote communities in a set of workshops.

Combining Research and Outreach?

Up until now, these outreach initiative have focused on teaching computer science and technology in local and remote Aboriginal communities in a face-to-face way approach. In order to combine these outreach initiatives with my area of systems research I am looking at ways to support distance education through IT infrastructure. This research would focus on how the use of technology to provide E-Learning solutions could provide a means to reach the largely remote Aboriginal population, what that learning environment would have to provide in terms of material and social support as well as the scalability of this approach.

The concept of a Virtual Learning Lodge (VLL) [3] was proposed by UVic's Department of Child and Youth Care (CYC). Based on the results of a survey [1] of 34 communities across BC, the top three requirements for the VLL are:

1. That the environment be dynamic—highly interactive and interpersonal.
2. That the system itself be adaptable as technology evolves, so as to be able to easily incorporate new features.

3. That the system be easy to evolve with respect to the understanding of interactions, in particular between Aboriginal students and technology.

Based on our teaching experiences to date and these high-level specification we can begin to establish the requirements of a virtual learning environment for Aboriginal learners.

Conclusion

Fitting outreach initiatives into the busy schedule of a student is difficult. In my experience, this work has been labor intensive and time consuming. The ability to manage the time associated with these initiatives is key to maintaining a balance. Combining outreach and research is one strategy for trying manage, but not always possible.

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G

Women in SETT (Science, Engineering, Trades and Technology) - Providing Resources for Industry and Post-Secondary Institutions

Margaret-Ann Armour, Hiromi Matsui and Carolyn J. Emerson

Introduction

The anticipated retirement of the 'baby boom' generation, decreasing birth rates, and the significant growth of natural resource and construction sector projects has meant that there are increasing national labour shortfalls. There will be a skilled labour force deficit in Canada of 1.2 million by 2025.[1] With the numbers of immigrant and temporary workers not being sufficient to fill these gaps, employers are recognizing the importance of recruiting and retaining employees from currently under-represented groups such as women. In 2006, however, Canadian women while 47% of the labour force, were only 12% of professional engineers and 4% of the construction workforce.[2] Are there opportunities for employer needs to be met in a sustained way by more effective practices to increase the participation of women in the science, engineering, trades and technology (SETT) workforce?

Women in SETT Initiative

In 2003, the Canadian Coalition of Women in Engineering, Science, Trades and Technology (CCWESTT) embarked on the Women in SETT Initiative to effect change at the institutional level to increase the recruitment and retention of women in SETT fields. In earlier phases of the initiative, we consulted with women in SETT and stakeholders to identify issues and priorities, developed the business case for the benefits of increased participation of women[3], and proposed the development of a Canadian Centre for the Advancement of Women in Science, Engineering, Trades and Technology.[4] The WinSETT Centre will be the catalyst for the on-going and sustained employment and advancement of women in SETT fields. The Centre will achieve its mission by developing and disseminating, through collaboration and partnerships, the tools and expertise useful to industry, government, educational institutions and women in SETT organizations to recruit, retain, and promote women in SETT.

Delivery of Tools and Services

In 2007-08, as pilots of the services and resources to be provided by the national Centre, the WinSETT initiative developed and delivered tools and data to employers to strengthen the recruitment and retention of women in SETT fields. Initially, these resources were designed for four specific sectors - construction / trades; post-secondary; oil and gas; and information technology. The resources consisted of workshops, presentations, strategic plans, and publications for human resource specialists, managers, deans and directors, and professional women in SETT. Full details on these initiatives

are being presented in separate presentations at the 12th CCWESTT Conference and appear in the Proceedings. [5, 6, 7]

a) Construction Sector / Trades. *Welcoming Women into Science, Engineering, Trades and Technology Workplaces: A Checklist of Strategies*[8] was produced as a practical booklet for use in workshops for employers and associations in the construction sector to identify issues, examine the workplace, and take actions to create work environments welcoming to women in the skilled trades. The resource includes current research and effective practices spanning the topics of recruitment, selection orientation, retention, career development, training, and health and safety, and provides questions to help guide the employer in developing their own action plan. Two facilitated pilot workshops based on the Checklist were successfully delivered to company owners, human resource personnel and sector representatives in Saskatchewan (Regina and Saskatoon) and to union representatives from the building trades council in St. John's, Newfoundland and Labrador (the latter delivered in partnership with Women in Resource Development Committee). Evaluation was highly affirmative with participants agreeing that the information was accurate and relevant and will have a positive impact on their workplaces.

b) Post-Secondary Sector. *Project Catalyst* resources including facilitator's discussion notes have been developed to advance effective strategies to increase the recruitment and retention of female university faculty in science and engineering in Canadian universities. The project has been disseminated through presentations and discussions with administrators, hiring committees and faculty in universities and colleges in Canada and at meetings internationally. Results at the University of Alberta have been very encouraging with significant increases in the numbers of new women faculty hired in their science faculty departments. For example, there has been a 50% increase in the percentage of women in the Department of Physics and a 66% increase in the Department of Mathematics and Statistics.

c) Oil and Gas Sector. While this sector has shown strong growth in both western and eastern Canada, the retention of women scientists and engineers has been noted as an issue. The *WinSETT / Becoming Leaders Career Success Workshop* was designed for presentation to early to mid-career women scientists and engineers in the oil and gas industry with the objective of increasing their retention and strengthening leadership potential. Participants are informed about the factors that influence career success and learn about high value skills to ensure recognition for their achievements and improve access to professional advancement. The initial pilot *Career Success: Skills and Strategies Workshop* is to be delivered to female engineers and scientists from two major petroleum companies in Calgary in late April. Dr. F. Mary Williams principal designer of the *Becoming Leaders*™ series of workshops will facilitate the event and outcomes will be presented at the CCWESTT Conference.

d) Information Technology Sector. CCWESTT's member organization, Hypatia Association, is working with a major aerospace IT and communications client in Nova Scotia on a retention project for women technologists in their workforce. The

project is in its fourth phase with Hypatia advising on the development of the company's strategic plan for increased recruitment and retention of women.

Advisory Panel

Providing strategic counsel in this phase of work of the WinSETT Initiative is a panel of eminent advisors:

- Barbara Byers, Executive VP of the Canadian Labour Congress
- Senator Lillian Dyck, prominent university scientist and aboriginal leader
- George Gritziotis, Executive Director of the Construction Sector Council
- Dr. Eric Newell, Chancellor, University of Alberta and former Chair and CEO of Syncrude Canada

Progress Toward a Canadian Centre for the Advancement of Women in SETT

The Working Committee has continued to advance the goal of establishing the Canadian Centre for the Advancement of Women in SETT through meetings with representatives of industry, post-secondary institutions, sector organizations and associations, and governments. Of particular note are the high level discussions with senior members and staff of the Alberta Government. Planning documents and a draft budget for the proposed Centre have been presented in response to requests for information. The outcomes of the delivery of tools and services are assisting in this process by generating endorsements and statements of support by industry stakeholders. Funding proposals are being drafted for obtaining the resources to complete the Centre business plan and begin implementation of its establishment.

Conference Panel Discussion

The panel will discuss the delivery and evaluation of the pilot resources and the plans for establishing the WinSETT Centre. The audience will be invited to present their perspectives and ideas on these major undertakings.

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Can women avoid the Research-Publication Vortex?

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One of the most important factors determining the success of academic scientists is their ability to acquire funding for research. In addition to actually paying for research expenses and graduate students, research funding is often a yardstick for the evaluation of how successful an individual is: Will they be promoted? Will they receive awards? Are they "high fliers"? An equally important yardstick of success in the scientific world is the number of publications produced by an individual and their research team. For this reason the level of research funding is crucial to the careers of academics and this may be reflected in the success of male and female scientists and engineers. Funding and publications are tightly connected. If funding is low, research will be limited and publications reduced. Fewer publications will lead to reduced funding in the future (Figure 1). I refer to this as the "research-publication vortex." It is easy to spiral down in this vortex with dire consequences to academic success.

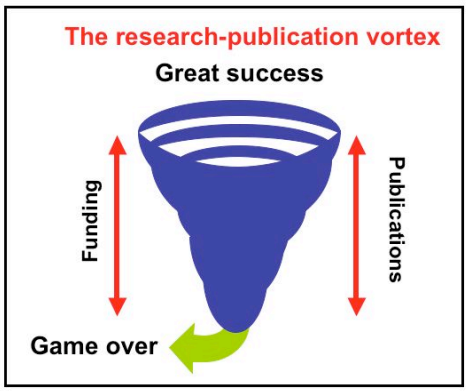

Figure 1. The research-publication vortex. Publication rate is directly related to funding and funding directly related to publications. Reduced productivity can rapidly lead to the end of the game.

The success of women in obtaining research funding has been the topic of many studies. An analysis of research funding in 26 European countries showed that men received more research funding in 17 countries and women more in 9 (differences not all significant)[1]. What is the situation in Canada?

Federal research funding for scientists and engineers in Canada comes from the Natural Science and Engineering Research Council (NSERC). Discovery Grants are the core of funding for university and some government laboratory researchers. The success rate for these grants is relatively high, approximately 94% for renewal applicants, but grant sizes are relatively low compared to international standards. Currently the grants are for 5 years. The results of the competitions are posted each year and before 2005 it was possible to use these lists to determine the level of funding for women and men applicants based on the first names given on the lists. More recently only the initials of applicants are provided on publicly available lists so any information about grants to men and women must be obtained directly from NSERC.

For the 2004 to 2005 fiscal year I compared the sizes of grants awarded to men and women in five disciplines that had a reasonable number of female applicants. For all of these the average amount of grants awarded to women were smaller by the following percentages: Chemistry -15%, Ecology and Evolution -24%, Cell Biology -3%, Plant Biology -7% and Psychology -19%. Only the differences for the Ecology and Evolution and Psychology Committees are statistically significant (Table 1). It is interesting that these are the committees with the most female applicants and also the lowest average grant sizes. The overall success rates of applications from men and women for the years 2002-2007 were the same, 71% (information from Dave Bowen, NSERC).

Category	**Men**	**se**	**N**	**Women**	**se**	**N**	**Signif.**
Psychology	$26,377	1935	68	$21,273	1621	70	P<0.03
Ecology	$28,846	1407	104	$21,784	1628	34	P<0.01
Plant Biol.	$36,031	1642	30	$33,367	2677	67	NS
Chemistry	$46,938	3092	76	$39,688	5845	8	NS
Cell Biology	$39,160	1997	51	$37,800	1289	33	NS

Table 1. NSERC Discovery Grants in 2004-2005 for 5 areas of research. Gender of recipients based on first names. NS - nonsignificant.

Because I am an Ecologist and because the differential was the highest for the Ecology-Evolution category I obtained more information to look at the long-term trends in funding levels in this area. Figure 2A shows the overall trend for women to receive smaller grants and in some years they are considerably smaller, approximately $6700 less on average in 2005 and $7500 less in 2007, while in other years they are only slightly smaller (2006 and 2008). A possible explanation of the differential between the sizes of grants of women and men is that more women are coming into the academic stream and thus are more junior and receive smaller grants. If this explained the pattern of reduced

funding, the differential in funding between men and women receiving their first grants, generally the more junior applicants, should show less of a differential than those receiving renewal grants. This tends not to be the case although in 2007 and 2008 the average grants to new female applicants were considerably larger than those to males ($3,092 in 2007 and $4,467 in 2008)(Figure 2B). Sample sizes are particularly small for first time female applicants and thus standard errors given for 2008 are large.

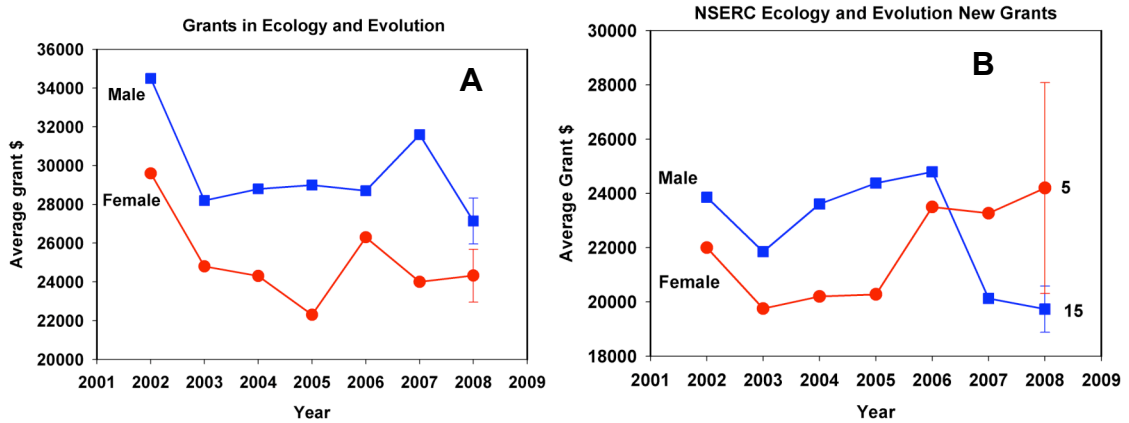

Figure 2A. Average NSERC Discovery grant sizes for all categories of male and female applicants in the areas of ecology and evolution. Figure 2 B. Average NSERC Discovery grant sizes for Canadian men and women in the area of ecology and evolution applying for the first time to the program. Only have summarized data are available for 2002 to 2007 and standard error bars are given for 2008 as well as the number of new applicants.

This advantage to new female applicants in 2007 and 2008 was reversed for those seeking renewals in that year. Females in the renewal category received on average $6137 less than their male colleagues in 2007 and $5531 less in 2008 (Figure 3). Thus the overall trend is for grants of women to be less in that year (Figure 2A). In 2006 the average renewal grants of women were higher than those of men by $3371 and in 2002 they were the same, but in 2005 they received on average a whopping $8581 less than men. Given that grants are for 5 years this differential can have serious impacts on the academic careers of researchers.

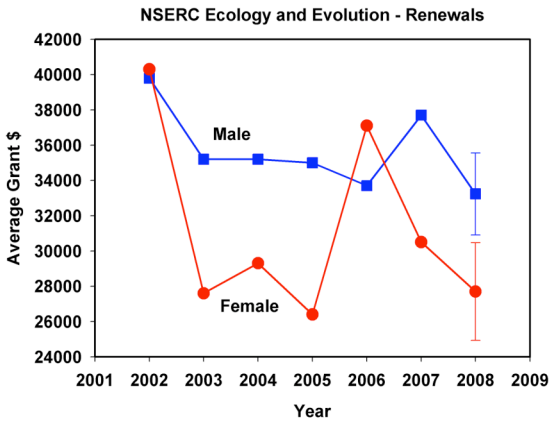

Figure 3. Average NSERC Discovery grant sizes for Canadian men and women in the area of ecology and evolution who were previously successful and are renewing their grants. Standard error bars are given for 2008.

NSERC grant competitions have a strong "memory" component such that the size of the first grant will have a large impact on the size of subsequent renewals. The overall tendency for women in Ecology and Evolution to receive smaller grants will be reflected throughout their careers and this differential is sufficient to have an impact. In Canada the sizes of NSERC grants are correlated with the number of publications of applicants (http://www.nserc.gc.ca/about/bibliometric_app3_e.htm#table11). This will contribute to the tendency for women to spiral down the publication vortex. The question is what causes the differences in grant sizes; some gender-based bias in the selection process or some systemic difference in the profiles of men and women?

In 1997 the classic study of Wenneras and Wold[2] showed that in the evaluations of the Swedish Medical Research Council postdoctoral competition, women were given lower competence scores than men for the same standardized impact factor. Recently Ledin et al.[3] analyzed the success rate of women receiving European Molecular Biology Organization's (EMBO) Long-Term Fellowships and selection for the Young Investigator Programme. Approximately half the applications for these awards were from women, but women received 20% fewer awards than men. To determine if the lower success rate of women in obtaining EMBO fellowships was influenced by some unrecognized gender bias in evaluation of applicants, they carried out a study in which all indications of the gender of the applicant was removed from the application. The higher success rate of male applicants still occurred. The authors next considered other characteristics that might lead to the greater success of male applicants. This analysis showed that both successful and unsuccessful female applicants had fewer publications than the male applicants. For those receiving the award, the publications of women had a slightly, but non-significantly, lower impact factor (citations to the study) on average. A survey of applicants for the 1998 Long-Term Fellowships showed some other differences among women and men that might influence research productivity: more women had partners with a Ph.D., had partners that worked more than 46 hours a week, and had moved for a partner. Trends were similar in a study carried out in 2006. All of these characteristics could influence the research success of women.

The transition between being a postdoctoral fellow and a Principal Investigator is one in which women seem to drop out of the pipeline. Martinez et al.[4] investigated the transition from postdoctoral fellow to PI for scientists with the National Institute of Health in the US. As with the European study cited above, more women than men reported having a spouse who worked more than 40 hours a week and more men than women reported that a spouse cared for their children during the day. While 59% of the males responding to the survey said they were confident that they would receive a PI position, only 40% of women thought they would be successful. Important factors for women that would make a PI position more attractive were childcare availability and flexible working hours. This study indicates that women often are not as confident as men about going on in a research career.

A study of the acquisition of research grant support by male and female faculty at eight Harvard Medical School-affiliated institutions identified another factor that might influence the variation in the research funding of men and women[5]. Women requested lower amounts and shorter periods of funding and this was reflected in the amount of funding they received. This study was based on 6319 applications and thus a small difference in the success rates of men and women was significant (45% for men and 41% for women). It would be interesting to know if this variation in the amount of funding requested by men and women was also the case for NSERC applicants in Ecology and Evolution.

All of these differences that have been identified between the research funding and careers of men and women could also be reflected in their publication rates. Symonds et al.[6] analyzed the patterns of publication of men and women researchers in Ecology and Evolution. They showed that in the first four years after the first publication, the mean number of publications per year of the women was lower than that of men. For the next 5 years the publications of women increased at a rate parallel to their male colleagues. Another decline occurred 8 to 10 years after the first publication. Whether this pattern is general is not known, but it could possibly be interpreted in terms of the impacts of motherhood and childcare on the publication rate of women. The study of Symonds et al.[5] also considered how a reduced publication rate can influence the commonly used measures of the impact of scientists' work and this may too influence the success of women.

In addition to reduced research funding as a possible cause of fewer publications by women, another interesting impact on women's publication rate was discovered by the study of Budden et al.[7] of impacts of a double blind review process. Acceptance of papers in which women were the senior authors increased significantly in the journal Behavioral Ecology that initiated a double-blind reviewing procedure. No similar trends were observed in other comparable journals that did not obscure the names of the authors. The cause of this shift is not known, but one can speculate that normally papers by well-known senior scientists, who are more likely to be male, do not receive the same critical review as those by junior female authors. It is my experience that women respond to having papers rejected by being slow to resubmit to another journal and this has long-term impacts on their rate of publication.

In conclusion research has shown various ways in which women can enter the research-publication vortex. Are there ways in which this pattern can be changed? Mentoring may help with strong encouragement for women graduate students to avoid the dip in productivity in the early years of their career. If they are moving to accommodate a partner or having a baby at this time, a change to this publication profile might be difficult. Another approach may be to look at the system of selection for research funding. We all have our biases and it is likely that these creep in to our decisions when evaluating research proposals as indicated by the study of Wenneras and Wold[6]. It is certainly likely that grant reviewers have biases about different types of research and if

men and women tended to do different types of research, this bias could be reflected in the selection.

An approach to research funding that would avoid gender bias is to divide the available funds in proportion to the number of male and female applicants and allocate the two funding resources independently. No one that I have talked to thinks this is a good idea although it would seem to have merit in assuring that women got a fair share of the research funding pie. A more acceptable procedure to reduce the rate of decline into the publication vortex would be to use an index of publications per research dollar for evaluating applications for grants. There is a tendency to say that this person has more publications than another and therefore they are more productive. But if research dollars are directly related to the numbers of students and publications, these latter factors could be converted to a per dollar basis. This would allow research productivity to be evaluated for those who have already been funded, but would not help those applying for grants for the first time.

There are no simple solutions to this conundrum but awareness of potential biases of selection committees and paper referees, and consideration of the differences in life style characteristics of men and women, may help to make the process of funding grants and reviewing papers more fair to women scientists and engineers in the future.

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Biography

Judy Myers is a population ecologist recently retired from the University of British Columbia. She served for 8 years an Associate Dean of Science to promote the hiring and retention of women students and faculty in Science at UBC. She is currently the president of CCWESTT.

I

Retaining Girls in Science: Exploring the Effects of the Operation Minerva Program

Terri L. MacDonald

Abstract

This paper presents findings from a three year study exploring the impact of a junior high science intervention program for girls. The purpose of the study is to explore the effects of the operation minerva program across eduational sectors (public, catholic, alternative) with respect to the intervention experience, course and career plans, and attitudes and factors influencing female science retention. Findings suggest that the operation minerva program is effective at encouraging girls to pursue science as evidenced by 60% of participants reporting plans to enrol in at least three senior (level 30) science and math courses, 91% reporting plans to pursue post-secondary science and 89% reporting plans to pursue a career in science. An exploration of attitudes and factors influencing science retention reveals continuing concerns related to family-career balance and the positive impact of interest and ability, female science role models, applied science experiences, and parental support. Findings are discussed as they relate to intervention program organizers, female science mentors, educators, and stakeholders from industry and government.

Introduction

Driven by concerns over junior high girls losing interest in science, the Operation Minerva Program was established to provide girls with hands-on experience in various fields of science and engineering. The program, now in its 15th year in Calgary, has expanded to urban and rural areas across Alberta (e.g. Red Deer, Medicine Hat, Fort McMurray, Athabasca, Grand Prairie and Pincher Creek). Approximately 90 girls and 30 female science mentors participate in the one-day Calgary Operation Minerva Program in May of each year. Student participants job-shadow their mentor and participate in hand-on activities that bring out special aspects of the job. For example, a mentor in the oil and gas industry demonstrated how one can drill for oil by removing chocolate from a cake "ground". Students have also utilized three-dimensional software for generating geological models and examined mutations in fruit flies through the use of a specialized microscope.

The purpose of the study is to explore the effects of the Operation Minerva Program across educational sectors (public, catholic, alternative) with respect to the intervention experience, course and career plans, and attitudes and factors influencing female science retention. The experiences of both students and science mentors are explored. Recommendations are provided for intervention program organizers, educators, women scientists, and stakeholders from industry and government. This paper presents findings from the 3-year study.

Literature Review

Retaining Girls in Science

Literature outlining gender differences in science achievement, enrollment, and employment reinforce the need to focus efforts on attracting and retaining females in science. At the elementary and junior high levels, girls perform as well as their male counterparts until age 13, when they begin to slip behind in science achievement (Connolly, Hatchette & McMaster, 1999). This gap increases each year until senior high, when females select few relevant electives, exhibit more negative attitudes and, by the end of high school, score considerably lower than boys in math and science (Oakes, 1990).

Enrollment patterns at the secondary, post-secondary and graduate levels reveal a similar trend. Compared to males, females enroll disproportionately more in senior high biology courses while avoiding other sciences, especially physics (Johnson, 1987). By university, women comprised only 22% of full-time students in engineering and applied sciences in 1997-98, up from 3% in 1972-73. Enrollment in mathematics and physical sciences rose from 19% in 1972-73 to 29% in 1997-98. By graduate school, the gender gap in science enrollment increases with women comprising only 23% of doctoral mathematics and physical science students, and only 16% of those in engineering and applied sciences (Statistics Canada, 2000, 87). Recent statistics indicate that women remain the minority, representing 21% of engineering, mathematics and natural science professionals. Post-secondary enrollment statistics also indicate that females continue to be under-represented in engineering, mathematics and science (Statistics Canada, 2003, 10). Regardless of educational attainment across all disciplines, female university graduates employed full-time earned 73% of what men made in 1997 (Statistics Canada, 2000, 141).

Attrition: Biological, Sociological and Educational Influences

Females decide not to pursue science courses and careers due to a combination of factors. Biological influences alone do not exclude girls from science; sociological and educational influences represent spheres that have a significant influence on attrition. Nevertheless, some scholars continue to use biology, and more specifically brain measurement (Moir & Jessel, 1991; Klekamp, Riedel, Harper, & Kretschmann, 1991), to justify girls' under-participation in science. Feminist scholars have critiqued these studies by highlighting the ways in which biological determinism has driven and ultimately distorted findings. As Kaplan and Rogers (1994) note, a desire to prove gender and race differences in brain functioning is an attempt to provide an apparent scientific rationale for the existing social order. Recent research exploring cognitive abilities suggests that gender is not a sufficient explanation for the under-participation of

females in science. Following a review of twenty-three studies involving over 7,600 clinical interviews, McArthur and Wellner (1996) discover minimal gender differences in visual-spatial abilities. In their meta-analysis, Hyde and Linn (2006) considered more than 5000 studies based on the testing of approximately 7 million people and found girls and boys to have similar cognitive abilities although significant gender differences were identified in the areas of physical aggression and activity level. These findings support the assertion that biology is not a sufficient explanation for female science attrition. Regardless, not all females, or males for that matter, are destined to be scientists. Of concern however, are those females who have science aptitude but leave science due to limited opportunity and a lack of necessary supports.

A number of scholars highlight the influence of factors other than biology on the attrition of females from science. Research on early childhood play reveals that boys are more competitive, confrontational and individualistic, while girls are more cooperative, accepting, sociable, and intimate (Grugeon, 1993). As children mature, more boys than girls report having participated in science-related activities. Although girls desired more involvement with science activities, they lacked previous experience (Kahle & Lakes, 1983). This lack of experience may be correlated to gender differences with respect to interest in science. Jones, Howe and Rua (2000) discovered significant gender differences in sixth grade students' attitudes and experiences related to science. While boys were most likely to have engaged in extracurricular experiences with a variety of tools such as electric toys, fuses, batteries and microscopes, girls reported experiences with bread-making, knitting, sewing and planting seeds. And while boys were more interested in atomic bombs, atoms, cars, computers, x-rays, and technology, girls reported interest in animal communication, rainbows, healthy eating, weather, and AIDS. Students' perceptions of science revealed significantly more females than males reported that science was difficult to understand, whereas more males reported that science was destructive and dangerous, as well as more 'suitable' for boys.

Differences in psychological development help to explain girls' focus on relationships as opposed to competition (Gilligan, 1982). Girls are particularly vulnerable during adolescence due to a strong relationship orientation, coupled with low autonomy and self confidence. This susceptibility greatly impacts a girl's construction of herself and significantly impacts her life choices. Science experiences that do not nurture these aspects of girls' psychological development can be enough to deter her from selecting science courses in high school and in turn, narrow her science course and career options in the future. Psychological differences and different access to science-related activities highlight the importance of providing girls with meaningful science experiences starting at an early age, especially at the junior high level.

A number of recent studies point to the role of parents in providing encouragement and access to out-of-school science experiences. In a study of naturally occurring family conversation, Crowley, Callanan, Tenenbaum and Allen (2001) found parents to be three times more likely to explain science to their pre-school boys than girls. Simpkins, Davis-Kean and Eccles (2005) discovered parents' behaviours to be powerful positive predictors of elementary school children's participation in computer, math, and science

activities. In a study of parent-adolescent conversations about science Tenenbaum and Leaper (2003) discovered parents were more likely to believe that science was less interesting and more difficult for daughters than sons. They also found that parents' beliefs significantly predicted children's interest and self-efficacy in science. When parents' teaching language was explored, fathers tended to use more cognitively demanding speech with sons than daughters. The above studies point to parental influence as an important factor in science retention. Parents should be aware of how their beliefs, behaviours and language can work to encourage or discourage their child's interest in science.

Teaching approach, classroom / school culture, student-teacher interaction, and peer influences each have significant educational influences on science attrition. In terms of teaching approach, gender inclusive strategies including an emphasis on relationships resonate with girls' interest in the connections to life, ownership of learning and a feeling of efficacy. In addition, facilitating learning through relational knowing does not deter male students from liking science (Hutchinson, 1996). Classroom culture also influences science attrition. An inquiry into graphic representations of scientists in classrooms revealed males made up 93% of images (Jones & Wheatly, 1989). In addition, science textbooks may contain subtle forms of sexism in the selection of language, images, and curricular content (Potter & Rosser, 1992). Research on student-teacher interaction in science classrooms revealed that females are at a disadvantage in terms of teacher time, (Haggerty, 1991) opportunities to carry out demonstrations, (Jones & Wheatly, 1989), and engagement in higher order questioning (Shakeshaft, 1986). Recent debates have focused on single-sex schooling in order to counter adolescent boys' dominant participation in the science classroom. However, findings from Dreves and Jovanovic (1998) clarify that girls with higher ability perceptions at the beginning of the school year were likely to remain confident throughout the year, actively engage in hands-on activities, and not perceive boys as the dominant participants in the classroom. While their findings suggest that the process by which girls come to view themselves as less able in science than boys is more complex than simply implicating dominance in the classroom, girls with lower confidence levels remain susceptible to classroom influences. Kessels (2003) further illuminates the impact of peer influence on science attitudes and interest. In a study of 8th and 9th graders, she discovered that girls perceived physics to be a masculine subject, and girls whose favourite subject was physics were perceived as more masculine than feminine. Both boys and girls held negative stereotypes (e.g. unattractive) of girls who liked or did well in science. Girls with good grades in physics considered themselves to be particularly unpopular with boys.

For girls with science aptitude, a number of interrelated influences can work to either encourage or discourage their continued participation in science. Future retention efforts should ensure that learning materials and hands-on science activities relate to girls' interests. Parents should be reminded that their beliefs, behaviours, and language have a significant impact on girls' science choices. Educators should be aware of gender bias in learning materials, classroom examples, and student engagement, and provide extra support and encouragement to promising female and male students. Parents and educators could also help to counter negative stereotypes associated with girls who do

well in science by highlighting the exciting career options available to both girls and boys who decide to continue with science pursuits.

Project Methodology

A total of 295 junior high girls participated in the Operation Minerva Program from 2005 to 2007, with 265 girls completing the survey (response rate 90%). Of the 265 respondents, 100 were from the public sector, 83 were from the catholic sector, and 82 were from the alternative sector (drawn from public, catholic, charter and independent schools). An estimated total of 90 mentors participated each year of the program with 77 completing the mentor survey over three years (response rate of 29%).

Table 1. Respondents by Educational Sectors

Sector	2005	2006	2007	Total
Public	27	41	32	100
Catholic	29	31	23	83
Alternative	26	20	36	82
Mentors	29	21	27	77

Survey questions related to the Operation Minerva experience were imported from the Operation Minerva 2004 formative evaluation survey. One question was added to the mentor questionnaire: "what attracted you to becoming a mentor". Questions related to plans for science studies and career choices were imported from MacDonald (2000). The exception is a question exploring senior high science course enrollment plans. This question was revised to gather more specific information on science course choice in the Alberta context.

Questions relating to attitudes influencing science retention were taken from Smith & Erb's (1986) Women in Science Scale (WiSS), a tool used to measure attitudes of adolescents toward women in science careers. Five attitudinal questions from the twenty-seven item questionnaire were chosen for inclusion in the current research as a follow-up to a retrospective study of 1991 Operation Minerva program participants (MacDonald, 2000). While former Operation Minerva participants (six years following their participation in the program) were found to possess very positive attitudes toward women and science according to Likert scores, five of the twenty-seven questions revealed less positive attitudes. These five questions are included in both the student and mentor questionnaires in order to further explore these controversial statements. While these controversial questions do not relate specifically to science careers, they do focus mainly

on statements related to family – career balance from the female perspective. Questions related to factors influencing science pursuits were generated from a literature review and included qualitative findings from MacDonald (2000, 2004). Quantitative data from questionnaires was analyzed according to descriptive statistics. Qualitative data from questionnaires was analyzed according to grounded theory (Strauss & Corbin, 1990) and presented according to the percentage of respondents indicating each theme.

The Operation Minerva Experience

Participants indicated the most enjoyable and interesting features of their job shadowing experience were *hands on activities and exposure to applied examples (67%), exposure to female science role models and career options (29%), lectures, presentations and meetings (5%),* and *other (5%). 'Other'* responses focused primarily on enjoying lunch with mentors.

Table 2. Most Enjoyable Features of the Operation Minerva Program

Most enjoyable features	Public	Catholic	Alternative	Total
hands on / applied experiences	77%	77%	45%	67%
exposure to female scientists & career options	32%	31%	23%	29%
lectures, meetings & presentations	3%	6%	4%	4%
other	7%	4%	2%	5%

The least enjoyable aspects of the job-shadowing experience included: *lectures, meetings & presentations (26%), amount / type of information (14%), not enough hand-on / applied science activities (7%), length of experience (4%), student groupings (2%),* and *other (9%).* A number of respondents also commented that all aspects of the experience were enjoyable (14%). Comments related to amount / type of information suggested comprehension of some material was an issue. In addition, respondents recommended more time with mentors, and specifically more one-on-one time with mentors.

Table 2. Least Enjoyable Features of the Operation Minerva Program

Least enjoyable features	Public	Catholic	Alternative	Total
lectures, meetings, presentations	31%	17%	28%	26%
all enjoyable	17%	13%	11%	14%
amount / type of information	8%	27%	9%	14%
not enough hands on / applied experiences	7%	7%	6%	7%

length of OM experience	3%	5%	5%	4%
student grouping	2%	0%	5%	2%
other	10%	6%	11%	9%

Participants recommended the following improvements to the Operation Minerva Program*: more hands-on / applied science activities (23%), lengthen the experience (11%), student preferences for types of job shadowing experience (10%), smaller participant groups (10%), more time spent with mentors (7%),* and *'other'(10%)* mainly related to coordination of transportation.

Table 3. Recommendations for Improvements to the Operation Minerva Program

Recommendations for OM Improvements	**Public**	**Catholic**	**Alternative**	**Total**
more hands on / applied experiences	18%	27%	24%	23%
lengthen / expand the experience	13%	8%	10%	11%
all positive / no recommendations	17%	10%	5%	11%
preferences for job shadowing experiences	7%	10%	13%	10%
smaller participant groupings	9%	7%	13%	10%
more time spent with mentors	6%	8%	6%	7%
other	6%	6%	20%	10%

Mentors were also presented with a series of open-ended questions related to their experience with the Operation Minerva Program. When asked "what attracted you to becoming a mentor" respondents indicated: *opportunity to encourage girls / promote science (68%), recruited through friend / workplace (18%), similar personal experience (17%), rewarding / opportunity to volunteer (9%),* and *opportunity to network with other mentors (3%).* When asked if they enjoyed having the students for the time period given mentors commented on *the enjoyment of their time spent with student participants (38%)*, *amount of time including 'too much' and 'too little' (14%), challenges / recommendations related to effectively engaging students (10%), effective student / mentor grouping (6%),* and *'other' focused mainly on details of the experience (6%).*

Mentors were also asked what they gained from the Operation Minerva experience. Comments included *self reflection / rewarding experience (36%), interaction with students (32%), opportunity to inspire / potential impact (32%),* and *networking with other mentors (4%).* When asked for recommendations on how to improve the Operation Minerva experience, mentors focused comments on *improved mentor / student preparation (19%), expanding / lengthening the program (10%), improved selection of students (ensure interest) (9%), match student occupational preferences (5%),* and *'other' (5%).* Commentary related to improved preparation focused on students as opposed to mentors and comments on the selection of students related to grade level, ensuring interest level, and targeting 'at risk' students.

Science Course Enrollment and Career Plans

60% of Operation Minerva participants reported plans to pursue at least three senior high math and science courses. As outlined in Table 4, 71% Operation Minerva participants planned to enroll in pure math 30, 64% planned to enroll in biology 30, 60% planned to enroll in chemistry 30, and 48% planned to enroll in physics 30. This finding suggests that Operation Minerva is somewhat effective at encouraging girls to enroll in senior high school science courses. Level 30 science and math courses are a requirement for most post-secondary science programs and as such are critical to the pursuit of a career in science. The lower percentage of students planning to enroll in physics 30 is consistent with Johnson's (1987) finding that girls enroll disproportionately more in senior high biology courses while avoiding other sciences, especially physics (Johnson, 1987). Mentors, intervention program organizers, parents and teachers should emphasize the importance of continued science and math course enrollment in senior high.

Table 4. Planned Senior High Courses by Sector (%)

Senior High Courses	Public	Catholic	Alternative	All Sector Total
pure math 30	70%	73%	68%	71%
chemistry 30	60%	58%	61%	60%
biology 30	67%	52%	73%	64%
physics 30	46%	43%	54%	48%

According to educational sector representation, the highest percentage of Operation Minerva participants planning to enroll in chemistry 30 (61%), biology 30 (73%), and physics 30 (54%) were from the alternative sector, and the highest number of participants planning to enroll in math 30 were from the catholic sector. It is also interesting to note that only 52% of catholic sector participants reported plans to pursue senior biology in comparison to 67% of public sector and 73% of alternative sector participants. This finding contradicts previous research that suggests girls are most likely to enroll in senior high biology courses (Johnson, 1987).

As outlined in Table 5, 68% of Operation Minerva participants reported plans to pursue a post-secondary science degree or diploma, 23% of participants planned to pursue at least

one post-secondary science course, 3% planned *not* to take a post-secondary science course, and 6% were unsure of post-secondary plans. A comparison of educational sectors reveals a high percentage of alternative (76%) and public (70%) sector participants planned to pursue a post-secondary science degree as opposed to only 59% of catholic sector participants. Considering 91% of participants plan to pursue a science degree / diploma or at least one post-secondary course the Operation Minerva Program is effective at encouraging girls to continue science course enrollment at the post-secondary level.

Table 5. Planned Post-Secondary Science Pursuits by Sector (%)

Post-Secondary Science Courses	Public	Catholic	Alternative	All Sector Total
post-secondary science degree	70%	59%	76%	68%
at least one post-secondary science courses	21%	33%	16%	23%
no post secondary science	3%	0%	5%	3%
unsure	5%	8%	4%	6%

It is interesting to note that while 91% of respondents reported plans to pursue science at the post-secondary level (either a degree or at least one course), only 60% of respondents reported plans to pursue at least three senior high science / math courses. This finding points to a disjoint between planned senior high science and post-secondary science enrollment. As stated above, mentors, intervention program organizers, parents and teachers should continue to stress the importance of senior science and math course enrollment as a prerequisite to most post-secondary science programs.

Table 6. Consideration of a Science Career by Sector (%)

Career Plans	Public	Catholic	Alternative	All Sector Total
science career	86%	90%	91%	89%
non science career	11%	10%	7%	9%

89% of Operation Minerva participants reported plans to pursue a science-related career. This finding suggests that the Operation Minerva Program is effective at encouraging girls to consider a career in science. Sector comparisons reveal minimal deviation. Themes from qualitative comments included *preferred occupations (52%), the influence of interest on science & career choices (25%), uncertainty over career choice (12%),* and *preference for non-science occupations (7%).*

Attitudes Influencing Science Choices

As stated in the methodology, questions relating to attitudes influencing science retention were taken from Smith & Erb's (1986) Women in Science Scale (WiSS), a tool used to

measure attitudes of adolescents toward women in science careers. Five attitudinal statements from the twenty-seven item scale were chosen for inclusion in the current research as a follow-up to a retrospective study of 1991 Operation Minerva Program participants. (MacDonald, 2000) A 6-point Likert scale was used for each statement (strongly disagree to strongly agree; 1 - 6). While these statements do not relate specifically to science careers, they do focus on attitudes related to family – career balance from the female perspective. In addition, while these statements were described by participants (students and mentors) as outdated and archaic, it is a useful exercise to explore controversial attitudes related to gender, career choice, and family-career balance.

Table 7 presents levels of agreement (including somewhat to strongly agree) for each statement. 13% of Operation Minerva participants across all sectors agreed that for a woman it is more important to be a successful wife and mother than it is to be successful in a career. 8% of participants agreed that getting married is the most important thing in a woman's life. 5% of participants agreed it was better for a woman to study home economics than chemistry, 4% agreed a woman's basic responsibility is raising children, and 3% agreed that careers are good for women as long as they are not the boss.

Comparisons across educational sectors reveal that public sector and catholic sector participants were more likely to agree with controversial attitudinal statements than alternative sector participants. Of particular interest, 19% of public sector and 12% of catholic sector participants agreed that being a wife and mother was more important than career success, and 10% of catholic sector and 8% of public sector participants agreed that marriage was the most important thing in a woman's life. These findings suggest that career – family balance continues to be an area of concern (with family identified as the priority) for girls especially those from pubic and catholic schools.

Table 7. Agreement with Women in Science Attitudinal Statements (%)

Science Attitudes	Public	Catholic	Alternative	All Sector Total	Mentors
Careers are good for women as long as they are not the boss.	5%	2%	2%	3%	0%
A woman's basic responsibility is raising children.	6%	2%	4%	4%	8%
Getting married is the most important thing in a woman's life.	8%	10%	6%	8%	4%
For a woman it is more important to be a successful wife and	19%	12%	6%	13%	25%

mother than it is to be successful in a career.					
It is better for a woman to study home economics than chemistry.	5%	6%	2%	5%	1%

Qualitative themes from participant's additional comments related to attitudinal statements further illuminate concerns related to characteristics, opportunity, and compatibility. 24% of respondents provided commentary on *characteristics* indicating girls have the aptitude to succeed in science, 15% indicated *equal opportunities* exist, and 13% of provided commentary related to *compatibility* with the majority indicating women can achieve both career and family success.

Mentors strongly disagreed with three out of the five attitudinal statements. However, a surprising 25% of mentors agreed that being a good wife and mother was more important than career success and 8% of mentors agreed that a woman's basic responsibility is raising children. 4% agreed that getting married is the most important thing in a woman's life, 1% agreed that it is better for a woman to study home economics than chemistry, and 0% agreed that careers are good for women as long as they are not the boss. Additional comments from mentors focused on *compatibility* (integrating a science career with family life) (47%), *equal opportunities* exist (8%), and *characteristics* (women have the aptitude to succeed in science) (3%). The majority of mentors clarified that family and career success is possible with balance. In addition, the majority of mentors indicated the priority is motherhood over career especially when children are young. 25% of mentors and 12% of student respondents also reacted to controversial attitudinal statements describing them as outdated and archaic.

Overall, only a small percentage of participants and mentors expressed a level of agreement to controversial attitudinal statements. Regardless, it is interesting to note that family-career balance continues to be a contentious issue. Mentors, parents, and teachers should be encouraged to discuss science career compatibility concerns with girls; highlighting success in both spheres is possible with balance. Stakeholders from industry should attempt to accommodate employees through flexible hours and job sharing as men and women strive to achieve a healthy work-family balance.

Factors Influencing Science Retention

Potential factors influencing science pursuits were generated from a literature review and qualitative findings from MacDonald. (2000, 2004) Table 8 presents levels of agreement (including somewhat to strongly agree) for each factor across sectors and also includes mentor responses. Strongest reported influences reported by student respondents included: interest in science (90%), impact of female role models / mentors (85%), science ability (85%), and impact of classroom learning (77%). A high number of participants also reported parental influence (72%), impact of 'out of school' science experiences (66%), and impact of the peer network (63%). 38% of participants reported

media and 16% of participants reported traditional stereotypes as factors influencing their decision to pursue (or not to pursue) science. Strongest influences reported by mentors included: interest (92%), ability (83%), parental influence (70%), out of school experiences (68%), classroom learning (62%), and role models / mentors (55%). Mentors also reported peer network (45%), media (26%), and traditional stereotypes (17%) influence science choices. It is interesting to note differences between student and mentor responses related to role models / mentors and peer network suggesting mentors underestimate the influence of these retention factors. Results support findings from MacDonald's (2000, 2004) retrospective study of Operation Minerva participants that highlighted influences on science career choice including: parental influences, the positive impact of the Operation Minerva Program, the positive influence of interest and ability, and the positive influence of hands-on science learning.

Participant qualitative comments reinforce the impact of the following factors on science choices: *science interest and ability* (15%), *impact of the Operation Minerva Program* (5%), *social influences* (5%), and *hands on science learning (5%)*. Mentor qualitative comments focused on *recommendations for / the impact of intervention efforts (38%), hands on science learning (29%), societal influences (8%),* and *science interest and ability (5%)*.

Table 8. Factors Influencing Science Retention (%)

Retention Factors	Public	Catholic	Alternative	All Sector Total	Mentors
interest	89%	90%	91%	90%	92%
role models / mentors	82%	87%	87%	85%	55%
ability	84%	86%	87%	85%	83%
classroom learning	76%	73%	80%	77%	62%
parental influence	76%	61%	77%	72%	70%
out of school experiences	70%	64%	63%	66%	68%
peer network	57%	64%	70%	63%	45%
media	39%	40%	37%	38%	26%

traditional stereotypes	18%	18%	12%	16%	17%

Participants were asked to provide recommendations on how best to retain girls in science. Student comments focused on *recommendations for / impact of Operation Minerva (30%), the positive influence of science interest and ability (17%), the positive influence of hands on science learning (13%),* and *social influences (12%).* Mentor comments focused on *recommendations for / impact of Operation Minerva (38%), the positive influence hands on science learning (29%), social influences (8%),* and *the positive influence of science interest and ability (5%).* Recommendations for future intervention efforts focused on continued exposure to science career options through classroom speakers, role model and job shadowing opportunities, and videos.

Additional comments provided by participants focused on the *positive impact of the Operation Minerva Program (43%), recommendations for the Operation Minerva Program (9%), social influences (2%),* and *interest and ability (1%).* Additional comments provided by mentors focused on *the positive impact of the Operation Minerva Program* (41%), *recommendations for Operation Minerva improvements (24%), social influences (20%),* and *the positive impact of hands-on science learning (14%).*

Conclusion and Recommendations

Findings from this three year study reveal minimal differences with respect to intervention experience, science course enrollment and career plans, science attitudes, and the impact of factors influencing attrition across educational sectors. Respondents across all sectors agreed that improvements to the intervention experience should focus on hands-on science activities, lengthening the experience, ensuring the provision of age-appropriate information, more one-on-one time with mentors, and matching occupational preferences. Mentors also recommended lengthening the experience and matching occupational preferences, and added improved student preparation and improved selection of students with interest in science as a prerequisite.

Planned senior science and math course enrollment revealed only 60% of respondents planned to enroll in at least three senior high science and math courses. This finding suggests that girls need additional encouragement to continue to enroll in science at the secondary level. In contrast, a high percentage (91%) of participants reported plans to pursue science at the post-secondary level (degree or at least one science course) and are considering a science career (89%). This finding highlights a disjoint between planned senior science and post-secondary enrollment and suggests that girls need to be reminded that senior math and science courses are prerequisites for post-secondary programs and science careers.

A few interesting differences were discovered across educational sectors. A comparatively low percentage of catholic sector participants reported plans to pursue senior high biology and a comparatively high percentage of alternative sector participants planned to pursue senior high physics. In addition, a comparatively low number of

catholic sector participants reported plans to pursue a post-secondary science degree. Educators, especially those from the catholic sector, should encourage girls with science aptitude to continue to enroll in senior science courses and consider post-secondary science degree programs.

A consideration of science attitudes influencing career choice revealed girls and mentors believe females have both the characteristics and equal opportunity to succeed in the scientific field. However, levels of agreement to attitudinal statements suggest concerns over family-career balance persist for both girls and mentors. While qualitative comments clarify respondents believe success in both spheres is possible with balance, future efforts should include continued discussion of this contentious issue. Mentors should be encouraged to discuss strategies used to achieve this balance in their everyday lives. A consideration of factors influencing science retention revealed interest and ability are powerful predictors of continued science pursuits. Role models, mentors, parents, peers and hands-on-science experiences were also reported to be influential science retention factors. Minimal differences across educational sectors appeared in relation to attitudes and factors influencing retention. The exception was a comparatively high percentage of public sector and low percentage of alternative sector respondents reporting concerns related to family-career balance.

Findings from this study are consistent with the literature review and suggest that the success of future retention efforts requires the understanding and contribution of a cross-section of stakeholders including educators, intervention program organizers, women scientists, and stakeholders from community, industry and government. Women scientists should make themselves available to intervention programs. Within these programs, role models should continue to address concerns related to family-career balance, engage girls in applied science experiences, and stress the importance of continued senior science course enrollment. Educators should continue to encourage girls in science through the use of hands-on, applied learning experiences, exposure to science career options, and the use of 'female friendly' examples and applications in order to connect to girls' interests. Parents should continue to encourage their daughters in science by engaging in 'out of school' applied science experiences, encouraging secondary and post-secondary science enrollment, and discussing science career options. Stakeholders from industry and government should continue to support science intervention programs through funding support, job shadowing opportunities, and encouraging employees to become mentors. While the Operation Minerva Program envisions a future full of possibilities for females in science, it is up parents, schools and science communities to work together to ensure that this vision becomes a reality.

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Bridging the Age Gap: Creating Fun Science Programs for All Ages

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Abstract

WISE-UP (Women in Science and Engineering Undergraduate Project) was formed in 2004, and was the first known organization of its kind in Canada. WISE-UP is affiliated with WISE-NL (Women in Science and Engineering Newfoundland and Labrador), and

acts as a support network for female undergraduate students studying science and engineering. Along with increasing awareness of gender inequality and career opportunities, the group is involved in several outreach programs which promote scientific careers to young people. WISE-UP is involved with the WISE-NL SSEP (Student Summer Employment Program), which offers science and engineering summer jobs to girls in grade 11 who may be considering careers in these fields. WISE-UP also visits Girl Guide groups and schools, offering demonstrations and interactive activities that are both entertaining and educational, exposing the audience to a variety of careers in the fields of science and engineering.

This paper will address the key steps required when creating a fun, educational and cost-effective outreach program for young women. Such programs can be offered in conjunction with existing extracurricular programs or offered independently. A case study of a successful WISE-UP program, offered in association with Girl Guides of Canada (Guides du Canada), will be discussed. This program involves regular visits to Spark, Brownie, Guide and Pathfinder groups, working with them to complete their science and engineering badges. This paper will cover aspects such as how to create and modify a program to suit the target audience, as well as how to market the program and maximize the use of available resources. In particular, it will also be shown how the Guide program was modified to suit the educational curriculum guidelines for school presentations.

Introduction

There is no question that the percentage of women in science and engineering has increased over the past 50 years. However, statistical studies regarding female involvement in these fields yield troubling results. A study performed by the National Science Foundation (NSF) in 2001 showed that women received only 16% of PhD degrees awarded in engineering, 16% in computer sciences, 24% in physical sciences, and 43% in biological and agricultural studies.[3] A report published in 2007 by UNESCO's Institute for Statistics (UIS) indicates that women represent less than 30% of researchers in 34 out of the 89 countries surveyed, with gender parity being achieved in only 17-18% of the countries surveyed.[1] Worldwide, women represent only 10% of top tier researchers. These figures are at best a cause for concern, leading one to ask why women continue to be under-represented in most areas of science. A lack of promotion in the primary to secondary education levels is a definite suspect. Science is often portrayed as a male-oriented field, with few jobs available in fields generically associated women. In 2006, Miller *et al*. studied gender differences in High School students regarding their views of science. When female students were asked why they did not plan to study science in the future, the following comments were made:[2]

> When I study science I can in no way relate it to people, the world and the philosophy of why we are here (planning to pursue English).
>
> I think science, like chemistry, males relate to more. I don't exactly know why though (planning to pursue Education).

Such views regarding science and engineering leave women who decide to pursue such careers feeling isolated and alone in a male-dominated world.

WISE-UP (Women in Science and Engineering Undergraduate Project), the first known group of its kind, is a Memorial University of Newfoundland (MUN) society that was formed in 2004 as a support network for female undergraduate students studying science and engineering.[4] WISE-UP is very active in the community, offering interactive science and engineering programs to youth groups and schools in the area. These programs, developed by members of WISE-UP, were designed to be entertaining and educational while simultaneously introducing young people to exciting careers in scientific fields. This paper provides an outline of WISE-UP's experiences while creating these programs and provides a series of guidelines to facilitate the creation of similar programs.

WISE-UP

WISE-UP was founded in 2004 by Allison Noftal and Heather Brown. These two undergraduate engineering students had participated in a WISE-NL (Women in Science and Engineering Newfoundland and Labrador) program called SSEP (Student Summer Employment Program). The SSEP program gives grade 11 girls the opportunity to work for a summer in a science or engineering field. Their experiences with this program encouraged them to enrol in the engineering faculty at MUN (Memorial University of Newfoundland) at which time they also decided to join WISE-NL as undergraduate members. After attending several WISE-NL events, they became acutely aware that they were the only undergraduate students in WISE-NL. Although there were existing programs for high school students (SSEP), graduate students (GSS- Graduate Student Section) and post-graduates (WISE-NL), no program was available for undergraduate students. In February 2003, Noftal and Brown approached the office of the NSERC/Petro-Canada Chair for Women in Science and Engineering, Atlantic Region (CWSEA) about creating a sub-unit for undergraduate students in science and engineering. In April, WISE-UP was formed and had over 20 members by the close of its inaugural year.

While the primary goal of WISE-UP is to act as a support network for young women pursuing scientific careers, the group also aims to increase awareness of gender inequality and to promote scientific career opportunities, specifically to young people. The group receives invaluable support from WISE-NL, CWSEA, as well as from the Faculties of Engineering and Science (including the Biology, Chemistry and Physics and Physical Oceanography departments) and MUNSU (Memorial University of Newfoundland Student Union).

Science programs are offered to Girl Guide groups at the Spark (5-6 years old), Brownie (7-8 years old), Guide (9-11 years old), and Pathfinder (12-14 years old) levels. The program began when a local Guide leader (referred to as a "Guider" within the organization) contacted WISE-UP regarding assistance with their engineering badge. The members of WISE-UP attended a meeting with the group, introducing them to a variety of engineering disciplines. The presentation was so well received that a program for Pathfinders was developed. At the time, the group members were primarily engineers. However, in 2005 a group of science students joined and further developed the

Girl Guide Program. Two of these students, Holly Baker (Physics), who is a Guider, and Erica Lester (Biochemistry) obtained the Guide badge requirements and created chemistry and physics activities that complemented the existing engineering program. As word of the WISE-UP Guide Badge Program spread through the Guiding community, leaders from Brownie and Spark groups approached WISE-UP requesting similar programs for their groups. WISE-UP currently offers the following programs:

Pathfinder career night

Members of WISE-UP lead a group discussion about different career opportunities available to women in the fields of science and engineering. This discussion often extends to gender issues, and the challenges that women face when entering male-dominated careers.

Guide badges

Three different badges are currently offered to Guides: engineering, chemistry and physics.

Engineering: The engineering badge focuses on four disciplines of engineering. The Guides are divided into four groups, and WISE-UP sets up four stations. The first station is naval engineering, where the girls build tinfoil boats, learning about buoyancy and stability by testing their boats with pennies. At the second station, electrical engineering, basic circuits are introduced. The girls then use this knowledge to create their own circuits and to solve puzzles. At the civil engineering station, the girls learn about the properties of mixtures by making tasty “asphalt” cookies. Finally, at the mechanical engineering station, the girls learn how simple machines are used to make fun toys, and participate in catapult competitions. A chemical engineering station is sometimes substituted for another discipline when the supplies are unavailable. At the chemical engineering station, the girls learn about how chemistry is harnessed to do work by building mini rockets.

Chemistry: The chemistry badge focuses on chemical reactions and the properties of matter. Interactive demonstrations, such as an oscillating reaction and a reaction that makes nylon, are followed by a hands-on activity where the girls create their own polymer (“slime”) from white glue and borax cleaning solution. The girls then learn about how the properties of matter change with temperature through demonstrations that involve the freezing of regular items with liquid nitrogen and dry ice.

Physics: During the physics program, the girls learn how bubbles form and why they are shaped like spheres. Following a discussion of pressure, the girls participate in a craft, making bubble blowers out of paper cones that are able to create surprisingly large bubbles. Then the concept of angular momentum is introduced using a bicycle wheel and rotating platform that demonstrates the concepts in a fun and active way. This helps relate the abstract concept to real life by using examples such as riding a bicycle/unicycle and spinning a top.

Brownie badge

The Girl Guide program for Brownies is organized differently than the other Girl Guide sections. It is organized into “Keys” and each key has a set of interest badges. Keys are typically completed during group meetings, while interest badges are completed individually. WISE-UP members visit Brownie groups to help them complete their “Key to STEM” (Science, Technology, Engineering and Math). The demonstrations are a combination of the ones used in the Guide physics and chemistry badges; however the explanations are adapted to suit the age group.

Sparks badge

The program for the Sparks age group is an adaptation of the brownie badge, with less physics and fewer demonstrations, and more introduction as to what is science, as well as some basic information on the safety precautions scientists take (lab coats, gloves, safety glasses, etc). If time allows, each girl gets to dress up as a scientist and get their picture taken.

While science education is a major goal of the WISE-UP badge programs, the primary aim and greatest achievement of the project is getting young people interested and excited about science. In many instances, the audience has misconceptions about what a scientist does. Clarifying these misconceptions and introducing the students to good role models working in scientific fields opens the doors to many possibilities that the audience may not have considered. The demonstrations used are always exciting, colourful and attention grabbing for the age group targeted. For the younger audiences, baking soda and vinegar is often sufficient, however for the older audiences, making nylon in a beaker or creating “warm snow” is something that they have never seen before and can get excited about. For this reason, everything done during a program is fun, interactive and easily adaptable to any age group. Often, the adult chaperones of groups will comment afterward about how much they learned themselves during a program.

<u>Creating an outreach program</u>

Programming

The first step in creating an outreach program is to gather a team of dedicated volunteers to organize the program. The first thing to decide is the target audience for the program. Some programs target young children to stimulate their interest in science, while others target older groups or adults. Choosing an initial target audience is helpful for creating a basic program, however it is always possible to adapt a program to suit audiences of different age or knowledge base. When looking at children as the target audience, most provincial governments have a website providing outlines of the school curriculum, which can be helpful when determining at what grade level specific concepts are learned. Some groups, like Girl Guides, are looking for certain concepts to be covered; for example, the chemistry badge for Guides must include information on chemical

reactions, and where chemical reactions can be found in everyday life. In such a case, it is important to communicate with the group and ask what they are hoping to get out of a program. For groups with mixed ages, it is a good idea to include demonstrations and activities that are interesting and exciting for the younger age group, while educating the older audience members with a more advanced explanation. Often, the experiences of the organizers dictate the direction the activities will go in. For example, a trades person may design a program for high school students to educate them on trades as an option for post-secondary education. Ideas for specific activities are widely available on the Internet and in resources such as journals (i.e., Journal of Chemical Education, Journal of Geological Education, etc). Another useful resource are books that outline science fair ideas, "do it yourself" science for kids, and other science education books.

Advertising

A huge obstacle when creating an outreach program is getting the information out to the target audience. In the case of WISE-UP, it began with Girl Guide groups and spread from there. Word of mouth is by far the best tool. Contacting a Girl Guide group begins with a visit to the Girl Guides of Canada website, http://www.girlguides.ca. The web pages for the provincial councils are linked from the main website, and contain contact information for the provincial council office or commissioner. From there, the provincial council members are able to spread the word to district commissioners, who contact the guiders for individual groups. For the school system, often the contact information for guidance counsellors and teachers can be obtained from school websites. Many other organizations also have websites with contact information and it is worth researching the various youth and community groups that are in the area.

Posters and pamphlets are another way to advertise an outreach program. Posting information at local Guide/Scout shops, community centres, recreational centres, and staff lounges at schools are a great way to advertise the program.

Kit organization

In order to provide the greatest possible experience for everyone, organization is the key. Demonstrations should be well constructed, including which experiments will be performed and what materials are needed. When choosing experiments, pick those that have few and easily obtained materials. For those experiments which require assistance from a local university, it is best to become familiar with people in the appropriate departments. Ask for their help when attaining the chemicals and glassware needed, as well as their assistance with proper equipment operation. Be sure to allow adequate time for the supplies to be obtained and prepared. Before using chemicals or special equipment, ensure that proper handling techniques are known to all members of the group who will be performing the demonstrations. Safety is first and foremost when carrying out any program. Prior to the demonstrations, program "kits" should be prepared for use. The kits should include everything that will be needed throughout the demonstration, even materials that may only be needed in emergencies. First aid kits are a must-have in all demonstration kits. Also a list of safety procedures and precautions (such as MSDS

sheets) should be available. If an emergency does unfortunately occur, a list of contact phone numbers should also be on hand. In addition, extra paper towels will always be needed. If money is a concern for the group, most materials for experiments can be bought inexpensively at local dollar stores. Borrowing materials from universities can be beneficial, as well as recycling previously used materials. Including an inventory list in the kit is useful, especially for ensuring consumable materials are replenished before the program is repeated, as well as a reminder for materials that must be borrowed. The kit system allows for a great deal of versatility and ease when repeating a presentation or modifying it for a different age group. This type of project requires extensive planning, organization, safety and creativity, but in the end the results are priceless.

Volunteers

The most crucial part of any program is the volunteers; without them, programs would be impossible. To look for volunteers, it is easy to search within a local university. Universities usually have volunteering programs set-up, providing a bank of people who are always willing to help. If this is not available at the nearest university, one can ask undergraduate science professors if the group can ask their science classes for volunteers. There are always people available who love to volunteer, and generally, volunteers do not need to have a vast, comprehensive knowledge of science. Especially for performing youth programs, as the science covered is usually elementary. Another way to obtain volunteers is to place posters around universities and/or high schools, particularly in the science buildings. Also ask professors if they could recommend people, or if they could mention it to their classes. Volunteers are literally the backbone of every program, and be sure to get to know them. Train volunteers for the programs they will be offering, and volunteers should not do presentations by themselves. Be very appreciative of volunteers, and thank them for their help. Ensure that they have as much fun as possible. If they feel wanted and leave with a positive experience, they are more likely to return. They may even bring their friends the next time a program is offered. Remember, there is no such thing as too many volunteers.

Safety and Insurance

It cannot be stressed enough that when offering a program with demonstrations and activities, the most important consideration must be the safety of everyone involved. Unnecessary risks should never be taken and it is important to inform everyone in attendance of the safety precautions. At the beginning of a demonstration, ground rules should always be expressed and agreed upon by everyone, including the audience. For example, when doing a demonstration with dry ice (solid carbon dioxide at a temperature of -79°C), it is important to tell the audience that the dry ice should not be touched at all, and that if some was to fall on the ground, they should not attempt to pick it up, even to be helpful. Instead, they should get the attention of a demonstrator and let them take care of it with proper safety precautions.

It is also important to consider insurance and liability issues that can be involved when doing an outreach program. In the unfortunate event of an accident, the organizer of the

event and the volunteers could be held legally responsible. For existing organizations such as Girl Guides and Scouts, there should be an existing infrastructure to cover insurance, provided the leaders of the group have followed the proper protocol. Girl Guides has a document called "Safe Guide" (available online) that outlines risk management protocols that must be followed and the limits for activities covered at Girl Guide events. When in contact with the groups (especially youth groups), it is advisable to let the leaders know that the activities planned may increase the risk level of the meeting. With this contact, specific information about activities may also be included. For example, some people have a fear of loud noises or fire, so if a demonstration involving either is included it is a good idea to let the organizers know. If in the presentation there may be something that could cause an allergic reaction, the group should be informed in advance. Ask to be made aware of any major allergies which may be present within the group. Also, when working with children, be aware that image releases must be signed by parents/guardians to give permission for photographing, videotaping or recording voices.
Offering an outreach program that stands independently of an existing organization is a risky and expensive project. Legislation protecting not-for-profit organizations and their volunteers from unfounded liability claims (when proper precautions were taken) does exist in some provinces and jurisdictions. It is important to know the law in the region in which the program is offered. In most cases, insurance must be obtained independently and is usually quite expensive, especially for programs involving children. In a circumstance such as this, most of the funds raised would be used to cover insurance costs.

Tips

When beginning the demonstration, be sure to introduce everyone who will be involved, what each person studies and where they work. Also explain that each one is a scientist or technician in their own discipline. This allows the audience to relate with their presenters and hopefully make them comfortable enough to ask questions and partake in the discussions to follow. It would be advisable to know the target audience well in advance, so that preparations can be made for the demonstration to target whichever age frame that will be present. This will make a big difference, especially in the level of explanation that is required. For example, for a younger audience, it is important to keep everything very simple, but for an older audience it is advisable to ask if they have covered the material in school. Scientific terms are best left out or at least explained in basic terms. If chemicals with lengthy names are being used in the demonstration, reading them out will provide some entertainment for the audience, especially if the name proves difficult to pronounce. An explanation of what the chemicals are or how they are obtained is not necessary.

Sometimes the regular experiments do not provide the reaction that was expected. In order to increase the anticipation, get the audience involved by asking questions. One can even add simple ingredients to spice up the experiment such as food colouring or dish soap. The audience will usually have an opinion about what colour they would like a solution to be. It also helps if the group providing the demonstration is excited for something to happen. Explanations of the science behind the experiments are necessary

and how it relates to their everyday lives. For example, explaining how friction allows people to walk, or how torque allows screws to be screwed into a piece of wood.

Following the group demonstration, there should be an interactive activity in which everyone present can participate. The messiest activities should be left for the end of the event, especially for children, as it creates excitement as they get ready to go home. This also allows the clean-up to be done as the audience is leaving, ensuring that no mess is left behind. To get the maximum effect from the activity, it is advised to split the audience into smaller groups of three or four, depending on the size of the group, for a more intimate and hands-on approach.

Unexpected Things to Expect

Presentations such as these will illicit questions from the audience. There will be times when the presenters will not know the answers to the questions, which is okay. It is impossible to know everything. When a question is posed that the presenter does not know, they can explain to their audience that they do not know the answer and that it was an excellent question. Encourage them to pursue the answer themselves, and that the presenter will do the same.

One of the best parts of performing the experiments is that it will never be the same twice. There will even be times when the experiments won't work. When this happens the presenter can laugh it off along with the audience, and then proceed to figure out what caused the problem. This can lead to a discussion about what an experiment really is and why scientists do them. An educated hypothesis is stated, and then an experiment is carried out to prove or disprove the hypothesis. This would also be a good time to mention that science is always a surprise.

Some of the experiments will be messier than anticipated. This can take everyone by surprise, but the audience will love it. The more mess produced, the better. Just laugh and mention that it will be cleaned up when the presentation is over. Always clean up before leaving the area, as there will be some chemicals that should be properly disposed of. It is the presenters' duty to make sure that everything is cleaned up and that no chemical residue remains.

There are some experiments that have to be performed outdoors, as they need open ventilation. This, of course, depends entirely on the weather. Just in case the weather is not favourable, it is best to have some other activity planned that can be performed inside.

Occasionally, some of the materials will be misplaced or forgotten. In cases like these, it is best to improvise with the materials that are present or, if time allows, someone can venture in search of the missing materials.

Time can also become an issue during some presentations. Make sure there is enough time allotted for each experiment that the group wants to present. If, for whatever reason,

time does begin to run out, just cut out some of the less interesting experiments. The audience will be enthralled with whichever experiments are demonstrated and will not mind (or notice) if one or two experiments have been cut out of the original presentation. It is more favourable to have fewer experiments and allow for questions and audience participation, rather than racing through all of the experiments. If the presentation is rushed, the audience will not have time to process all the information that is being thrown at them, and they won't concentrate on the experiment being performed.

Often an overly enthusiastic member of the audience can be disruptive to your presentation, especially if they ask many questions or want to get involved. While questions are encouraged, too many questions can prevent the presenter from continuing, or will take up too much time. The best way to handle this situation is to involve that audience member in the presentation by asking them to distribute materials or help with a demonstration. For excessive questions, the audience member can be reminded that they can ask questions following the presentation.

Conclusion

Since its creation in 2004, WISE-UP has undergone a great deal of evolution. While it is a close-knit support network for female undergraduates in science and engineering, it has also become a great resource for young girls. By following the tips and guidelines laid out in this paper, a series of successful and popular science badge programs have been created for girls in Girl Guides of Canada/Guides du Canada. In the near future, WISE-UP will be putting the finishing touches on a set of school presentations aimed towards children from the primary to secondary levels. In a very short time, these fun and inspiring programs were created and made available to the public. By following the tips laid out in this paper, similar programs can be created in any community, so long as there are few dedicated volunteers to be had.

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The Jade Bridges Project and Network

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Abstract

In light of the continuing low participation of women in engineering and some fields of science, two major challenges for our fields are to create a positive image of career paths in the physical sciences and engineering and to provide a supportive environment for women who choose to pursue an education in these fields. An initiative of the NSERC/General Motors Canada Chair for Women in Science and Engineering, the Jade Bridges Project has helped fund several initiatives in British Columbia and the Yukon that address these challenges. One key component of the Jade Bridges approach is to support committed individuals who are taking the lead in developing effective initiatives. The second key component is to increase the overall level of engagement at colleges and universities in advancing such efforts. Jade Bridges has created and sustained a network of academic leaders who are knowledgeable about good practices for addressing the problems and can effect longer-term institutional change, and project leaders are starting to have influence on larger-scale institutional engagement. Here, we describe the ingredients that have made Jade Bridges effective and discuss how its successes might be leveraged into bigger gains in the future.

1. Introduction

Women continue to be severely under-represented in the sciences and engineering (S&E) at both student and faculty levels. In 2006, while women made up 47% of the Canadian workforce, they comprised just 22% of professionals in the natural sciences, engineering and mathematics [1]. The percentage of female students in Canadian S&E programs at colleges and universities is also very low, being 25.3% in mathematics, computer and information sciences and 21.2% in architecture, engineering and related technologies in 2004-05 [2]. Moreover, a 2008 study of science and engineering graduate students at Canadian universities found that female graduate students in engineering perceived their environments as significantly less congenial than did their male counterparts; the study also reported significant differences between women's and men's feelings of self-efficacy, importantly associated with success [3]. Even in fields where women are well represented at the undergraduate levels, there is a persistent leak in the pipeline of women who progress to graduate degrees and on to careers in academia or at research institutions. For example, in the physical and life sciences, the percentage of female FTE enrolments in Canadian colleges and universities has been well over 50% and growing since 1995, yet the percentage of female FTE enrolments in doctoral programs had risen to just 40.6% by 2003 [4].

These problems are of significant concern to faculty and administrators at colleges and universities. While some individuals at academic institutions are proactive in developing

new ways to recruit and support women in their programs, overall there is still limited engagement by departments and academic units in grappling with the complex underlying issues and in finding effective solutions. Often, those individuals who do engage get poor support or recognition from their institutions for their efforts, risk compromising their own career success, and have difficulty sustaining their initiatives.

Funded through the NSERC/General Motors Canada Chair for Women in Science and Engineering, the Jade Bridges Project aims to address these challenges. Here, we describe lessons learned from our experiences in the first three years of the Jade Bridges Project. In Section 2, we describe some organizations that work to interest women in science and engineering careers and to support those in the pipeline. We emphasize organizations in the B.C. and the Yukon region, but mention also a few U.S. programs that inspired the Jade Bridges approach. We then describe the Jade Bridges Project in Section 3, comparing its goals and structure with those of organizations described in Section 2. In Section 4, we provide perspective on the progress of Jade Bridges in achieving its goals, informed by results of a survey of project leaders and institutional representatives. We conclude with suggestions on ways that the collective experiences of the network of Jade Bridges leaders may leveraged, as we tackle the larger challenge of fostering broader, and deeper, institutional engagement in advancing the participation and success of women in science and engineering.

2. Shoring up the Leaky Pipeline

Here, we review just a few of many ongoing efforts to expand the pipeline of women in science and engineering and to stem the leak from this pipeline. We emphasize efforts that have influenced the Jade Bridges model, both in B.C. and the Yukon, and across North America.

- **Regional Professional Organizations.** The **Society for Canadian Women in Science and Technology (SCWIST)** has created a strong network of Canadian women scientists and engineers, using email, web and newsletter media and through networking events. SCWIST also offers conferences for girls in B.C. and Yukon secondary schools and supports professional women who are immigrating to Canada. Similarly, the **Division for the Advancement of Women in Engineering (DAWEG)** runs several initiatives to increase the number of women working in engineering and geoscience in British Columbia.

- **National Organizations.** Focusing on locally delivered programs throughout Canada with an emphasis on reaching traditionally underserved communities, **Actua** employs college students to inspire children and youth to learn about science and technology, and reaches tens of thousands of girls annually. The **Canadian Coalition of Women in Engineering, Science, Trades and Technology (CCWESTT)** draws its members from academic institutions, NGOs, corporations and individuals. Their Women in Science, Engineering, Trades, and Technology (WinSETT) project, led by Hiromi Matsui and Margaret-Ann Armour, focuses on federal policies and resources that support the recruitment, retention and promotion of Canadian women in SETT

careers. Project leaders are piloting workshops with industry and have proposed the creation of a national centre for the Advancement of Women in SETT

- **Discipline-Specific Organizations.** Many initiatives, particularly at the national and international levels, are organized along disciplinary lines. One organization that has influenced our approach is the Computing Research Association (CRA), which represents academic computer science departments across North America. **CRA's Committee on Women (CRA-W)** focuses its efforts on expanding the pipeline of women in computing research, both in Canada and the U.S.

While all of these organizations have strong ties with academic institutions, through, for example, partnerships on projects or through their academic members, they do not have institutional transformation as a primary goal. Since institutional engagement is a goal of the Jade Bridges project, we next take a brief look at some national programs in the U.S. that do aim to engage academic faculty and department heads in working toward institutional change.

- The **National Center for Women in Information Technology (NCWIT)** is a major initiative with a broad agenda and a strong focus on institutional change. Membership is composed primarily of academic department heads and other institutional leaders across the country. One example program is its "effective practices" campaign, wherein effective practices for recruiting and retaining women in IT careers, and which have undergone substantive evaluation, are collected, analyzed, codified, piloted, and adopted at other institutions. The U.S. National Science Foundation (NSF)'s **Broadening Participation in Computing Program (BCP)** funds computer science departments and other organizations that work to recruit women and members of other underrepresented groups to the field of computer science. Finally, **NSF's ADVANCE program** provides significant funding for initiatives housed at academic institutions that aim to transform the academic environment for women faculty.

We close this section by describing programs initiated by members of academic institutions in B.C. and the Yukon that are both supported by those institutions independent of the Jade Bridges Project and which have an explicit focus on women.

- The **Women in Engineering and Computer Science (WECS) at the University of Victoria** (UVic) initiative [5], with a full-time coordinator, Anissa St. Pierre, and funded by the Faculty of Engineering, "strives to make changes to the established culture and teaching methods of the Faculty of Engineering and Computer Science to make it more attractive to women." In 2007 the initiatives of Anissa St. Pierre and her colleagues reached approximately 900 students from middle and high schools throughout British Columbia. **SFU's Faculty of Applied Science** has a full-time **Director of Diversity and Recruitment**, Hiromi Matsui, who has worked to develop policies and provide support for female faculty and students in computer science and engineering, including groups such as **WICS@SFU** [6], and also to advocate for resources and policy change at the national level. The **University of British Columbia (UBC) BCS (ICS)** program is a 2-year degree program that offers students

with degrees from any field the opportunity to obtain a computer science degree. Roughly 40% of BCS graduates are women. UBC also sponsors **Tri-Mentoring Projects** [7] in several of its departments in which upper-level students are paired with professionals in their fields for ongoing mentoring and professional development. In computer science alone, roughly 40% of tri-mentoring students are women. UBC CS also has a **Focus on Women in CS** committee that organizes events supportive of women in the department and conducts outreach to girls in the community.

3. The Jade Bridges Project

Created in 2004, the Jade Bridges Project [8] is one of four components of the NSERC/General Motors Canada Jade Project. Jade Bridges aims to build institutional links between the Jade Project, located at UBC's Department of Computer Science, and individuals at other colleges and universities in British Columbia and the Yukon who are working on recruiting and supporting women in science and engineering.

Much of the inspiration for the Jade Bridges model derived from CRA's Committee on Women (CRA-W), of which the NSERC/General Motors Canada Chair, Anne Condon, was a member. CRA-W takes an activist approach, in which committee members, all of whom are leading researchers or educators, take responsibility for major projects. The time and energy devoted to projects by all committee members, together with the support of the CRA, sends a strong message that the work at hand is important. Finally, there is strong camaraderie and valuable networking among women in the group, experiences that are often missing in their own sub-disciplinary research communities.

Like CRA-W, Jade Bridges aims to bring together individuals who wish to lead a project and to provide a strong networking and support structure for those individuals. However, Jade Bridges differs in significant ways from the CRA-W model. Because of the mandate of the NSERC Chairs program, Jade Bridges has regional scope but encompasses many disciplines. It does not focus solely on encouraging women researchers; rather, its projects span everything from K-12 outreach efforts to support for graduate students, and they involve community colleges and universities as well as academic research institutions. Anyone at a college or university can apply for Jade Bridges funding, unlike the CRA-W model in which committee membership is by invitation only. In these ways, the project resembles more closely—and on a much smaller scale—the NSF Broadening Participation in Computing program. Also, unlike CRA-W's model, Jade Bridges has an emphasis on projects that not only aim to increase the participation and success of women in science and engineering, but which have a chance to foster institutional engagement as well. However, the amount of funding per Jade Bridges is not suitable for major institutional initiatives such as those funded through NSF's BPC or ADVANCE programs.

Would a regional approach with broad scope and a small amount of funding per project achieve anything of significance? Would people participate in a network that is not affiliated with a major professional organization and is not closely aligned with any

particular institution? Would individual project leaders want to network with people in other disciplines and across institution types? The answers to these questions were not clear when Jade Bridges got underway. Before we address them, we first describe elements of the Jade Bridges Project in greater detail.

Project Mechanics: Proposals are submitted one time per year. The applicant, any co-applicant(s), and authorized department representative are identified in the proposal. The application process is fairly lightweight. Applicants describe the project they wish to work on (in three pages or less), give a proposed budget, and describe how they will evaluate the success of the project in meeting its goals. Upon completion of the project, leaders submit a final report, summarizing the project outcome, the number of female participants, and the results of the evaluation. Project leaders maintain a web page, which is updated as the project progresses. Project proposals are reviewed by the Jade NSERC/General Motors Canada Chair (Anne Condon) and the Jade Project Coordinator (Michele Ng). Often, an email exchange with applicants helps clarify details or guide efforts before final decisions are made.

Scope of Projects: Since 2005, 31 projects have received funding. A total of 530 girls were reached through the 2005 and 2006 projects (figures on the number of girls served in the 2007 projects are not yet available). Feedback from participating students, both in the form of surveys and student testimonials, was overwhelmingly positive.

Examples of some of these projects are included here. The **Jade Bridges Workshop at UBC Okanagan** provided women interested in science careers the opportunity to meet female scientists and to learn more about effective communication skills. The **Women in Engineering Program at UBC** seeks to build student networks of women in engineering, together with industry and professional partners. Sponsored by UBC's Department of Biological and Chemical Engineering, the **Sustainability, Science and Engineering North of 60°** initiative in the Yukon encourages girls to become involved in science careers, particularly as they pertain to sustainability, environmental engineering, and sanitation technology for remote communities. Co-sponsored by SFU and SCWIST, the 4-part workshop series **Tools for Transition: Navigating Change and Making Life-Shaping Decisions** offers graduate students and post-docs in science and applied science at SFU and UBC the opportunity to map key events in their careers, learn to make decisions during transitions, clarify values and envision a future career path. The **Chictech** program, which began at SFU in 2005 and was then run simultaneously at SFU, Capilano College and Langara College in 2006, helped teams of 9th and 10th grade girls compete with each other to design web sites for non-profit organizations, expanding the girls' computer science skills and benefiting community organizations. "One time only" events include **funding for the keynote speaker at the 2005 Canadian Association of Physicists Annual Conference.** The keynote speaker raised awareness of the contributions of women and was a guest of honour at a networking event for women.

Three additional projects are described in more detail in the accompanying boxes. The Kwantlen University College project illustrates the creative ways in which an extremely busy faculty member and chair of a department at a small institution can carve out a

program that combines student education and outreach in a sustainable way. The Robotics Summer Camps project illustrates how people from different institutions can work together to develop materials and acquire valuable expertise on ways to excite girls about robotics. The Women in Engineering Physics program shows how developing a part-time student coordinator position within a traditionally male department can sustain support structures for women in that department. Yet other projects are described in other papers of the proceedings of this conference.

Funding: The average amount per program funded was approximately $3,000, with minimum and maximum grants of roughly $1,200 and $6,000. Some initiatives have brought in significantly more funding from additional sources. Overall, institutional support (including in-kind support for space, office supplies, and some staff time) for the project between 2005 and 2007 totaled $14,940. The level of funding, together with matching funds, has been sufficient to cover the costs of space and food for an event, the cost of materials and supplies, and/or prizes for competitions. For smaller institutions with tight budgets, even this level of funding would be impossible to generate from standard operating funds. In some cases, the funding provided a small stipend for a student who played a major role in executing the project.

Bridges Leaders Network: Biannual meetings bring project leaders together to share their collective expertise and discuss ongoing challenges that the projects pose. Jade Bridges project leaders are using the network to share their expertise and discuss lessons learned from their projects and to strengthen their commitment to the goals of recruiting and supporting women in the field. In particular, project leaders have presented and discussed good practices pertaining to

U Can Do IT (Youths Can Do Information Technology)
Organized by Andy Law, Chair of the Department of Computing Sciences and Information Systems at Kwantlen University College, Surrey, B.C.

Jointly sponsored and administered between Jade Bridges and the School of Business of Kwantlen University College, U Can Do IT is a program designed to promote the participation of high school students, particularly female students, in information technology-related careers and education. First offered in 2006, U Can Do IT was delivered as an IT knowledge competition. In the first round of the competition, third- and fourth-year Kwantlen University College IT students visited 22 high schools in Surrey, Richmond, and Langley and administered a written test on IT knowledge to more than 500 students. Test questions were designed with input from IT employers and Kwantlen University College and UBC faculty members. An e-Book containing hundreds of facts about the IT world was posted on the web so that potential contestants could study prior to the competition. Several questions highlighted women's contribution to the history of computing and women's representation in contemporary IT. One girl and one boy were selected as winners at each of the high schools and each received a small prize. These winners entered the final round competition, held online [9]. From this final round, one girl and one boy were selected as winners and awarded grand prizes.

The 2006 program proved successful as outreach, as a large proportion of the participating institutions agreed that the visits provided valuable information for their students. The inaugural year also helped establish guidelines for making the project sustainable over time. Andy Law, Kwantlen's IT department chair, integrated the program into his IT Project Management course so that Kwantlen IT students could continue to gain project management experience. He also recognized the need for making each year's "theme" appealing both to the participants and the Kwantlen students. In 2007, the theme of the program was "Digital Game for IT Learning," in which Kwantlen's IT students again visited area high schools, this time to solicit user requirements for the development of an interactive computer game. Each visit had two parts. The Kwantlen students first briefly explained the hardware and software logic behind video games, passing around an uncovered Play Station box to show its hardware components and demonstrating computer game engine programming. The Kwantlen students then delivered a knowledge competition about computer games. Four game prototypes were produced from these visits and made available in December 2007. New also in 2007 was the addition of two strategies targeted specifically to girls. Kwantlen students showed the high school classes a CISCO video in which women in IT shared their experiences in pursuing IT courses of study and careers and they presented findings from the Web about women's experiences in today's IT industry.

Eliza Kuttner Robotics Summer Camps

Organized by Yvonne Coady, UVic, Tamara Dakic, Capilano College, Paul Carter, UBC

Designed through active collaboration among the University of Victoria, Capilano College, and UBC, the Eliza Kuttner Programming Camps for Girls provided girls in grades 5-7 the opportunity to engage in hands-on work in robotics and engineering in a day camp setting. Offered at each of the collaborating institutions throughout the summer of 2006 and reaching 100 girls, the camps were designed to increase girls' participation in computer science and engineering. Program coordinators researched the best practices of existing science and engineering day camps. Using Lego Mindstorms Robots and other software systems, they developed programming tasks that a girl with no prior programming experience could reasonably complete in one day. They also developed research materials, such as profiles on female role models in science and engineering, for inclusion in a take-away package. Named in memory of Eliza Kuttner, an instructor at Capilano College who spearheaded this project, the programming camps fulfilled the several purposes of Jade Bridges: to increase participation of young women in computer science and engineering programs, to engage in a multi-institutional partnership between Capilano College, the University of Victoria and the University of British Columbia, and to develop the program in such a way that materials will be freely available to other B.C. and Yukon institutions that may wish to run local camps of their own.

Eliza Kuttner's vision continues to drive hands-on activities using robotic devices beyond Lego Mindstorms, including Pico Crickets and even general purpose design boards. Like the original offerings, these exercises are extremely well received by the students, and camps typically sell out in advance. These lines of activities stand as a cornerstone for several continuing outreach offerings to children around the province, with programs now extending to participants from a vast array of age groups and backgrounds, including youth from Aboriginal communities and girls' clubs in B.C. Program organizers have been able to upgrade equipment so that girls are able to work with the latest generation of robots. In one example of a recent activity, teams of participants successfully built their own Neptune Rover to follow a simulated track on the ocean floor and collect samples for scientific observation. Materials developed in this project have been modified and adapted by other departments at UBC for developing their own outreach projects, and thus this program marks the success of a multi-institutional endeavor to develop shared materials and best practices.

project evaluation, as well as strategies to ensure that projects continue when the initial leader moves on to new things. Materials prepared for these meetings are made available from the Jade Bridges Project website [8].

Funding for project leaders to travel to conferences and present the results of their project is also provided. A third means of support is the Jade Bridges Project Newsletter, which is published bi-annually on-line, highlighting the personal and professional successes of project leaders as well as student project participants. The newsletter also provides a means of keeping in touch with students who have participated in any Jade Bridges

program. Finally, in a small number of cases, the NSERC/General Motors Canada Chair was able to support project leaders in other ways: providing letters for award nominations, advocating with department heads and faculty members to ensure that faculty who were leading significant projects got some relief from other duties, and encouraging faculty members to provide advice and support for students leading projects.

Women in Engineering Physics: Recruitment and Networking
Organized by Andre Marziali, Director, Engineering Physics, UBC and Anja Lanz, Student Representative, Engineering Physics, UBC

The Engineering Physics Women Recruitment and Network project was created in response to demand from female students in the engineering physics program at UBC. The project is intended to give female engineering physics students an opportunity to meet regularly with other female engineers and to provide mentoring and networking opportunities with engineering alumnae. Through this network and its activities, an additional aim is to increase recruitment of female students to the engineering physics program.

Targeted recruitment includes sponsoring high school females in grades 9 and 10 to attend an engineering physics information event held at UBC each fall. Support from the Jade Bridges Project enables younger female students to attend this event, exposing them to potential career paths before they make decisions about elective courses in high school that may limit their choices in university.

Once in the engineering physics department, many women find networking and social interaction with other female students difficult due to the substantial dilution of women in the student population (engineering physics has the lowest female enrollment of any of the scientific departments at UBC). To address this and other issues, the project created a female student representative position. The representative serves many vital roles. She maintains ongoing contact with other engineering women organizations on and off campus such as Women in Engineering at UBC (WIE/UBC), DAWEG, and SCWIST and can inform students of upcoming events sponsored through those organizations. Via email, she connects current students with alumnae of the program and draws on those alumnae to serve as mentors and to participate in networking events. She also reaches out to potential female recruits to the department and assists them in establishing relationships with current students.

In addition to providing ongoing mentoring and networking opportunities for students, the program also financially assists students who wish to participate in other engineering women events such as conferences and networking events.

4. Perspective

The strong participation by people in a broad range of institutions in the Jade Bridges Project and in the network affirms that this type of initiative does fill a real need in the B.C. and the Yukon region. The project has brought together an incredibly talented team

of women and men who have developed high-quality, creative projects. Some of these leaders have also catalyzed other initiatives at their institutions, although the credit for these lies solely with the project leaders who have shaped them. In the rest of this section, we provide some perspective first on the value of the project leaders' network, and second on the degree to which institutional engagement, beyond that of the leaders, has been achieved.

4.1 Jade Bridges Leaders Meetings

Experiences at Jade Bridges meetings have provided ongoing insight as to why the network is so useful. At one meeting, a discussion about the merits of running women-only programs ensued, with participants discussing the challenges of defending such programs. One participant noted that her children have asked her why Mother's Day and Father's Day are holidays but no "children-only" holidays are celebrated. Her time-honoured response is that "every day is Children's Day," and the point was made that every day in a typical engineering program is "Men's Day" in that men dominate the environment and set the tone for interactions. The need for forums that allow women to share and compare experiences and identify common concerns is thus of paramount importance. This discussion also underscored the importance of support from department heads or administrative leaders: their visible expression of support sends a strong message to department members that efforts to create a positive climate for women are important, reducing possible discomfort with a targeted program. Interestingly, some project leaders themselves also voice reservations about women-only programs, giving the lie to the notion that women speak with one voice on this (or any) issue. Discussions on such topics help participants deepen their understanding of the ways in which the structural components of an initiative influence its effectiveness, and they sharpen participants' abilities to articulate the rationale for their own program designs.

4.2 Perspectives of Project Leaders on Experiences with Jade Bridges

A survey was used to assess the level of satisfaction of Jade Bridges leaders with their projects and with the leaders network. An invitation to participate was emailed to 29 project coordinators in February 2008, with 19 coordinators completing the survey by the deadline. Of these, 13 identified as faculty members and six as students; 15 identified as female and four as male.

Overall, questions about the value of the Jade Bridges Projects to their respective project coordinators yielded positive responses. As Table 1 below shows, the first four survey questions, discounting those few respondents who replied "not applicable," netted a 100% positive response. Other responses to questions were similarly positive. When coordinators were asked if participation in Jade Bridges activities had provided a renewed sense of importance in their own work, careers, or field, 88% said that it had. Fifty-two percent of respondents disagreed that Jade Bridges activities had been more time-consuming than anticipated, while a full 84% disagreed with the statement that participation had compromised the quality of other work, such as classes, teaching, or research. Fully 95% agreed that their participation had led them to better understand the

issues for women in their field. Interestingly, while just 63% agreed with the statement that participation would allow them to better influence their department/unit, a full 89% stated that participation made them more confident in their ability to lead. These numbers allow us more than a guarded measure of hope for the future of these projects in positively influencing the culture of their respective science and engineering departments.

Substantive comments provided by project coordinators yielded a trove of information and ranged from thoughts on the value of individual projects to advice for improving projects in the future and reflections on general strategies for improving the recruitment and retention of women in coordinators' own departments. Many respondents spoke positively of the Jade Bridges Project Leaders' meetings they had attended, finding great value in sharing ideas and supporting each other's vision. Those who had attended one or no meetings reflected that they had missed out on the opportunity and hoped that they would be able to attend in the future. Several respondents spoke of time commitments and the difficulty of balancing teaching duties with meeting attendance.

Table 1. Summary of Project Coordinators' Responses to Survey Questions

Statement	**Agree**	**Disagree**	**NA**
For me, meetings of Jade Bridges Project Leaders have been valuable for networking.	14	0	5
For me, meetings of Jade Bridges Project Leaders have been valuable for information sharing.	14	0	5
For me, participation in Jade Bridges activities has provided personal reward in supporting the next generation.	17	0	2
For me, participation in Jade Bridges activities has provided personal contact with girls or women.	19	0	0
For me, participation in Jade Bridges activities has provided renewed sense of importance of my own work/my career/ my field.	16	2	1
For me, Jade Bridges activities have been more time consuming than expected.	9	10	0
For me, Jade Bridges activities have compromised the quality of other work (classes, teaching, research, etc.).	3	16	0
I felt supported by the head of my department, or authorized departmental representative for my project, for my work on the project.	18	1	0
The head of my department, or authorized departmental representative for my project, valued the project.	18	1	0
As a result of participating in Jade Bridges, I better understand the issues for women in my field.	18	1	0
As a result of participating in Jade Bridges, I am better able to influence my department/unit.	12	7	0
As a result of participating in Jade Bridges, I am more confident in my ability to lead.	16	2	1
For my work on Jade Bridges, I obtained some reduction in other service duties to my department or received a stipend.	1	18	0

I would be interested in sharing my expertise at workshops or in written materials, with department heads and other institutional leaders.	16	3	0

Several ideas were floated regarding effective communication with participants outside of meetings. One respondent wondered about the possibility of a dedicated "communications support" person to alert members to upcoming events, while another suggested writing up a list of ongoing projects, together with tips and advice, to distribute to members unable to attend. To keep abreast of current literature on women and science, one respondent suggested a library of research papers that could be distributed to undergraduate and graduate students. From these comments we believe we could be supporting the community more effectively between meetings by using electronic resources to connect members with each other and with ongoing research, and we plan to follow up on these suggestions.

To augment the program's strengths, the suggestion was made to have meetings combined with a field trip and to have more regular ongoing mentoring meetings between students and scientists and engineers in their fields. Some respondents noted that efforts should be made to increase the visibility of Jade Bridges. Two respondents suggested developing some form of printed matter, such as a brochure or bookmark, that could be distributed to high school students and draw their attention to the program.

Despite the positive evaluations of institutional support received from their departments, a number of respondents noted that the future of their projects is highly dependent on instituting key changes within their department. One coordinator put it this way: "The main issue at this point is institutional support: I either need my institution to take over my project or to give me time release in order for me to continue improving the project and to continue putting it on. Through the Jade Project Leaders meeting I found out that I should have been working toward operationalizing my program right from the start (good advice!), but I didn't receive that message until I was three years into the project and losing energy." Another respondent was equally candid in her assessment of how projects could best be leveraged in the future: "In my experience, an effective way in which the Jade Project could assist in supporting women and in building institutional commitment to such goals would be to support people already committed to such goals to achieve key roles in their respective institutions." Ways in which the NSERC/General Motors Canada Chair can help facilitate such institutional support at additional institutions should be explored.

4.3 Engagement of Departments/Units/Institutions

From the start, the NSERC/General Motors Canada Chair believed that an ongoing challenge would be to see individual projects adopted by and integrated into academic departments, with continuing solid support from department heads and deans. Garnering this support would ensure that the projects will survive after Jade funding has ended. There was no expectation set initially for project leaders that they work out a longer-term plan. Nevertheless, a small number of prescient project leaders were able to build

institutional support for their projects. For example, projects in engineering at UBC, led by Elizabeth Croft, have evolved into a suite of programs coordinated by a paid staff person (Erin Biddlecombe). The NSERC/General Motors Canada Chair may be able to build on examples like this to encourage adoption at other institutions.

To further assess institutional support, we surveyed the 29 Jade Bridges project coordinators.
When asked about institutional support for their efforts, their responses ranged from positive to highly positive. For example, 95% of coordinators felt their project work had the support of either the department head or authorized departmental representative and 95% felt that the department head or authorized representative valued the project itself. However, just 1 respondent received a reduction in duties or received a stipend for work performed in the service of the project.

We also surveyed the 17 departmental representatives who signed project proposals to indicate their institution's commitment. Though just six representatives responded, their responses were largely positive. When departmental representatives were asked, for example, if targeted outreach to female K-12 students is part of their unit's mission and if that outreach is successful, a clear majority responded affirmatively. As a group they were divided on whether their unit's strategies for K-12 outreach is informed by the literature on what works for girls. Fully 100% of respondents agreed with the statement that "targeted recruitment and/or support of female students is part of the mission of my unit," though respondents seemed less sure about their unit's ability to recruit and support female students and, as with their responses to the K-12 cohort, they were equally divided on whether their unit's recruitment and retention strategies were informed by the literature on what works for women.

More positively, respondents were largely in agreement with the statement that they are "comfortable/confident when I speak about issues pertaining to recruitment or retention of women in my unit," and 100% of them agreed with the statement "I know who to contact to get statistics on participation of female undergraduates and graduate students in my unit." On the issue of whether they know who to contact for national/North American statistics on participation of female undergraduates and graduate students in their fields, four respondents responded positively and two responded negatively. Four of six respondents have requested and/or read statistics on women in their unit within the last six months, and five respondents have shared statistics on women in their units with their faculty within the last six months.

Fifty percent of respondents have personally attended Jade Bridges activities, and their observations at these events are illuminating. Two respondents enjoyed the events and the energy of the project leaders. One respondent had an eye-opening experience: "I was at first shocked by how little the students seem to have thought about anything beyond 'getting into university'…the details about what fields they might pursue seemed largely irrelevant. I was also quite shocked by accompanying teachers and principals who basically told me that any recruitment of high school females had to appeal to their

preoccupation with what was considered fashionable, and 'in.' One principal actually told me that if would help if our female presenters wore makeup (I think she was serious)."

For the following statements, respondents were largely positive: "The project was successful in achieving its goals" (83% affirmative); "Experience with the project has enhanced my unit's commitment to organize outreach events or provide support structures for women" (100% affirmative); and "Experience with the project has increased understanding within my unit on how to effectively organize outreach events or provide support structures for women" (83% affirmative).

Just one of six respondents was committed to the support of their project coordinators through a reduction in service duties or through offering a stipend. Half of the respondents mentored their coordinators, while 80% were able to show their unit's appreciation to the coordinators through some kind of public event or award. Half of all respondents were shown a summary/evaluation upon the project's completion. Fully 100% are either very interested or interested in learning more about statistics on the participation of women in their field, what works to interest K-12 girls in science and engineering, what works in recruiting and retaining female students in their units, how to support members of their unit who work on outreach, recruitment, or retention of women, and funding opportunities for programs targeted at women. Four of six respondents said they already participate in forums to address these topics of interest. 100% of respondents noted that dedicated workshops are the most effective forum, while just half feel that pointers to articles or web resources are effective, and only one respondent believed that regional, national, or international conferences are effective venues for addressing these issues. Three of four respondents noted that events they already attend, such as heads' retreats, are an effective venue.

In all, these responses suggest that while some institutions are engaged, we clearly have work to do to reach more departmental representatives and to more fully engage them if the projects are to succeed in the long term. In doing so it may be instructive to keep in mind the thoughts of one department representative: "It is of critical importance for us to make very clear that this is not an issue that involves competition between individual universities—it is an issue of national importance and we need to ensure we have government and industry support as we try to move ahead."

4.4 Conclusions and Future Outlook

Overall, we believe that the Jade Bridges Project has been successful in its goal of supporting individuals in the B.C. and the Yukon region who are playing leadership roles in supporting girls and women to pursue careers in the physical sciences and engineering. Project leaders' thoughts about their projects are overwhelmingly positive. They find their projects personally and professionally rewarding. They feel a greater ability to lead and to enact change within their own departments and they generally feel supported within their departments. Even when there is a lack of institutional support, they continue to feel excitement about the larger goal of supporting girls and women: "We all do these activities because we believe things need to change for the next generation of young

women, and the thanks and feedback we get from the young women participants is the big reward." The network has also been successful in fostering communication among members of diverse institution types in the B.C. and the Yukon region, and the opportunity to get to know people in other institutions has certainly been a valuable and rewarding aspect of the network.

Jade Bridges could certainly strengthen its support of project leaders. One mechanism for this, as indicated by survey comments, would be to improve communications between meetings, for example, to provide information about events, or pointers to new articles or resources on topics pertaining to women in science and engineering. This type of support is certainly feasible, and we expect to act on this in the near future.

We also believe that the talent, experience, and commitment of the Jade Bridges project leaders is a significant asset for our region. We hope that many of these leaders will continue to stay involved as we address the continuing challenges of fostering broader and deeper institutional engagement in advancing the participation and success of women in science and engineering. Despite the modest feedback supplied by department representatives to the Jade Bridges survey, we have seen positive trends with respect to the institutionalization of some Jade Bridges projects, thanks to the initiatives of project leaders. An important next step would be to have a dialogue with a larger group of department heads and deans, which can shape our directions in the future.

One concern for the future is that the term of the current NSERC/General Motors Canada Chair will end in April 2009. It is possible that the current initiative could form the basis for a similar or new initiative of a future chair. However, there is no built-in mechanism for project continuity across chair terms (and it's not clear how desirable such a mechanism would be). Alternatively, it is possible that a network of academic leaders who are working on the advancement of women in science and engineering could be sustained by a partnership among institutions in the B.C. and the Yukon region. Indeed, there could be many advantages to a model in which the network reports directly to administrative heads of institutions in the region. Input from department heads and deans could play a more significant role in shaping future initiatives of the network, and institutions could share data on recruitment and retention of students in their programs. However, such a model does suffer from the disadvantage that there currently is no regional network of administrative heads of science and engineering departments; rather, such networks tend to be organized nationally by discipline. Still, in light of the evident value of a regional network for project leaders, we believe that a regional approach has real merit. We recommend that a regional network of administrative heads be created as a first step, and from there, a natural second step would be the creation of a network of academic leaders who can focus on the advancement of women.

Finally, we note that many other individuals and groups not affiliated with the Jade Bridges network are working successfully on the issues. Future incarnations of the current network should be informed by their input as well. Other organizations that may be able to provide support include the regional NSERC office, which is already

facilitating networking among leaders of science and engineering outreach programs, professional organizations such as SCWIST or DAWEG, and industry partners.

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Success in Trades and Technology
Welcoming Women into Trades and Technology Workplaces - A Checklist of Strategies and Employers Workshops

Valerie Overend, Carolyn J. Emerson, and Susan Hollett

Introduction

The Canadian workforce is changing dramatically because of a number of convergent demographic factors. The aging of the 'baby boom' generation will see a dramatic increase in retirements over the next two decades. Lower birthrates have contributed to the reality there will not be sufficient workers to fill these gaps. Booming energy and construction sector projects, particularly in western Canada, have exacerbated this situation especially in trades and technology fields.

Some numbers illustrate this reality:

- Canada will have a shortage of over 200,000 skilled tradespeople by 2015 according to the Construction Sector Council of Canada.[1]
- 15.3% of the workforce is over 55 years old and increasing.[2]
- The average aged of a skilled tradesperson is over 41.[3]
- Oil and gas and mining (7.5%) and the construction sector (4.5%) were the fastest growing sectors between 2001-06.[2]

The flow of immigrant and temporary workers into Canada has not kept pace with these shortages. Thus employers are recognizing the need to recruit and retain employees from currently under-represented groups such as women and aboriginal peoples to meet this growing demand. In 2006 however, women, while 47% of the employed workforce, were still only 4% of the construction workforce [4], and 2% of apprentices in the 15 predominant trades (in 2002).[5]

An important question then is how can we bring about the significant movement of women into the trades and technology workforce? Post-secondary institutions, sector councils, employers, unions, governments, and community organizations have been articulating the need to increase the participation of women in trades and have undertaken individual and collaborative actions. The Canadian Coalition of Women in Engineering, Science, Trades and Technology (CCWESTT), with its specific mandate to advance the recruitment and retention of women in these fields, is playing an important role.

The Women in SETT Initiative

CCWESTT began its Women in SETT (Science, Engineering, Trades and Technology) Initiative in 2003 to strengthen policy and practice to increase women's recruitment, retention and advancement in SETT in institutions and across sectors throughout Canada. Primary work included input on important issues from CCWESTT members, consultations with stakeholders and institutional leaders, research, and building

relationships with the assistance of eminent advisors. At the WinSETT National Stakeholder Forum in Calgary in 2006, we presented the business case for increasing women in SETT and proposed the development of the Canadian Centre for the Advancement of Women in Science, Engineering, Trades and Technology.

The proposed Centre will partner with stakeholders to:

- Collect best practices for the recruitment, retention and promotion of women in science, engineering, trades and technology (SETT);
- Prepare tool kits from these best practices;
- Provide workshops using the tool kits for human resource and other representatives from industry;
- Work with industry to develop innovative approaches to improve participation and achievement of women in SETT;
- Communicate and promote ways to make workplaces inclusive and welcoming for under-represented groups;
- Gather statistics and follow trends;
- Review and advise on institutional policy and practice; and,
- Monitor the success of its programs.

In 2007-08, as examples of the expertise to be provided by the Centre, the WinSETT initiative developed HR resources and piloted services in several sectors including construction. *Welcoming Women into SETT Workplaces - A Checklist of Strategies*[6] was produced as a practical booklet for use in several workshops for employers and sector associations to identify the broad issues, examine current conditions, and take action to create work environments welcoming to women in the skilled trades and other SETT fields.

Checklist and Employer Workshops

Welcoming Women into Science, Engineering, Trades and Technology Workplaces -A Checklist of Strategies provides a compact (81 pp) and easily administered first step to raise awareness and initiate the process of effective positive change. It includes current research and effective practices spanning the topics of recruitment, selection, orientation, retention, career development, training, and health and safety, and provides a series of questions to help guide employers in developing their own action plans.

CCWESTT has been using the *Checklist* in several pilot workshops delivered to construction and resource industry partners in several geographical regions in Canada with the intention of dissemination more broadly across the country.

Workshop #1 – Saskatchewan, January 2008

The first of these workshops, hosted by the Saskatchewan Construction Association, was delivered to 12 industry participants in Regina, and by videoconference, in Saskatoon, Saskatchewan. Attendees comprised company owners, HR managers of construction

firms, and representatives from the Provincial Apprenticeship Commission and the Association itself.

Valerie Overend (tradeswoman, co-author of the *Checklist*, instructor at the Saskatchewan Institute for Applied Science and Technology, and strong advocate for women in the skilled trades) was the facilitator for this workshop. Participants were taken through five key sections of the Checklist – filling out the question sheets and then discussing the issues, situations in their work environment, and effective solutions. After the workshop, WinSETT Evaluator Susan Hollett facilitated a participant discussion evaluating the Checklist. Participants also completed an online survey to capture additional feedback on the resource and workshop to guide future modifications and delivery.

Outcomes

On the logistics, facilitation and process aspects of the session, there was very strong positive agreement that the workshop was well organized and delivered.

While there was immediate agreement on the need for better recruitment, integration and retention of women on their work sites (in view of labour shortages), participants acknowledged difficulties in doing so, and at the beginning of the session, lacked the recognition that there was a need to address gender considerations specifically. It was primarily through the references to the extensive research and the first-hand experiences of women that participants came to appreciate the unique challenges for women. By the end of the session, all agreed that the information was useful and they were planning on implementing a number of the practices.

- *This workshop has helped me to look at some ideas that I hadn't thought about.*
- *The Checklist will be a good tool to help us to recruit.*
- *Good book and good to have a facilitator even if only to go through a few sections and get them started on working through the rest of the book.*

From the survey –

- 100% agreed the reading level of materials was appropriate and it was easy to find and understand information in the booklet.
- 86% agreed the information was accurate and 71% agreed that all relevant issues were addressed.
- 86% responded that the material will make a positive impact.

One key learning emerging from the event for the organizers was that it was important that the facilitator, or one of the co-facilitators, have strong credibility in the sector. It was also important to partner with or be able to identify a local organization(s) working on women in trades/technology issues to provide future additional information, networks,

and role models for the employers/employees. That local organization can in turn benefit from possible support from these industry partners for their programs and activities.

Another suggestion is to include in the participant materials a one-pager that highlights the economic and employment status of women to provide a backdrop as to why this is a key issue for women – women want to work, they are in the workforce, and many need to work.

Participants also wanted a follow-up source of information, including a knowledgeable person to consult with, to assist with the next steps in taking action after completion of the *Checklist*. This request points to the need to formalize that capability, and a workplace consultancy service is planned for the proposed Canadian Centre for Women in SETT. Participants also suggested that promotion of the workshop be through associations and sector councils.

Workshop #2 – St. John's, NL, April 2008

The second *Checklist of Strategies Workshop* is scheduled for delivery in St. John's NL in late April 2008 to representatives of unions in the Provincial Building Trades Council. The event is being hosted by CCWESTT member organization, Women in Resource Development Committee. WRDC delivers career information initiatives for high school females and notably the Orientation to Trades and Technology Program for women exploring training and career options in natural resource-based industries. The latter project has successfully resulted in the vast majority of participants entering formal training programs in the skilled trades. This workshop provides critical information and strategies for the logical next step – supporting women into actual employment in the construction sector and developing retention practices for women in their workplaces.

Valerie Overend is again facilitating with Susan Hollett providing evaluation, and their observations will be important in assessing any future modifications for expanded delivery. This event will also be combined with a train the trainer opportunity to develop the facilitation expertise of selected WRDC staff. Two individuals will attend the session to co-facilitate and provide local expertise. Several more facilitators will be involved in a follow-up training session after the event where the workshop will be debriefed and the reviewed. WRDC staff facilitators will then be able to deliver the workshop to key industry, government and post-secondary partners in various regions around Newfoundland and Labrador.

This event's partnership will also be the model for finalizing a consultants' agreement for CCWESTT's WinSETT Initiative to establish the working and financial relationships with member organizations for future delivery of resources and services.

Additional information on evaluation and outcomes from the second workshop will be provided in the presentation of this paper at the CCWESTT Guelph Conference.

<u>Future Plans</u>

Based on feedback from the two pilot workshops and other individuals' input, the *Checklist of Strategies* will be revised and undergo a larger print run. Discussions are planned with potential stakeholder partners for delivery of the *Checklist Workshop* in British Columbia and southern Ontario in late summer and early fall. Evaluation and testimonials from participants at these successful events will strengthen new proposals for support to expand facilitation and organizational capability to offer the resources and services across Canada, potentially through the Canadian Centre.

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N

Women Unlimited: Meeting the Needs of Tradeswomen and Employers in Nova Scotia

Nan Armour
The Hypatia Association

Women Unlimited is a 3-year, women-centred pilot project in Nova Scotia. It works to address the systemic barriers which diverse women face, and support their successful transition into skill enhancement programs and non-traditional workplaces. The program is designed to assist unemployed and underemployed women obtain and retain employment in science, trades and technology. To date, about 100 women have participated in the program. There are two pilot sites for Women Unlimited, one in a rural area of the province–Lunenburg/Queens–and one in the Halifax Regional Municipality. There are four components of the program.

- Gender Diversity Recruitment A pro-active outreach strategy that focuses on the recruitment of diverse women to non-traditional science, trades and technology training and employment.
- Career Exploration and Decision-Making A 12 week program providing women with the opportunity to explore careers in science, trades and technology.
- Women in Training Support for women's full participation in science, trades and technology training.
- Women in Trades and Technology Workplaces Partnering with employers to create supportive work environments for women.

Women Unlimited is sponsored by two non-for-profit women's organizations, the Hypatia Association with a mandate to promote women in science, engineering, trades and technology, and the Women's Economic Equality Society that develops and delivers programs to enhance the economic well being of women.

This paper describes the fourth component of Women Unlimited. Through Women in Trades and Technology Workplaces**,** we partner with employers to create supportive work environments for women. In Nova Scotia, many employers are facing current or anticipated skills shortages in trades and technology at a time when the employment of women in these occupations is very low, only 5% in skilled trades for example. Women are an untapped source of potential employees to meet skill shortages.

Women in Trades and Technology Workplaces is a work-in-progress. It is designed to enhance employers' capacity to employ women in non-traditional trades and technology as a strategy to address skills shortages. In doing so, the economic benefits for women in Nova Scotia are significant through increased employment in skilled trades and technology occupations.

The anticipated outcome of this initiative is a resource guide to be used by employers to recruit and retain diverse, skilled women in trades and technology. The guide is being designed for implementation by employers, adaptable to meet the needs of large and

small workplaces throughout Nova Scotia. It is being developed, tested and revised with input from industry partners, small businesses, and women currently employed in trades and technology.

Hypatia initiatives preceding Women Unlimited examined the factors influencing career choices of women and why so few choose non-traditional trades and technology. Combined with findings from numerous national and international research projects, and for our purposes in Hypatia, we have compiled the findings of our research into five main groupings or categories. Each of these categories includes numerous issues:

- Gender stereotyping, attitudes and expectations
- Images of trades and technology and self-images of girls and women
- Culture and learning environments in education institutions
- Workplace culture and environment (including work/life balance)
- Gender equity policies (or lack thereof)

In designing the Women in Trades and Technology Workplaces component of Women Unlimited, our focus was initially on the workplace culture and environment category. This included the 3Ps–policies, practices and procedures–that have an influence on women's experiences in the workplace and on the employer's capacity to recruit and retain women. It did not take long, however, to realize we were also addressing gender stereotypes, images and attitudes about the role of women in the workplace, access to training opportunities and the general lack of gender equity policies in the workplace. In short, we were addressing most of the issues identified in earlier research.

Our first step was to form partnerships with employers. The foundation of each partnership is the shared goal of increasing recruitment and retention of women in trades and technology occupations and the willingness of employers to expand their capacity to achieve this goal. Each employer agreed to create a project team to work actively with us in all phases of the project. It is critical that the employer team take ownership of the initiative and that it not seen as being imposed or imported from outside the workplace. Central to the partnership with all employers is the assurance of confidentiality. Details of research findings and strategic approaches to address workplace issues are not shared outside the workplace.

We entered into partnerships with three large employers. The first phase of the project was research to better understand the impact of workplace culture and environment on women. Standard qualitative research methods for conducting employment systems reviews were used. Individual interviews and focus groups were conducted, involving male and female employees, and included managers and supervisors.

Many workplace practices and procedures were identified as having an impact on women. Some were positive and seen to be supportive of women. Others were reported to have had a negative impact on women and were suggested as being in need of modification or change. For some practices, both positive and negative impacts were mentioned. Many of the issues identified had an impact on men as well as women in the

workplace. One of the important findings of the research is that the majority of women we talked to love their work and want to continue in non-traditional occupations.

Following the collection of data, themes or recurring issues were identified. Although we worked with each employer separately, we have compiled the findings from the three workplaces into a composite report. The practices and procedures identified as having an impact (some positive, some negative) on recruitment and retention of women included:

• Employee appreciation and validation	• Communications within the workplace
• Internal promotions	• Access to training and support
• Work life balance	• Physical barriers for women
• Harassment – verbal, physical, sexual	• Management style
• Personnel policies	• Orientation to the workplace
• Recruitment practices	• Presence and image of the employer in the community

Detailed research findings were first shared with senior management, followed by an analysis of the data to identify the implications for the employer's capacity to recruit and retain women. This was the first step in the development of an action strategy to respond to the issues identified in the research. Each strategy builds on existing policies, practices and procedures that support the employment of women, and designs changes or modifications in other practices as indicated by the research. Although each strategy is customized the meet the needs of individual employers, there are common elements. For example, each strategy acknowledges the importance of:

- Commitment and leadership of senior management;
- Active participation of all levels of employees, managers and supervisors;
- Monitoring of progress and incorporation of action strategies into accountability measures;
- Identifying training needs for successful implementation and sustainability.

We have found the World Café facilitation model to be effective in the design and development of the workplace strategies. It encourages active engagement of a large number of participants, and facilitates the documentation of their ideas and insights for incorporation into the strategy. In evaluations, the participants have responded positively to the opportunity to play an active role in the development process.

We continue to work closely with each employer team in the development of an action strategy for their workplace, not only to reflect the findings of the research but also responding to production schedules and other industry considerations. The action strategies are currently at different stages of development with each employer and proceeding on slightly different timelines with a goal of completion in November 2008.

We learned quite quickly that the culture and environment in workplaces with large numbers of employees and human resources managers is significantly different than the

culture in workplaces with a much smaller number of employees. We have therefore taken a different approach in our partnerships with small and medium-sized enterprises.

Small and medium sized enterprises (SMEs) are locally owned, have fewer employees than large industries, tend not to have human resources managers, and owners often take responsibility for recruitment and HR training for which there is little if any time allocated. Owners also tend to be part of the "hands-on" workforce on the floor or in the shop. The majority of employers in Nova Scotia are in this category.

Our approach with SMEs is to facilitate a series of half-day workshops involving several employers from one geographic area or industry sector. Participating SMEs self-identify as having an interest in increased employment of women in non-traditional trades and technology occupations. In keeping with Women Unlimited, the goal is to build the capacity of SME owners to address skills shortages in trades and technology through increased recruitment and retention of skilled women.

The initial workshop in the series involved representatives of ten SMEs from different industry sectors in one geographic region. We again used the World Café model. We asked participants about the challenges they face as SMEs when hiring and retaining women in trades and technology. The issues identified included:

• Stereotypes and societal norms that don't support women in non-traditional roles	• Images of trades jobs as male jobs
• Reaching a "critical mass" of women in trades and technology	• Work-life balance, shift work
• Finding interested women and finding the right women	• Lack of time for HR training
• Lack of respect for women in non-traditional workplaces	• Having only one female in a workplace
• Perception that women can't handle the physical aspects of the job	• Day care/child support

We also asked them what they could do as individual employers to increase the recruitment and retention of women, and in what ways they could work together as a group of SMEs to support more women. The responses to "What can I do?" included ideas such as: installing and maintaining women's washrooms; learning more about gender issues in the workplace; changing workplace attitudes and practicing zero tolerance in the workplace; providing orientation to help women fit into the workplace, and supporting job shadowing and summer job opportunities for female students.

The employers had several suggestions about how they could work together to support women in trades and technology such as jointly supporting a mentorship program, sharing the cost of scholarships for women in trades and technology and working together to change attitudes in the community about the employment of women.

Our role now is to work with these SMEs and help them address their unique challenges. At the end of the first workshop, employers left with specific suggestions for recruiting women, a short checklist to identify the strengths and weaknesses of their workplace in preparation for increased employment of women, and a summary of the benefits of increased employment of women. The participants responded very favourably to the suggestion of future workshops to support them in the development of workplace strategies based on the ideas proposed at the first session. As a follow-up, we are now working with three of the employers in a field test of a workplace checklist specifically designed for small and medium-sized businesses. They will report on their experiences and progress at the next workshop.

In a closely related initiative, we are facilitating a series of focus groups with women currently employed in trades and technology. To date, we have met with about 60 women. The purpose is to learn from their experiences and insights as women in non-traditional workplaces and to incorporate their suggestions into the workplace strategies.

The resource guide produced as the outcome of Women In Trades and Technology Workplaces will contain a compilation of methodologies and strategies incorporating the lessons we learned throughout the process. It will be designed to be adaptable and easily customized for distribution and implementation by industries, employers, and small and medium-sized enterprises across the province. It is anticipated the guide will be available on the Hypatia website (www.hypatiassociation.ca) in November or December of 2008.

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Workshop on Evaluating Impact and Identifying Measures of Success: When are Outreach Initiatives Successful?

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Abstract

The student enrolment numbers at Canadian universities in Computer Science and Engineering are low, despite of a high industry demand of graduates in the disciplines. With the goal to reverse this trend, many outreach initiatives are on the way. While many articles on those efforts can be found, the evaluation of the programs is often left out or done poorly. Evidence of success is not just important justification for everybody involved in the activities, it is also crucial for continued funding. This workshop sets out to investigate how to evaluate the success of different outreach programs and to develop strategies and tools to do so. In this paper, we discuss issues about evaluation. We further highlight some outreach activities in the Department of Computer Science at the University of Victoria and address current assessment strategies as well as questions evaluation should address.

1. Introduction

At the University of Victoria, the Computer Science and Engineering departments have responded to the issues of enrolment and retention of female students. They have fortified their commitment with the investment of a full-time staff coordinator position for Women in Computer Science and Engineering in the role of support and outreach.

The success of this program so far is shown in the vast number of females that have been touched by this program. As a snapshot, in 2007 alone, 900 students from middle and high schools throughout British Columbia attended our Lego Mindstorms Robotics workshops: 65% of those were women and over 13% were Aboriginal. Several other outreach and retention activities are actively engaging our faculty, staff, graduate, and undergraduate students including: developing materials and workshops for teachers, teaching seniors to use the internet, certificate programs for Aboriginal youth, and an interest in conducting research on best outreach practices.

While a strong program base is necessary, a means for measuring the success of these programs is essential for sustainability. Consequently, evaluation techniques to measure impact are crucial for the current outreach and retention initiatives that are currently expanding. Furthermore, evaluation plays a significant role in obtaining sufficient support from industry and funding agencies, as well as for raising awareness.

In particular we propose the development of assessment and evaluation tools that investigate the following questions:

- Do outreach workshops for girls in middle and high-schools lead to a higher percentage of female students in Computer Science and Engineering?
- How can we effectively measure the impact of such events?
- Do higher percentages of female faculty members yield an increase in female enrolment and retention?
- What appropriate short and long-term quantitative and qualitative goals can we set?
- How can we test whether the change of enrolment numbers are linked to specific outreach activities?

Joining the forces? By the Oxford American Dictionaries, success is defined as "the accomplishment of an aim or purpose". For the last few years the Computer Science and Engineering departments have faced great difficulties with female enrolment and retention. Consequently, the industry in these fields is losing great potential employees. As these issues are more evident in industry, there is a clear need for institutions and industrial companies to collaborate. In response to this issue, University of Victoria has invested in a full-time staff position and attempted to recruit through outreach activities and to raise educator's awareness about the importance of Computer Science. However, most institutions are hesitant in investing in a full-time staff position to respond to this issue. By evaluating success through quantifiable measures, we can validate the need for such positions and the necessity to obtain additional support from industry.

Because outreach evaluation is relatively new in the computing and engineering field, we must rely on information from other disciplines to support our discussion.

In the remainder of this paper, we will discuss various research methodologies that can be used for outreach evaluation in section **Error! Reference source not found.**. Then in section **Error! Reference source not found.** we will look into outreach evaluation done in other fields while designing and implementing our own evaluation approaches in section **Error! Reference source not found.**. Next we will evaluate our current evaluation in section **Error! Reference source not found.** and summarize our discussion in section **Error! Reference source not found.**.

2. Research Methodology

Similar to software development research [8], because the main subjects in outreach are human, our research methods should be drawn from disciplines that also study human behaviour i.e. psychology and sociology. Thus, we have looked into methods that were suggested McGrath[13]. In this section, we will introduce four methodologies that we believe to be relevant for outreach evaluation:

- Survey
- Ethnography
- Action Research
- Mixed-Methods Approaches

For each method, we will look into the type of situation that the method is best suited for and the type of stakeholder that we can satisfy with the particular method.

A. Survey

Surveys allow us to collect quantitative data about a specific population and consequently allowing us to generalize with respect to the population. While conducting a survey, we attempt to gain evidence about variables or information within the targeted population. One of the advantages of conducting a survey is the ability to acquire a large number of concrete evidence to show funding providers the "success". A major disadvantage of a survey is the accuracy of information. In some cases, subjects may provide answers that present themselves in a favourable light. For this reason, we must keep in mind that there is a threat to validity of the result.

B. Ethnography

According to McGrath's categorization [13], ethnography is one of the many methods within field study. It is a well-known approach to collect qualitative data with a focus on sociology based on field work. Because relations exist between subjects understudy and these patterns of relationship will affect the overall group structure [12], it will affect the outcome of our research. A prominent ethnography characteristic is that investigators do not need hypothesis; they are conducting the study in hopes to understand the structure and relations within the community understudy. This approach is good for evaluating materials presented and is useful to educators. A serious side effect of ethnography is bias. While investigator "strives for a natural, relaxed relationship with the subjects"[16], their presents/interference in the environment often introduce bias. Furthermore, the investigator's understanding also introduces bias into the results. In spite of the aforementioned reasons, as long as the investigator carefully reflects upon the results and address all the threads to validity, then it is safe to use ethnography.

C. Action Research

As stated by Davison [6], action research investigators study not only the problem but also the experience. They attempt to improve the way the issues are being addressed and solved. This approach is well known in the education field, "where major changes in educational strategies cannot be studied without implementing them, and where implementation implies a long term commitment, because the effects may take years to emerge" [8]. Similarly, in Computer Science education evaluation, it may take many years to track the effect until we can analyse the result. While investigators perform action research, it is of great importance for investigators to reflect upon his/her own actions, attempting to recognize the cause of success and failures. One limitation for this approach is that once the investigator interferes with the setting, it makes a permanent impact. The investigator can never find out what happen if another method was applied.

D. Mixed-Methods Approaches

As each of the aforementioned methods have their own strengths, weaknesses, and limitations, the mixed-methods approaches attempt to select groups of methods in such a way that the strengths of each will counterbalance the weaknesses in others. The three most common approaches are: *sequential explanatory*, *sequential exploratory*, and *concurrent triangulation*.

In a sequential explanatory approach, the investigator uses qualitative data to explain and interpret quantitative findings. On the contrary, investigator of sequential exploratory approach uses quantitative data to interpret qualitative findings. To separate itself from the other two approaches, concurrent triangulation uses a number of methods concurrently for the purpose of confirming and cross-validating [8]; collecting multiple sources of the same data helps improve validity and soundness of the findings. The major flaw of mixed-methods is its time-intensive nature to collect and analyze data. In addition, investigators of mixed-methods must be familiar with all the various forms of research (i.e. quantitative and qualitative). This double-edge nature of the mix-methods allows investigators to collect data and information for both the educator and the funding source.

3. Related Work

Over the last few years, Computer Science and Engineering have been facing challenges in recruitment and retention [1][2][5][7][9][14]. Although IT is booming and the job opportunities for its graduates are excellent, the public perception reflects a contrary attitude [15][22]. While some backtrack this gap to the dotcom crash, paradoxically in Software Engineering the jobs had never declined [11]. Others make the image of the computer scientist or engineer responsible [4]. For example, in a CBC interview broadcasted on February 24, 2008, Bill Gates conjectured that the "nerdy image" of Computer Scientists and Engineers has a negative impact on the current recruitment situation.

The lack of Computer Scientists and Engineers naturally amplifies to a larger scale when the focus is placed upon minorities such as females [21]. But what are the real reasons responsible for the current trends? Which initiatives, intended to reverse the trends, are indeed successful, which ones aren't? What is the best age to approach youth and in particular females to introduce and increase awareness in subjects such as Computer Science and Engineering? Is the practiced education in elementary, middle, and high-schools sufficient? The finding of answers to all those questions depends on quality assessments.

The authors in [3][19][20][23] address the influence of certain activities and programs in K-12 with respect to awareness and interest in Science or Engineering are studied using assessment and evaluation techniques. These techniques include questionnaires (identical pre- and post-questions) and some statistics. NSF research to develop evaluation tools for STEM (Science, Technology, Engineering and Mathematics) research is currently

undertaken by Cornell researchers on "`Evaluation of Science, Technology, Engineering and Mathematics (STEM) education programs'". Results from this project are expected in 2008 [17].

Outreach models investigated in studies in the literature include the leveraging of knowledge via college or high-school students [10][19][20], and outreach programs targeted for the recruitment and retention for female students [3][23].

Studies have shown that institutionalizing a pervasive inclusiveness mandate with dedicated resources, extending outreach to potential students, and creating mentoring programs all have positive impact in terms of female recruitment. A detailed report on this can be found in Steele's article [18].

4. Our Current Approach

The University of Victoria currently supports a number of outreach and retention programs. The programs are knit together by the common goal of increasing enrolment numbers, but are often managed and implemented by a variety of people who may or may not collaborate on research techniques. Within this section we will introduce some of the programs as well as describe the current methods of research and data collection that occur within the confines of the individual programs.

A. 1st Year Computer Science Audio Forensics Project

As part of an effort to produce more engaging projects for first year introductory programming classes, an 'Audio Forensics Project' was recently developed which unites the basic concepts taught in an introductory programming class with a more interactive challenge. The project takes four weeks to complete, and the students are required to complete two assignments that build on each other. Although the students are graded on their performance, at this time quantitative data based on assignment marks has not been collected and analyzed. The majority of the data collected is qualitative feedback in the form of paragraph-style questions incorporated into the assignment, along with anecdotal observations regarding the students excitement and motivation levels as the project progressed. A more quantitative evaluation is desired for this project, but is currently not in practice.

B. SPARCS After School Club

The SPARCS After School Club is a one hour weekly session lasting six weeks as produced by the SPARCS Research Group at the University of Victoria. The SPARCS After School Club targets students grades 3 and above. The students are exposed to concepts in Computer Science and basic Engineering through a series of activities as coordinated by instructors. This is a program which was tested in the winter of 2007 and opened up to the public in spring of 2008.
In evaluation, data was collected at three separate points. The first is at registration; age, gender, location of residence, and "how they heard about the program" are collected. This

data is intended for administrative purposes, and is used to identify first, what the effective methods of advertising are, and second what types of students are currently interested in the program, so that methods can be developed to target alternative groups to produce a more diverse student base. The second point of data collection occurs at the end of each weekly session. Instructors are required to complete a 'Session Review Sheet' which asks the following questions:

"Briefly describe the activities completed during today's session."
"Was any of the planned curriculum not used? If so, why not?"
"Did you modify the lesson in any way? If yes, please explain."
"Were there any questions you could not answer? If yes, please list."
"What was the overall impression from the campers?"
"Any additional comments?"

The Session Review Sheet is designed to provide feedback to the supervisor of the SPARCS After School Club Program regarding the individual successes and difficulties that the instructors handle while presenting the activities. Upon completion of the session, final data is collected through an online survey. The survey is sent to the parents of the students with instructions to complete the survey with their child.
The questions of the survey were designed to:

- Identify the motivation as to why the student was enrolled in the program
- Identify which activities were most enjoyed by the students
- Identify which activities were not enjoyed, and why
- Identify the expectations parents held regarding the program
- To receive feedback on the performance of the instructors

Currently students attending the SPARCS After School Club are not tested on the materials learned.

C. LEGO Robotics Festival (Saturday)

The Saturday LEGO Robotics Festivals are six hour workshops focusing on a challenge that can be solved through the building and programming of a LEGO Mindstorms NXT Kit. The LEGO Robotics Festival has been attended by students grades 5 and up since 2005. In the past, data was collected only at registration to cover necessary administrative requirements. In 2008, much like the SPARCS After School Club, data is now collected through registration and through Session Review Sheets. The type of data collected and the purpose of the collected data are consistent with the SPARCS After School Club. Students are not tested on materials learned. Each workshop is independent, and currently there is no progression in the workshops for students who have attended a workshop in the past. Curriculum is currently being planned to allow for an intermediate stage, where students are required to posses the skills already learned in a previous workshop in order to complete the intermediate level workshop.

D. LEGO Robotics Festival (School)

The LEGO Robotics Festival for school groups differs very little from the Saturday LEGO Robotics Festival. School groups attending the workshop are registered by a teacher from a local school, and no registration data is collected outside of the number and gender of students. Session Review Sheets are currently completed for school groups, having become common practice in the spring of 2008.

E. Tsawout First Nations Computer Workshop

The Tsawout First Nations Computer Workshop were daily three hour sessions held between November 5th and 16th of 2007. Although no registration data was gathered, the class consisted entirely of First Nations students. Data was primarily collected through over 30 hours of video footage, focusing on the students' progress through the workshop and concluding with their final presentations. Each student produced a demonstration to showcase their knowledge to their peers, parents, and the instructors. Within the original curriculum, quantitative data regarding the progress of the group was to be collected. Two quizzes were scheduled, one for the third day of the course and the second for the last day of the course. In implementation the quizzes were not used.

5. Evaluation of Our Current Approach

While obtaining results from individual outreach activities, we are of course interested in which findings we can generalize to larger populations. An obstacle for this for example may be that in some of our outreach activities, the audience is self-selected to participate. As Computer Science researchers and educators, we are deeply interested in introducing the field to the world, often forgetting to formally evaluate what we do.

We have also come to realise that the outreach community is currently lacking communication. Individual parties are constantly reinventing the wheel. There is an urgent call and a need for collaboration between organizations to share and discuss evaluation strategy and results.

6. Conclusion

Outreach evaluation serves many purposes, ranging from motivation for grant requirement reasons to gaining insight to assist us in research and education [17]. In order to fulfil the needs of various stakeholders however, we must use a variety of methods to bear each aspect. As stated by McGrath, "Each method should be regarded as offering potential opportunities not available by other means, but also as having inherent limitations" [13].

While studying evaluation approaches in other disciplines, we have gain ideas and insights for types of technique that we can apply. However, the details for these individual techniques are usually neglected in papers. Thus, many of our questions are still left unanswered.

There is an absolute need for concrete evaluation methods that we can apply for a particular type of events in a specific amount of time (i.e. one hour, one day, one week, more than one week). Moreover, we need a further breakdown of evaluation methods that map to different variables (i.e. interest, awareness, particular knowledge) and details on how each method can be applied.

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Building on Success: Increasing the Percentage of Women Faculty in the Sciences

Margaret-Ann Armour

Abstract

The percentage of women in undergraduate and graduate science programs has increased dramatically over the past 20 years, but this success has not been reflected in the representation of women in faculty positions. Of considerable concern is that there has been little change over the past 6 or 7 years with the percentage of women faculty in the physical sciences and mathematics stalled at about 15%. New administrative positions are being created to effect change. As the first incumbent in such a position, Associate Dean of Science, Diversity, at the University of Alberta, I am implementing some of the principles, ideas and practices which have been suggested by many researchers and activists in the field to counter the factors which cause the continuation of low numbers of women faculty in the sciences. This has provided me with a unique experience: to see at first hand the cultures of the Departments which comprise the Faculty of Science and how these very different cultures affect hiring practices, promotion and retention of women faculty. Initiatives to date have included discussion sessions with Department Chairs and with all hiring committees, finding ways of identifying potential female candidates and inviting them to apply, implementing an effective mentoring program for new faculty, and lobbying for adequate high quality day care spaces on or near campus. Longer term strategies include having sessions with female graduate students, postdoctoral fellows and research associates in each Department in which women are markedly under-represented, and maintaining contact with women who complete their undergraduate degree at the University of Alberta and who go on to graduate school at other universities. It is also necessary to retain the women who have been recruited by creating a welcoming and supportive Departmental environment so that the women are more likely to stay and have successful careers in the academy. The initiative has been named "Project Catalyst"; the results to date are described.

Introduction

The representation of young women in first year undergraduate science programs in North American Universities has increased over the past 20 years to 52% mirroring their percentage of the population. How did this change occur? Considerable research has been undertaken to try to understand the factors which influence women's choice of a career in the sciences[1]. Not surprisingly, many factors have been identified. Societal norms have changed over the past 20 years such that women are entering career fields which they used to not consider. Many groups have been established at the local level to take action to inform and excite girls from elementary to high school about the sciences, to introduce them to role models and to publicize and celebrate the contributions women have made in this area. For example, in 1982, Women in Scholarship, Engineering,

Science and Technology (WISEST) [2] was formed at the University of Alberta and in 1987 the Canadian Coalition of Women in Science, Engineering, Trades and Technology (CCWESTT)[3] was established to enable communication and empowerment among the groups.

These initiatives have had a marked effect on the number of young women entering post-secondary education in scientific and technical fields. In the academy, it was expected that as these young women completed higher degrees and gained postdoctoral experience in their discipline, they would become faculty members in the sciences. However, at the University of Alberta, in spite of the equal proportion of undergraduates, and the increasing proportion of female graduate students, the percentage of women faculty in Science has remained almost constant at about 15% for the past seven years. Thus, the expected increasing movement of qualified young women into faculty positions has not occurred. To take action to change this situation, in 2005, a new position of Associate Dean, Diversity, was established in the Faculty of Science. The mandate of this Associate Dean is to take action to increase the representation of women as faculty members, and also that of the other three "designated groups" identified by the Federal Government as being under-represented in the work-force, often markedly so in the sciences. In addition to women, these groups include persons with disabilities, visible minorities and aboriginal people.

As the first incumbent as Associate Dean of Science, Diversity, my activities to date have been focused on increasing the percentage of women in faculty positions. It is expected that at least some of the strategies effective in increasing the participation of women will also increase the inclusion of members of the other designated groups. To achieve this increase, I am using some of the principles, ideas and practices which have been suggested by many researchers and activists in the field[4] to counter the factors which result in the low numbers of women science faculty. Some of these practices include discussion of the issues with Department Chairs in the Faculty of Science, identifying women as potential candidates for positions, being a member of selection committees, facilitating effective mentorship of new faculty, ensuring implementation of policies which make the workplace more inclusive of women, and employing strategies which will have an effect in the longer term such as discussions with graduate students and post-doctoral fellows, and being involved in workload/worklife issues at the University. I have called the initiatives, Project Catalyst[5]. They are described in more detail in the following paragraphs.

Discussions with Departmental Chairs

Chairs of Departments in the Faculty of Science at the University of Alberta have considerable influence in their Departments so one of my first actions was to have an information and discussion session with all of them. It was important for them to know about my activities and be supportive of them. We discussed the reasons why diversity of faculty is important and talked about the different approaches women bring to research problems leading to invigoration of research teams and more robust solutions. It was acknowledged that with the strong hiring happening at the University of Alberta, the time

was opportune to attract outstanding young women. As new Department Chairs are appointed, I talk with them about the initiatives.

Identifying Potential Female Candidates for Faculty Positions

Identifying and personally inviting qualified women to apply for specific positions is a strategy which has been shown to be effective in increasing the pool of female candidates. Identifying such women can be difficult; I have talked with people in the field to ask if they know of appropriate women to approach. When at technical conferences, I take note of award-winning women and female presenters of papers. For example, at the Joint Mathematical Meetings[6], the Association for Women in Mathematics[7] invites a select group of young women who are just completing their Ph.D. degrees to give oral and poster presentations. This provides an excellent opportunity to meet these women and know the area of their research, so that they can be invited to apply for appropriate faculty positions in the Department of Mathematics and Statistics or for postdoctoral fellowships at the University of Alberta. Personal contact of selected individuals is more effective in encouraging applications than sending out E-mails to large numbers of people. However, it is also good to send out the position notice to networks of women in the field. What is more difficult in the latter approach is knowing whether it attracted any additional female applicants and how effective it is. We cannot ask the gender of an applicant and names often do not allow such identification. Thus, unless reference letters are required with all applications and the referee refers to the applicant as she or he, it is often not possible to know the percentage of female applicants (and even more difficult to know the percentage of applicants in the other three designated groups) for any particular faculty position.

Selection Committees

I am privileged to sit on many of the selection committees in each of the seven Departments in the Faculty of Science (Physics, Chemistry, Mathematical and Statistical Sciences, Computing Science, Earth and Atmospheric Sciences, Biological Sciences and Psychology). This has allowed me to understand how the Faculty guidelines for the selection and hiring of faculty members are implemented in each of the Departments and to recognize ways in which the hiring process is inclusive of under-represented groups. These committees begin their work by writing an advertisement for the position available. Women often do not apply for a posted position since they believe that they do not meet the advertised criteria. Thus, the wording of these advertisements can have an influence on how many women apply. For example, a small change such as “the candidate should have an outstanding research and teaching record” to “the candidate should have an excellent research and teaching record”, can avoid having a potentially strong female candidate decide not to apply since she did not judge her record to be outstanding. We know that young women tend to underestimate their achievements compared to young men and so in their subjective judgment they self select themselves out of applying for positions for which they may be just as qualified as those who do apply.

At the first meeting of each hiring committee, I present a set of notes intended to help to make the process more inclusive and to share with the committee members the resources available to support diversity in hiring. Many of the points in the notes were taken from information on inclusive hiring practices published on University web sites by equity advisors and others working on equity programs. Some of the points in the notes which lead to discussion with the members of the selection committee, include the following:

- Messages which would normally be communicated to candidates during visit:
    - Seriously interested in candidate's scholarly work and credentials
    - The Department of …… at the University of Alberta is a good place to be since it is intellectually stimulating
    - The University of Alberta has a number of family friendly policies in place, e.g. day care; parental leave; human rights policies; desire for diversity
- How these messages are communicated to candidates can make a difference in recruiting women to departments where they will be outnumbered by male colleagues
    - Make it clear that the Department is interested in the candidate's scholarship and skills; quality will not be compromised to increase diversity
    - Consider how the Department will show that it is a place where women faculty can thrive, e.g.
        - Clear policies for evaluation and promotion
        - Sensitive mentorship
    - Schedule interviews and events with consistency, allowing equal time for each candidate to meet with the same personnel wherever possible
    - Give candidates a chance to interact with the Department's faculty in multiple venues. Formal talks may not reveal every candidate's strengths. Consider including less formal question and answer sessions
    - Focus on the candidate's ability to perform the functions of the job and avoid making assumptions based on sex, marital or familial status
    - Use a set of common questions for all candidates; e.g provide information about family friendly resources to all candidates, not just women
    - Introduce all candidates to some or all women members of the Department
- When making final choices, need to constantly examine whether judgments on candidate's accomplishments and potential are being affected by subjective factors, stereotypes or other assumptions, e.g. a person who is a good fit with the current "norm" of the Department and who will blend in with existing structures is judged on their potential while someone who does not is judged on their accomplishments.
- Good to have short list of candidates without labeling one as "most promising" so that all candidates on the short list can be fully considered.

- There is a Special Recruitment Fund for attracting members of the four designated groups, women, aboriginal people, persons with disabilities, members of visible minorities and an Employment Equity Discretionary Fund to support projects that meet recommendations for the University of Alberta's Employment Equity Plan or to support any special measures stipulated by the Federal Contractor's Program.
- There is also a Spousal Employment Fund to aid spouses in finding suitable employment and Career and Placement Services has a Spousal Employment Program.

Observing the practices of about twenty selection committees has allowed me to identify what I would define as best practices in making the hiring process inclusive. I have found that asking questions about why a certain process was followed has helped those on the committees to see how some of the accepted practices may favour candidates who are in the traditional mould. Understandably, committees would like to hire persons who have an easily recognized record in their field, but this may mean that the committee misses the "rising stars" especially those who belong to groups not strongly represented in their Department. It is expensive and time consuming to bring for interview more than three or four candidates for each position, and since application packages can be difficult to judge, it is important that the committee be ready to take a risk in making the final selection of the short list for interview. At our University, there are funds available from the Equity Office to bring in a candidate from one of the four designated groups who would not otherwise be invited for interview. This can help to increase both the recognition of the viability of non-traditional candidates and their visibility.

Sometimes, I have been able to question the practices of selection committees which appear to be discriminatory to women, even although not intended as such. I have also tried to uncover some of the systemic biases which help to account for the low proportion of women being hired. I have found that this is best done by relating examples of how our biases can affect our judgment. One question that I have found useful is asking how a selection committee would subconsciously react to an obviously pregnant young women compared to a young man about whose family they know nothing, since again, we may not ask. I have tried to ensure that diffident yet brilliant young woman is not at a severe disadvantage when compared with a self-confident young man who presents himself extremely well. Knowing that examples of unintentional gender bias have been documented (see for example the case of fellowship applications to the Swedish Research Council[8)], I have tried to watch for subconscious biases in the assessment of women candidates. I share with each committee the recognition that letters of recommendation for women often emphasize their personal qualities using phrases such as "wonderful mentor to my new graduate students", "very positive influence in the laboratory", to a greater extent than do letters for men. The latter give relatively more space to research accomplishments. This may result in an implicit message that the women candidates are not such strong researchers as the men.

Selection committees are searching for the "best" person for each available position. But how do we judge who is "best"? There are objective criteria which are an important part

of such a judgment: papers published since completing Ph.D., quality of journals in which the papers are published, number of times which the papers have been cited, creativity shown in research direction, fit of research to that of the members of the hiring Department, teaching experience and ability, mentorship of undergraduate and graduate students and so on. However, there are also subjective impressions of the candidate: will they be a good Departmental citizen, will they be a good role model, how will they represent the University at conferences nationally and internationally? It has been good to hear members of selection committees discuss these points when they meet to make the final selection of the candidate to whom the position will be offered.

Mentorship of New Faculty

Within the Faculty of Science at the University of Alberta, for each new faculty member, the Department Chair assigns an established faculty member as a mentor. The new faculty and their mentors attend an orientation session before the beginning of term at which I have the opportunity to talk about the expectations of the mentorship. It is then my responsibility to ensure that the process is effective and continuing, and particularly in the case of women in Departments with mostly male faculty, to provide further mentorship if needed. This is one of the important initiatives in the retention of women in male-dominated departments. It helps to create a welcoming and supportive Departmental environment so that women are more likely to stay and have successful careers in the academy[9].

Policies

It has been shown in business that when policies are implemented in the workplace which make it attractive to women, they make it more attractive to all employees. Thus, there is a strong case to be made for the introduction of these policies. The Alberta Heritage Foundation for Medical Research has taken the lead in Alberta in automatically increasing the tenure of a grant by one year for each maternity leave taken while holding the grant[10]. The important aspect of this policy is that it is automatic. Some Universities such as Princeton[11] have a similar policy related to tenure: tenure extension of one year is automatic for faculty who have become parents by birth or by adoption, and it is the responsibility of the Department Chair to ensure that this policy is implemented for all faculty.

Increasingly I have come to realize that unless adequate high-quality day care spaces are available on campus, it is difficult to recruit faculty with young children. This is even more crucial to the recruitment of female faculty. Most Universities have recognized this need, but it is often difficult to provide sufficient spaces with the current rate of recruitment of young faculty. Also important to new faculty with young families is flexibility in the time allowed to achieve tenure. Thus, flexibility and transparency in the practices for tenure and promotion are factors which can help to retain recently hired faculty, an important consideration in building a strong, stable and diverse Department and since there is frequently a high financial investment in providing start-up funds.

Longer Term Strategies

We are aware that many excellent female graduate students are not choosing careers in academe[12]. I have begun to talk with groups of female graduate students to identify some of the reasons why they do not make this choice. The answer I have received most frequently is that they would not be comfortable with the lifestyle of their faculty supervisor. It reflects a question which has been raised by young women scientists for many years: "how do I manage a career and a family?" The perception is that managing a career and a family in academe will be even more difficult than in other employment sectors. This is related to the fact that the tenure clock and the biological clock are ticking at the same time and increases the importance of flexibility of the tenure clock. However, at least in North America and Europe, it also reflects the work life expectations and stresses in the academy. The Association of Academic Staff at the University of Alberta recently conducted a survey[13] on these issues and together with the Senior Administration have established a Task Force to explore them and make recommendations.

Within the Department of Biological Sciences at the University of Alberta, the graduate students are 50% female, however among the postdoctoral fellows only 10% are women. Since the completion of a postdoctoral fellowship is often a requirement for being hired as a faculty member, this is a transition point in career progress that needs investigation. Focus groups with female graduate student and postdoctoral fellows are planned to tease out some of the reasons why there is such a large drop in representation of women between the two groups. A similar drop in numbers occurs in the transition between postdoctoral studies and becoming a faculty member[14].

Conclusion

Why do I believe it is important to have diversity among University faculty in each Department? Women are still socialized differently and may bring a different perspective to a problem, asking different questions. The more perspectives represented in the questions asked, the more robust the ultimate solution to the problem. A more diverse faculty can change the culture of the Department, the Faculty, and the entire University community to make it a more collegial and inspiring place to work, and a place where all people matter. The goal is to work towards having a critical mass of women in each Department in the Faculty of Science, a number which is considered to be at least 30 to 35% if the faculty. Then, the culture should slowly change to be fully inclusive of women, men and minority groups, so that each person can contribute to their full potential.

The University of Alberta is a large (35,000 students) research intensive University, but the initiatives described here could be implemented in many post-secondary institutions with Departments and Faculties which have low representation of diverse groups.

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The Climate for Women in Science and Engineering: Perceptions of Canadian Graduate Students

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Abstract

A sample of 199 women and 188 men in Canadian science and engineering graduate programs responded to a survey, which investigated their departmental climate, opportunities for collaboration, social support, and feelings of inclusion. Analyses were conducted to identify differences between genders and differences between disciplines. The results showed gender-related differences for collaboration: women reported higher levels of collaboration between genders than men reported. Gender differences were also found between disciplines: women in engineering reported that their departments were less congenial to women and reported significantly lower person-discipline fit than did men in engineering. Within life sciences, men reported significantly higher levels of social support than did women.

Introduction

Over the past thirty years, women in North America have made impressive gains in their representation in traditionally male-dominated occupations. Examples of this are law, medicine, psychology and management, where women now constitute 45% to 50% of students and a growing percentage of practising professionals.[1] There is little doubt however, that other science and engineering disciplines constitute notable exceptions to this trend. For example, although the number of women in engineering has increased significantly since the 1960s, the percentage of women receiving degrees in engineering is still low. In 2004 in Canada only 21.6% of undergraduate, 23.7% of Masters, and 15.5% of doctoral degrees in engineering were granted to women[2]. Moreover, only about 12% of faculty in engineering departments, and 12% of those employed as engineers in Canada were women[3]. U.S. figures are very similar[4]. In addition, research indicates that women who do become engineers are twice as likely as their male counterparts to abandon the profession after a few years in the workplace.[5] These figures suggest that the profession of engineering is having difficulty in both attracting and retaining women.

The failure of science and engineering programs to make themselves more attractive to women is troubling for several reasons. In the first place, it perpetuates occupational sex segregation. Secondly, given the increasingly significant role of technology in post-industrial societies, it means that women will continue to be largely excluded from powerful and central professions and the associated financial rewards and prestige. Lastly, and perhaps most importantly, science and engineering disciplines are failing to gain access to the skills and talents of half the population. In Canada, this will greatly exacerbate a forecasted serious shortage of scientists and engineers in the future.[6]

One reason for the failure to recruit and retain women in these professions could be the culture of the disciplines. Some have argued that, due to the past predominance of men in science and engineering, the cultures in these disciplines are "masculine". [7,8,9,10,11] Concern has been raised that, because of this, graduate education in science and engineering is not conducive to women's values or learning needs.[12] Moreover, the attrition of women from science and engineering is frequently attributed to the presence of a "masculine" culture which results in a "chilly" climate. [9,13,14, 15]

According to Dryburgh[13] there has been little previous research on how women experience the cultures they encounter in science and engineering. Understanding the issues faced by women graduate students is particularly important because graduate school is a time of socialization into professional identity and of transition between student and professional roles.[14] Recently there have been a few studies on the experiences of women students in science and engineering, but the focus has been undergraduates[16,17] and graduate students at U.S. universities. [8,18,19] A better understanding of the factors that contribute to the under-representation of women in science and engineering programs in Canada can be useful to increase the number of women in these programs.

In order to better understand the climate in which women graduate students in science and engineering programs find themselves once they enter graduate school, the present research looked at the departmental climate, opportunities for collaboration, social support, and feelings of inclusion of men and women students in Canadian science and engineering graduate programs. The aim of the research was to understand the role climate has in the under-representation of women in science and engineering graduate programs in Canada.

Method

Participants. The participants were 199 women and 188 men (plus 14 gender unidentified) graduate students enrolled in science and engineering programs across Canada. Respondents ranged in age from 22 to 54 years of age, with the majority being between 25 and 29 years of age. Fifty-six percent of participants were enrolled in a Master's program, 39% were enrolled in a Ph.D. program, and 5% did not indicate program type. The majority of participants were enrolled in engineering (37%) and life science programs (23%). There was a higher percentage of men than women in engineering programs and a higher percentage of women than men in life science programs. Eighty-five percent of the surveys were completed in English and 15% were completed in French. Fifty-nine percent of the participants listed English as their first language, 21% listed French as their first language, and 20% listed "Other" as their first language. Fifty-five percent of participants were single and 39% were married or living common law. Eleven percent of the participants had children living with them (27 men, 18 women) and 12% reported providing financial assistance to other family or relatives (36 men, 11 women).

Procedure. A link to the electronic survey was emailed to Deans/Department Heads of science and engineering programs across Canada, who were asked to forward it to graduate students in their departments. The survey was available to students in both French and English to ensure all students across Canada would be included.

Measures.

Overall department climate. Respondents were asked to rate the overall nature of their department climate using a scale taken from the University of Michigan Graduate Student Survey.[20]. The scale consisted of 14 bipolar adjectives: welcoming, friendly, racist, homogeneous, respectful, sexist, collaborative, cooperative, homophobic, supportive, flexible, protective, encouraging, and snobbish. The overall department climate score was composed of the average ratings of responses to the 14 adjectives. Scores ranged from 1 to 5 with higher scores representing a more positive climate.

Congeniality of environment to women. Perceived Congeniality of Environment to Women was assessed with a scale taken from Pascarella et al.[12] The score consisted of the average of the responses to eight statements regarding whether: 1) there is similar treatment of men and women; 2) prejudice or discrimination exists towards women; and 3) the course content reflects women's experiences. Scores ranged from *Strongly Disagree* (1) to *Strongly Agree* (5), with higher scores indicating a more positive (more congenial) environment.

Collaboration between men and women. Perceptions About Amount of Collaboration Between Men and Women were measured with a scale taken from Ferreira.[14] The score was composed of the average ratings of the responses to 13 statements that assessed students' perception of the interactions between men and women in their department (e.g., "In my department men students listen well to women," "I often discuss science/engineering with my male student colleagues"). Scores ranged from *Strongly Disagree* (1) to *Strongly Agree* (5), with higher scores indicating perceptions that there was greater collaboration between men and women.

Person-discipline fit. Perceived Person-Discipline Fit refers to the congruence between a person's values and those of their discipline. People prefer environments that match their values and fulfil their needs. Perceived Person-Discipline Fit was assessed by adapting a measure of Person-Organization Fit.[21] The Perceived Person-Discipline Fit score was composed of the average ratings of the responses to four statements that assessed students' perception of their fit with science and engineering programs (e.g., "My values 'match' or fit those of my graduate department," "My values 'match' or fit those of my research group/lab"). Scores ranged from *Strongly Disagree* (1) to *Strongly Agree* (5). Higher scores indicate a better perceived fit with the graduate program.

Feelings of inclusion. Feeling of Inclusion was assessed via the inclusion subscale of the Longitudinal Assessment of Engineering Self-Efficacy; Assessing Women in

Engineering (LAESE).[22] Scores were the average of the responses to four statements (e.g., "I can relate to the people around me in my class," "The other students in my program share my personal interests"). Scores ranged from *Strongly Disagree* (1) to *Strongly Agree* (5), with a *Don't Know/ NA* option included. Higher scores indicate a higher perception of inclusion.

Perceived social support. Perceived Support was assessed with items taken from a measure by Williams.[23] Scores were composed of the average ratings of the responses to six statements. Four were from the social environment support subscale (e.g., "It is easy to make friends with other students") and two were from the program involvement support subscale (e.g., "I have participated in a study group with other students"). Scores ranged from *Strongly Disagree* (1) to *Strongly Agree* (5), with a *Don't Know/ NA* option included. Higher scores indicate a higher perception of social support.

Results

Climate and culture. With respect to the overall departmental culture, respondents rated their department climate fairly positively ($M = 3.88$, $SD = 0.63$). Comparisons were made between men and women graduate students with no significant differences being found, t (384) = 1.55, $p > .05$. However, a comparison of students in Ph.D. and Master's programs did result in a significant difference, t (376) = 3.58, $p < .01$. Respondents who were enrolled in Ph.D. programs ($M = 3.78$, $SD = 0.67$) perceived their overall program more negatively than respondents enrolled in Master's programs ($M = 3.97$, $SD = 0.58$).

Overall responses were again positive with respect to perceived congeniality of environment to women ($M = 4.03$). Similar views were held by women and men respondents, t (380) = 0.17, $p > .05$. Differences were found, however, between women and men engineering students. Women engineering students ($M = 3.92$, $SD = 0.56$) perceived their environment as being less congenial to women than men engineering students ($M = 4.15$, $SD = 0.49$), t (140) = 2.48, $p = .01$. An additional difference was found between Ph.D. students and Master's students. Respondents enrolled in Ph.D. programs ($M = 3.94$, $SD = 0.62$) perceived their environment to be less congenial to women than respondents enrolled in Master's programs ($M = 4.10$, $SD = 0.55$), t (377) = 2.59, $p < .01$.

On average respondents perceived a fairly high amount of collaboration between men and women in their departments ($M = 3.93$, $SD = 0.56$). A difference was found between women and men respondents. Women respondents (M=4.02, $SD = 0.54$) reported significantly more collaboration than men respondents (M=3.85, $SD = 0.56$), t (381) = 2.98, $p < .01$. An additional difference was found between respondents in engineering and life science. Respondents enrolled in life sciences ($M = 4.12$, $SD = 0.53$) reported significantly more collaboration between men and women than respondents enrolled in engineering (M =3.82, $SD = 0.55$), t (235) = 4.22, $p < .001$.

Again average scores were moderate for person-discipline fit ($M = 3.50$, $SD = 0.77$), meaning respondents reported a moderate fit with their program. No significant

differences were found between genders overall, t (227) = 0.47, $p > .05$. However, differences between genders were found for engineering students. Men engineering students (M = 3.62, SD = 0.71) reported a significantly greater person-discipline fit than women engineering students (M = 3.35, SD = 0.80), t (135) = 2.10, $p < .05$.

Feelings of inclusion. Average scores were moderate (M = 3.46, SD = 0.81), meaning respondents felt they somewhat included. No differences were found between the genders, t (377) = 0.15, $p > .05$. Differences were found, however, between disciplines. Respondents enrolled in the life sciences (M = 3.66, SD = 0.84) reported greater feelings of inclusion than did Engineering students (M = 3.28, SD = 0.79), t (230) = 3.54, $p < .001$.

Perceived social support. Overall social support was reported to be moderately high (M = 3.68, SD = 0.71). No significant differences were found between the genders overall, t (383) = 0.75, p = .45. A significant gender difference was, however, found between for students in the life sciences. Men respondents (M = 4.01, SD = 0.55) reported significantly higher levels of support than did women respondents (M = 3.66, SD = 0.76), t (92) = 2.15, p = .03.

Discussion

The current study was an attempt to understand the role climate has in the under-representation of women in science and engineering graduate programs in Canada. In order to do this, graduate students in sciences and engineering were recruited from across Canada. Although the sample consisted of a relatively small percentage of the total population of graduate students in science and engineering in Canada, participants were drawn from students in a variety of subdisciplines in engineering, life sciences, math and computer sciences, physical sciences, and agricultural sciences. Furthermore, the sample had a good representation of Master's students and Ph.D. students. In addition, graduate students from all regions across Canada took part in the study.

Previous research had indicated that women graduate students in the U.S. were more likely to perceive their overall departmental climates[20] and the congeniality of those environments to women[12] more negatively than their men counterparts. We were, therefore, initially surprised to find few differences between the perceptions of men and women graduate students in this study. However, what this lack of differences appears to indicate is that men and women graduate students agree on the extent to which their department climates are inhospitable to women and to those from disenfranchised groups (e.g., racist, sexist, homophobic). What this does not imply is that men and women will be similarly affected by these climates. That is, men may be conscious of the fact that climates that are inhospitable to women and other under-represented groups exist in science and engineering, but as the predominant group, they may be immune from the negative effects of such climates.

The only overall gender difference that was found was in perceptions regarding the amount of collaboration that existed between men and women. Surprisingly, women

perceived significantly more collaboration between the men and women in their departments than did men. This is likely due, however, to the higher concentration of women in the life sciences and in Master's programs where collaboration was perceived to be higher than in engineering or in Ph.D. programs. Other gender differences were found within disciplines. Within engineering, women reported that their departments were less congenial to women than men did. In addition, women in engineering reported significantly lower person-discipline fit than men. Within life sciences, men reported significantly higher levels of social support than did women.

Differences were also found between degree programs and between disciplines. Ph.D. students reported that their overall department climate was more negative and less congenial to women than Master's students. Furthermore, students in life sciences reported feeling more included than did students in engineering. When taken together, the picture that emerges is that wherever women are under-represented (e.g., in engineering vs. life sciences and in Ph.D. programs vs. Master's programs) the climates are more negative and less congenial to women, they feel less included and more like they don't fit in, and they perceive a lower degree of collaboration between men and women.

The results of this study have a number of implications for science and engineering graduate departments. To begin, the fact that Ph.D. students perceived a more negative environment than did Master's students could negatively impact the decision of women to continue on to the Ph.D. degree once they have completed their Masters. As well, these perceptions may discourage women from seeking faculty positions when they graduate. With the aging baby boomer generation will come vacant faculty positions that will need to be filled. Ph,D. students who feel that their program is a negative environment are much less likely to apply for faculty positions than students who perceive a positive working environment. This suggests that efforts should be made to improve the working environment for Ph.D. students in order to retain them as qualified faculty in the future.

Findings from this study also have implications for the engineering field as a whole. Women engineering students found their environments to be less congenial to women and reported a lower person-discipline fit than their men counterparts. Clearly, such negative perceptions will impact future career choices and the ability of engineering faculties to recruit women.

There are several reasons why this study is important. First, it is the first to provide comprehensive information from men and women graduate students in science and engineering programs across Canada regarding their perceptions of their environments. As such, it provides up-to date data about the situations encountered by women graduate students in science and engineering. Second, it included a comparison group of men. From their data we were able to infer that men generally shared women's perceptions regarding the degree to which the graduate student climate was inhospitable to women and other under-represented groups, but that they sometimes did not experience the same negative effects of these climates (e.g., lack of social support, lower perception of fit with discipline) that women did. Third, the results of this study differed from data that had

previously been collected from graduate students in the U.S. using the same measures[12, 20] indicating that one can not necessarily generalize findings across countries.

The results of this study differed as a function of the gender of the participant, their program and their degree type (with women, Ph.D. students, and those in engineering programs generally reporting more negative experiences). It should be noted, however, that overall the scores on all of the variables were moderate to high, with means of 3.5-4 on a 5 point scale. Thus, one can not conclude that graduate school experience for students in science and engineering in Canada is a negative one. Still, the results of this study lay the foundation for future research and point to specific areas where improvements could be made.

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Create Leadership Synergy - Starting From the Inside Out

Karen Switzer-Howse

Abstract

Research has shown that leadership plays an important part in workplace culture and productivity, however you can not lead others effectively if you can not lead yourself. And to lead yourself, you have to understand what drives your decisions, your actions and your re-actions. This paper is for women in the SETT professions facing the unique challenges of dealing with people unlike themselves, the impact of people's unique individuality and the role of one's unconscious communication habits in reducing leadership effectiveness as well as workplace productivity.

Participants will learn how to obtain data to improve their interactions with others. Examples taken from the Author's work using two scientifically validated assessments (REISS Profile© and PEP™) will illustrate some of the many ways that people are different and how these combinations not only make each of us a unique individual, but can result in challenges when it comes to leading others effectively. This is especially so for women working in non-traditional areas.

Participants will discover how, by using many of the skills that make them successful in the SETT fields, they can uncover the unconscious desires (both their own and others') that too often sabotage well-meaning actions. They will learn how this knowledge can help them act and respond in a manner that will achieve their preferred results. Participants will also learn how knowledge of their own unique driving forces and way of behaving in the world can provide them with increased choices when dealing with others and how this knowledge can increase their ability to influence and impact others, gain new respect for their abilities and make them more effective leaders.

Introduction

One of the biggest challenges facing organizations to-day is leadership. This has been brought to the forefront in recent years by the scandals of Enron, WorldCom and Arthur Anderson, while closer to home Conrad Black and Hollinger have made front page news. Leadership needs have changed from the military style command and control so common in the past [1] [2] however adoption of new, more appropriate styles is slow in coming, The modern workforce no longer accepts the old style. It's members are highly educated and know that they have options - if they don't like the work environment, they can go elsewhere. They expect to be kept in the loop, to be part of the decision making process. They are looking for a chance to make a difference, to be involved. They don't want to be told what to do - they want to be told the expected outcomes and then allowed to decide on the best way to achieve those results themselves. Too often in the past organizations have made use of a very limited portion of peoples' abilities - the rest only came into play outside of work, where people became fully engaged in activities that they

did out of commitment, not coercion. Too many leaders expected people to leave their personal problems at home and put financial performance before everything else, in the process creating a workplace where the best in the industry wouldn't want to work. Today's workers want more, they are looking for leaders that have a meaningful vision for the future and can connect that to the work that needs to be done. They want leaders who care about them as people, who are honest and 'walk the talk', who show their commitment to the company, its' values and its' people by their actions. After all, people don't leave companies, they leave their bosses.

Because of these new demands from the knowledge workforce, success in the future will depend on the ability of the organization to tap into, bring together and use the full potential of all its people - and effective leadership is the key to realizing the full potential of intellectual capital. To lead knowledge workers in the 21st century a leader will have to have the people skills necessary to communicate, motivate, influence, collaborate and delegate among a very diverse, and often dispersed, workforce. A leader will have to have the character traits that call forth the best from others. And the leader must be confident and comfortable in their own skin, so that they can easily identify and bring on board the talent they need to fill the gaps that they can readily admit to having. A participant at the 2004 Canadian Biotechnology Human Resources Report said it well - "the people are the first thing that affect the success of a company - not the technology."[3]. And a 2007 Survey by The Center for Creative Leadership identified *collaboration, change leadership, building effective teams and influencing without authority* as the most needed skills for future leaders - all of which deal with the people side of business[4] and rely heavily on the ability to communicate and connect with others at a deeper level. These are not skills that you naturally think of when you picture the typical male role model of a leader. They are however, consistent with many of the strengths exhibited by women.

So people management, the ability to bring together and develop multi-disciplinary teams of diverse people, motivate them, provide encouragement and support when times get tough, mentor, empower and develop each person to realize and contribute from their full potential and then celebrate each and every success along the way – these will be the key leadership competencies of the future. The ability to bring out and bring together the best in oneself and others is what is required for leadership synergy - the result of which is something far beyond the mere additive results of putting highly talented people in the same room. To do this will require strong communication skills and a level of comfort and understanding of one's own abilities - knowledge of self that too few have taken the time to truly acquire. Leadership for the future will require both head and heart skills to gain the commitment of employees. Drucker has said that understanding one's strengths, being able to articulate personal values and knowing where we belong are essential to addressing the challenge of improving the "abysmally low productivity of knowledge workers"[5]. And strong communication skills are the backbone of effectively influencing and impacting others. They have been identified as key to the success of the virtual leader in the workplace of the 21st century [6]. These skills all come from a strong foundation of self-awareness, knowledge of core values and belief in oneself. Leadership that produces winning synergy in the workplace is truly an inside job, one

that is an ongoing journey of discovery and learning.

The Path to Leadership Synergy

Many people, especially in the SETT sectors, have only a limited understanding of themselves, and even less knowledge of the nature of others. This lack of knowledge about what affects the way we interact with others is a serious impediment to effectively influencing and having impact on people and decisions, abilities that are key to addressing the top challenges identified for future leaders [3] [4]. The challenges presented by the new style of leadership are further intensified by the tendency of SETT specialists to prefer working with data rather than people. Many have told me that they prefer to remain in a technical capacity rather than deal with the stress ands frustrations of having to deal with people. They often use the excuse that they're technical people, they don't have the necessary people skills that it takes.

However the ability to work well with others and be a great leader is not simply an inborn skill. We can improve our ability to achieve results with and through others once we know what behaviours give us the results we desire. And by gaining a clearer understanding of ourselves and why we react and do what we do, we can see other options and make better choices, in the process developing the self-leadership skills that will make us even better leaders.

One of the biggest hurdles to gaining an improved understanding of ourselves is the fact we don't know what we don't know. If we are to get better, to see new options for improved leadership interactions, we needs data to act on. One tool which is widely used to help understand where useful data might be found is the Johari Window, named after the first names of its inventors, Joseph Luft and Harry Ingham [7]. It divides the process of human interaction into four quadrants which represent our personal self-awareness. There is the information that is known to self and others, which is the open, public knowledge quadrant and the information that it known to self, but not others, which is the hidden private knowledge quadrant. Then there is the information that is known to others but is unknown to us, and that represents our hidden, or blind spots. The final quadrant (or pane) is the unknown, information about us that is unknown to both us and others.

To become more knowledgeable about ourselves we need to get additional information that will help us see new perspectives, information that is typically in our 'blind spot'. There are several ways to accomplish this. We can ask somebody to observe us in action and then give us their perspective on what they saw - a technique often used by consultants and executive coaches. We can also ask a number of people who know us for feedback, either on a specific situation, or in general. This type of feedback can be formal or informal. In the work environment it is often undertaken by means of a formal 360E Feedback Survey which includes responses from our peers, direct reports and supervisor. In some cases it also asks that family members fill it out as well. Another way to receive additional information is to use one or several of the available assessment instruments designed for this purpose. Whichever method we use, the information provided will give us additional insights which can help us improve our interactions with

others.

Developing the Self-Leadership Skills for Effective Leadership Synergy

To better understand how additional information and improved self-awareness can lead to leadership synergy, consider the following examples based on the Author's work as a trainer and leadership coach.

Use of Feedback and Feed-forward: Feedback can be an important component for self-improvement. The concept of feedback has been around for a long time, however it is a skill many have trouble with when it comes to delivering it. This is likely because it usually deals with challenges and negative performance and few like to hear about what they did wrong. Marshall Goldsmith has said that successful people tend to reject negative feedback because it is not consistent with their self-image [8]. A recent variation of feedback is the confidential 360° which solicits confidential input from all levels of the organization. The promise of anonymity helps insure that the people participating don't suffer from the 'shoot the messenger' syndrome and provides one of the best ways to discover what actions, or lack thereof, are creating problems in the workplace. Since the reason for the feedback is to improve performance, a better format elicits information on what needs to be done in the future to improve. This variation, called feedforward, was developed by Goldsmith [8] to overcome the negative connotations surrounding feedback, since it concentrates on identifying positive actions for future choices.

During a coaching intervention the Author employed both feedback and feedforward to advantage in helping a business owner improve his relationships with his staff. The owner had recognized that there was a problem with morale and productivity but felt that the problem belonged to the employees. He was looking for ways to motivate them to work harder. It was agreed that prior to each staff meeting the owner would identify what his expectations were for the meeting and his plans to achieve those outcomes. The owner told his staff that he had hired the Author to help him improve work relationships, morale and productivity and that the Author would be observing the staff meetings from the back of the room, as well as speaking to them individually. After the first meeting the staff took little notice of the Author and the Author's presence appeared to have no impact on their actions.

After each meeting the Author held a de-briefing session with the owner, asking questions to help him step back and see what had happened as opposed to what he had wanted to happen, and telling him what she had observed. This process allowed him to see his actions as others did and helped him realize that even off-hand comments said in jest could be taken negatively and lower morale. The new information, combined with the time spent on reviewing and reflecting on what actually happened, as opposed to what he had wanted to happen, helped him see how his actions were affecting his employees. Over time, with input from the Author and his staff, he changed his behaviours and achieved the results he wanted, not by changing others but by changing himself. Because the effect of his actions on his employees were a 'blind spot' for him, known to his staff but not to him, it is unlikely that he would have resolved his employee problems on his

own. With the help of an external, arms-length coach, however, asking pointed questions and providing a safe place to reflect and discuss what was happening, he was able to recognize the impact of his actions on his employees and he chose to change his behaviour.

Use of Assessments: Another way we can gather information to help us improve our ability to work with others is through assessments. There are many assessments on the market which have been scientifically validated and can supply information on a wide variety of personal attitudes, values, traits and characteristics. Examples of some of the more common ones the Author has used in coaching leaders include the Birkman [9], DISC [10], Myers-Briggs [11], Thomas-Kilmann Conflict Mode Instrument [12], Personal Interests, Attitudes and Values Profile (PIAV) [13], the Platinum Rule [14], Reiss Profile of Fundamental Goals and Motivational Sensitivities [15], and Path Elements Profile™ (PEP) [16]. It should be remembered, however, that while assessments can provide useful information they are simply a representation of a moment in time, not who you really are. Any results should always be reviewed by asking "how true is this of me?" and "how true is this of me at this moment in time?".

To show how information from assessments can be used to further your leadership development and contribute to developing leadership synergy two examples will be presented. The Reiss Profile and the Path Elements Profile™ are two of the Authors' favourite assessments because they are easy to understand and to remember, which improves the likelihood that they will produce lasting results.

The Reiss Profile of Fundamental Goals and Motivational Sensitivities was developed by Dr. Steven Reiss from research involving over 6,000 people and an initial list of 300 desires. The results of his studies identified 16 unique, statistically significant desires and was used to create an assessment instrument that provides a comprehensive measure of each these 16 basic human desires for a person. Desires that are statistically significant, either positive or negative, help explain what drives people, what's important to them and how strongly they feel about the issue.

The 16 basic desires that met all of Dr. Reiss's criteria for independent significance are: Power (the desire for influence); Independence (the desire for self-reliance); Curiosity (the desire for knowledge); Acceptance (the desire for approval); Order (the desire to organize); Saving (the desire to collect); Honour (the desire to adhere to traditional codes of morality); Idealism (the desire for social justice); Social Contact (the desire for interaction with other people); Family (the desire to raise one's own children); Status (the desire for prestige); Vengeance (the desire to get even with others); Romance (the desire for sex); Eating (the desire to consume food); Physical Activity (the desire to move one's muscles); and Tranquillity (the desire for emotional calm).

The strength of an individual's desire is an indicator of the core motivation that drives many of the actions that people take, often at the sub-conscious level. These deeply held desires are behind what is commonly referred to as "hot-buttons", incidents that elicit strong emotional reactions, often out of the blue. While people come to recognize their

'hot buttons', few understand what causes their reactions.

Reiss found that our desire profile plays a major role in how we communicate with other people - if their desire profile is similar to ours, communication will be easy. If, however, their unique desire profile is too different from ours it can lead to their "not getting it", and no matter how much more information we provide, it will not solve the problem. If anything, it will only serve to intensify the differences between us. This is an important point, given the significance of communication in the modern workplace. A recent survey carried out by the Author of environmental consulting and engineering firms identified 'communications' as the skill considered most important for staff at every level. It is also fundamental to establishing the deep connections required for leadership synergy and business success.

An example of how this plays out in the workplace can be illustrated by the desire for Order. People with a high desire for Order will keep everything in its place and have a place for everything. These are the people with a clean desk and an orderly filing system. But imagine the frustration of an assistant working for a boss who has a very low desire for Order, which can also be called a high desire for flexibility. No matter how many times she explains her filing system to him and how to find what he needs, he can't understand why she just doesn't leave everything out where he can 'find' it. To him it's a waste of time putting things away that you will likely need tomorrow or the next day! So frustration builds, lines of communication break down, stress mounts and the cost in wasted time, inter-personal friction and lowered productivity mounts. This is an example using just one desire - now imagine the variables at work with 16 basic desires and an almost infinite number of combinations and you can see how discord can arise in the workplace.

To make matters worse, everyone automatically thinks that their way is the best, not just for themselves but for everyone else as well. Reiss called this 'self-hugging'. And taken to its extreme it results in 'everyday tyranny', a term Reiss used to describe the use of pressure tactics to try and get others to change their basic goals, values or life style [15]. Another term for this is 'bullying'.

You should now be able to see how an understanding our own core desires and having the knowledge to help us understand those of our co-workers can de-fuse situations and reduce unnecessary friction between people with different core values. It can also provide us with the knowledge we need to create other ways to respond, ones which are more sensitive to the different motivating factors of our co-workers and ones which are far more likely to help us build synergy and get results with and from others. A national not-for-profit client of the Author was able to significantly improve workplace productivity after the senior management team all took the Reiss. As an example, the CFO was very high on order and there was significant friction between her and several others because of poorly done reports, overly casual estimates of costs and late submission of expense claims. Once they realized that these things were very important to her, they took them more seriously and made an effort to improve how they completed these tasks.

A second assessment which has proven very useful in helping leaders work better with others to increase the synergy in their workplace is the Path Elements Profile™, or PEP. It is a personality assessment and team communication tool developed by Laurie Beth Jones based on years of work with teams and leaders in many different sectors. While it is based on the four quadrant personality types like Myers-Briggs and DISC, it was designed to be simple, memorable, intuitive, fun and applicable in many situations. It uses the four basic elements - Earth, Water, Wind and Fire - to help people recognize their strengths and their challenges when working with others [16]. It uses a simple on-line survey to identify how you interact with the world around you. Because it uses the natural elements people find it easy to remember, and because each element has characteristics that can be seen as both negative and positive, it illustrates how each of us is capable of a wide range of responses. It is up to us to consciously choose the most appropriate in any given situation.

Awareness of our own element and the elemental make-up of our team members can help us build the cohesiveness that can lead to synergy. For instance, if I'm working with a Fire leader, I know that he is oriented towards tasks and activities – that he wants to see results. He also prefers to have the authority and control in his hands - Fires like action. In fact their default mode is the 'driven' leader that matches the stereotype of the type "A" personality and they often earn the reputation of being uncaring with respect to other people. The Author has worked with many Fire personalities during her career in research and as a leadership coach. Knowledge of their elemental make-up, however, can open new avenues for exploration, new perspectives on ways of interacting with others, both for them and for those of us who must work with them. After all, while fire can be described as blazing, catalytic, consuming and intense, it can also be attractive, cozy, glowing and civilized. The question becomes one of which attributes would be most likely to produce the desired result.

For instance, if you're an Earth leader, you are generally motivated towards order and stability, and like Fire, you are oriented towards tasks and results. However while Fire tends to like to move fast, you want to make sure you have all the necessary information, you prefer order and structure - no fly by the seat of the pants projects for you. In fact if you work with Fires, they will complain that you're taking too long and are holding them up. Knowledge of the attributes of Fires will help you manage your interactions with them to bring out both the best in you and them. They like to be in charge and do their best work when they have specific areas to control. They also like to be at or near the center of attention, so make sure they get recognition and on-going praise.

While Executive Director of a not for profit the Author worked with a Fire who was a member of the Advisory Board. Unfortunately he had a bias (all be it unconscious) to using only a portion of his full range of attributes. As a result he tended to rub many people the wrong way and created friction and tension which resulted in unproductive meetings and less than optimal results. If he and those he worked with had had a better understanding of his natural element, more would have been accomplished in less time with less stress, for everybody.

One of the strengths of the PEP assessment is that the use of elemental language removes many of the limitations produced by other assessments that put a single label on people, which they then use as an excuse or justification for their actions. While a complete understanding of what the label represents would be useful, too often people forget the details and only remember the label. Everyone understands the elements of Earth, Water, Wind and Fire and everyone can visualize a wide range of descriptors for each element. This helps someone ask - 'how can I best respond to this situation to get the results I want'. This is particularly useful in preventing a repeat of actions which have proven unhelpful in the past. Since it is easy to remember and makes use of what people already know there's no need to learn a new 'language' or to try and remember what a bunch of letters represent.

It should be noted that not only are the communication, interpersonal and leadership skills which support leadership synergy enhanced by the increased self-awareness provided from assessment results, but the ability to manage stress effectively is also improved. Acquiring the skills to recognize the most appropriate way to interact with others will result in less miscommunication and friction among co-workers and this will in turn reduce the frustration and stress often associated with working with others. Given that 88% of leaders taking part in a recent survey identified work as a primary source of stress and having a leadership role increased the stress factor [17], any knowledge that improves your ability to work better with others delivers the added bonus of providing you with a way to manage your stress levels in the workplace.

While it is an advantage to have everyone in a work-group take the same assessment we've taken, as was done with the not for profit group, it is not necessary for us to improve our ability to work with others. The knowledge we gain from the assessment about ourselves and about the assessment criteria will provide us with benchmark data which, when combined with our skills of observation, our analytical nature and our problem solving capabilities, will help us get a pretty good picture of why people act the way they do. Listen to what they say, the words they use, watch how they spend their time and look for patterns in behaviour. With practice you'll find you'll get pretty good at identifying what's really important to them. Then use this information to improve how you interact with them and watch your results improve. I have personally found the information gained from assessments I've taken to be invaluable in my work with others.

Conclusions

Leadership synergy, the bringing together of people and influencing them to put their best foot forward and become fully engaged in your endeavour to produce extraordinary results, is a daunting task. People are complex and, like an iceberg, what gives rise to their actions and impacts on others lies mostly hidden beneath the surface. The same can be said for each of us - for it is the rare person who truly understands what drives their actions and reactions. To lead others you must first be able to lead yourself. And to lead yourself you must find out as much about yourself as you can.

In the past women have often been passed over for leadership positions because they were considered not to have what it took to lead in the business world. The new skills and abilities that have been identified as essential to effective leadership in the future, however, (e.g. interpersonal communication, the art of collaboration, leading change, building effective teams and influencing without authority [3] [4] [5] [6]) are ones that women have made use of through out the ages. And when you combine strengths in interpersonal skills, a bias to self development, a willingness to support others and a less ruthless nature with the observational and analytical competencies which are standard among the SETT community, it becomes obvious that with the appropriate guidance and support, women can enhance and develop the skills and abilities which will set them apart as truly synergistic leaders. Women have the ability, the skills and the talent to make a major contribution by taking on more leadership roles. While it won't be easy, the very fact that this conference exists illustrates that women are willing to collaborate and work together to make improvements – key competencies for the 21st century leader.

This presentation has provided three means of learning more about yourself. Your job now, if you wish to accept the challenge and become a leader, is to put this new information into action, since leadership is, after all, about action. There are a variety of sites on the web that provide free assessments. One of my favourites is Dr. Martin Seligman's Authentic Happiness site [18]. Or if you are interested in the two I spoke of, you can contact me afterwards to learn more. And of course the easiest way to start might be to find a colleague you work with, or a friend you trust, and simply ask them "How can I do better?", or "How can I be a better team mate at work?" If you are already in a leadership role, you can ask your direct reports "What can I do to be a better leader of this group?" Once you have your answers, design a learning agenda that identifies one or two key behaviours that will produce the outcomes you want, then ask for support and feedback while you put these new behaviours in place.

The SETT communities need more effective leaders, ones who can create the synergistic effects that will produce outstanding results for themselves, their organizations and their communities. Women are well positioned to be key players - now is the time to take your first steps on your journey to creating leadership synergy.

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Leadership and the Science-Based Professional: Why Traditional Leadership Development Programs So Often Fail to Make a Difference in Science-based Organizations

Karen Switzer-Howse

Abstract

The importance of science and technology is generally taken for granted, however in a world where it has been said that the general population is nearly scientifically illiterate the various roles for science based professionals are expanding. Our scientific and technical communities are facing new challenges, whether it's moving beyond the bench into leadership roles, starting up their own company or providing credible information to non-scientists. Yet their scientific training has done little to adequately prepare them for dealing with or achieving results through others.

Science based professionals face many challenges when promoted into a leadership role, not least of which is the dearth of training on the "soft skills". Women in science, engineering, technology and trades (SETT) face additional challenges because these fields are often seen as a "man's world" and they are made to feel that they lack the ability to make the tough decisions and are 'too soft' to excel in leadership positions.

In the past science professionals went on courses to learn how to become better communicators and leaders. But traditional leadership development programs, heavily weighted to 'learning how to lead', have too often failed to produce the level of communication and leadership behaviour needed for success.

This paper will identify the issues and present research findings on why traditional leadership training and development so often fails in helping people make a successful transition and how women can draw on their innate abilities to address the four main hurdles facing the engineering, science, trades and technology communities for leadership development: 1) Their Natural Tendencies; 2) Their Training; 3) Academia and Workplace Culture, and 4) The Brain's Natural Hard-wiring - and develop their unique leadership skills.

The presenter will draw on her 25 years plus experience in private, public and not for profit science based research organizations to provide examples and data to illustrate why the very nature of a science and/or technical based education works against a successful transition for people in the SETT fields and how women can use their innate strengths to advance their leadership skills and play a larger role.

Background: The Need for Leaders

The Conference Board of Canada has stated that in an increasingly knowledge-based, globally competitive economy, a skilled workforce is a key determinant on driving

organizational success [1]. The need for leaders capable of leading these skilled workers in the knowledge based economy has also been identified by many Canadian sectors in recent years. For example in Canada "Leadership Development" was identified as a top learning priority for government workers by the federal departments and agencies who responded to a 2003-2004 survey assessing progress on the government's Continuous Learning Policy [2] at about the same time that The Canadian Manufacturers and Exporters reported in their "Manufacturing 20/20" study "that the growing complexity of tasks and the pace of change ... will mean that the core competencies of Canada's manufacturing workforce in 2020 will be substantially different from to-day. ... Future skills requirements will include: a mix of creative problem solving capabilities, ... business skills and an ability to interact with colleagues and customers."[3]. In the sciences, the Biotechnology Human Resources Council (now BioTalent Canada) identified "Strengthening Leadership and Management" as a key area for the biotechnology sector, and "softer" communication skills were identified as key skills required as companies evolved towards the commercialization stage[4]. The study also noted that in many cases scientists either did not want to become leaders/managers or did not have the required management/leadership skill sets. And the need has not lessoned. In 2006 the Canadian government reiterated the importance of leadership development by stating that "leadership development was key to ensuring that the public service was equipped to meet the challenges of the 21st century" [5], and a recent report from the Canadian Health Services Foundation identified leadership as an issue and indicated that "healthcare is not as effective as other organizations in developing the leaders of tomorrow."[6].

The need for leaders in the science, engineering, technology and trades sectors has, if anything, increased. The importance of science and technology to our way of life is generally taken for granted, however in a world where it has been said that the general population is nearly scientifically illiterate, the various roles that science based professionals are called on to fulfill are increasingly significant. The problems associated with a low level of science literacy and numeracy in to-day's knowledge-based economy led the Federal government to launch a $5 Million program to develop practical solutions to fostering these vital skills in our young people.[7] Our scientific and technical communities are facing new challenges in our complex global society, whether it involves moving beyond the bench into leadership roles within an organization, starting up their own company to take their technology to the market, or providing credible information to non-scientists for government policy making decisions [8], to name just a few examples. Yet their scientific and technical training has done little to adequately prepare them for dealing with others and achieving results with and through people, especially those not like them. John E. West, Director of the Major Shared Resources Center, U.S. Army Research and Development Centre, says that the majority of education {for technology professionals} is mostly technical and "most science, engineering and technical majors finish with only perfunctory general education classes in writing and speaking. .... Virtually no time is spent learning about...managing teams, leadership or seeing the broader business and social context of your contributions" [9].

In the Canadian report of the Expert Panel on Skills it stated that Canada has a "persistent shortage of....technically competent people who can work in teams, communicate effectively and apply technical knowledge to real world business problems."[10]. The report went on to say that "although post-secondary institutions tend to equip Canada's young people with the technical skills they require, employers find that graduates often lack the communications, teamwork and project management skills ... that they need." And these are the very skills needed to excel as leaders in to-day's diverse workforce. While changes are underway in many post-secondary institutes to address these issues, many of the people currently in the workforce are a product of the limitations described above.

The Challenge

So with all this awareness in the importance of leadership and interest in leadership development, one has to wonder why the problem hasn't been addressed adequately. We still appear to have a shortage of leaders in every sector, and the science, engineering, technology and trades (SETT) sectors are no exception. To better understand our current situation we have to look at what solutions have been tried. The method most often used in the past was to send the SETT professionals on professional development courses to learn how to become better communicators and leaders. But traditional leadership development programs, heavily weighted to '*learning* how to lead', have too often failed to produce the level of communication and leadership behaviour needed for success in to-day's society.

A review of the impact of training initiatives on results by Gilpin-Jackson and Bushe [11] reported that numerous studies turned up a low rate of transfer of training to results and Stolovitch has concluded that "organizations waste enormous sums of money on training when it's not appropriate, sufficient or effective"[12]. Personal experience with research scientists supports these findings in relation to non-technical training. However a large part this may be because the hurdles that scientists and technical specialists must overcome to become better communicators and leaders have been under-estimated, and therefore under-addressed.

Personal experience, backed up by a review of the literature, supports the fact that leadership success is not linked solely to IQ and technical competence, it is a very personal experience. Some of the most brilliant scientists I knew were very poor leaders. You can't excel as a leader if you are not first and foremost knowledgeable and comfortable with who you are. What lies at the heart of the matter is the fact that if you are not happy with the results you're getting, you must change your own behaviour to see the results that you want. This is one of the most difficult things for people to do. It means that you have to look closely at who you are as a person, why you do what you do and the implications for working with others. This is especially difficult for people in the science, engineering, technology and trades fields since the majority of their training has been analytical, fact based and emotion-free, all counter-productive to the concept of self-reflection and personal examination as a means of improving leadership and communication skills.

The Hurdles Faced by the SETT Communities

Based the author's experience in working with science professionals, there are four key areas that need to be considered and addressed to improve communication and leadership skills within the science-based communities. These areas are:

1) Their Natural Tendencies;
2) Their Academic Training;
3) Academia and Workplace Culture, and
4) The Brain's Natural Hard-wiring

Area 1: Their Natural Tendencies

People who enter the science and technology fields tend to:

* be highly task oriented and analytical in nature;
* have a strong belief in the superiority of logic;
* avoid emotionalism, as it clouds thinking
* be objective and rely on hard data,
* think they need more data when in doubt, or maybe they don't have the right data
* get caught in "analysis paralysis"
* be deeply committed to their work
* have an inclination towards perfectionism
* give a high priority to remaining current in their speciality
* become so focussed on their work that they loose contact with the people around them
* become frustrated by what they see as the illogical actions of others, and
* often see people as obstacles

Many of the careers in SETT support these natural leanings because they promote individual excellence and can lead to a 'lone wolf' approach to work, which is seen as an advantage by some. One scientist the Author coached, on moving into an Executive Director's position, remarked that she loved the job - if only she just didn't have to deal with people! Some of her frustration was a result of having to deal with emotions in the workplace, yet Goleman states that the fundamental task of leadership is an emotional one [13]. This tendency to avoid emotions and be independent is a draw back in the modern workplace where collaboration and team work are key to success. Many of the above identified tendencies also work against women who want to take on leadership roles. They find themselves facing deep-rooted stereotypes such as women are "too emotional" to manage, they aren't truly committed to their work, they're not as good as men and they're not natural leaders like men [14].

Traditional leadership development programs, rooted in providing facts and information in a typical classroom setting where scientists 'learn' new skills, are easy for them - they

'get' the information. However moving it into action isn't necessarily high on their agenda, especially when so much of their time is dedicated to staying current in their field and managing the day to day details of getting work done with increasingly limited resources. Santos and Stuart found that managers cited this lack of time as a major reason for not using new skills - it was easier to fall back on old patterns and habits [15]. Given the high pressure jobs often associated with SETT occupations, it is easy to see how reverting to well known patterns and habits would be the most attractive option. Even when the programs provide practice of new skills, either through experiential components such as simulations and/or ropes courses, there is limited proof of transfer of new leadership skills to the workplace [16].

The lack of action around new information is unfortunately not a rare occurrence and Pfeffer and Sutton have referred to it as the "knowing-doing gap" [17], a not uncommon situation in knowledge based industries that limits performance even when the knowledge is present. Goldsmith, an executive coach, has also identified one huge false assumption associated with the majority of leadership development programs -that if people understand, they will do. He's found that that isn't true - most people do understand, but they still don't do. Going to a program does not change people into better leaders - doing what they learned creates better leaders [18]. As Goleman points out, there is a crucial difference between knowing a concept (declarative knowledge) and being able to put that same concept and details into action (procedural knowledge) [19]. It doesn't just happen - without a strategy and the support to move knowledge into action back in the workplace, it is unlikely that behaviour will change and therefore few beneficial results will occur.

Area 2: Their Academic Training

Not only does the traditional scientific training not adequately prepare science and technical based professionals for dealing with others, it often results in widening the chasm between them and the rest of the population.

Academic training in science and technology subjects has a tendency to:

* promote the superiority of the logical approach
* discount feelings and emotions, since science deals with 'facts'
* place high reliance on case studies and theory based learning, the essence of education being talk and writing, not action
* gauge success by mastery of the facts, not taking action
* promote the superiority of whatever disciplines one is in
* create the impression of the superiority of science based disciplines over non-science ones
* promote the development of 'independent' thinkers
* create an atmosphere of competition, not co-operation

Speaking with science and technical graduates provides ample evidence of the above mentioned points. And length of time in the workforce doesn't seem to lesson the gap

between the science based professional and others. One example is the Author's experience in delivering workshops on commercialization to scientists. Key to the success of government/industry collaborations was the ability to work well with and through others, including those working outside the government and not directly under the lead scientist's control. The Author found that if a collaborative agreement failed, the most common reason related to a "people" issue such as interpersonal friction or poor communication. And discussions after the fact showed that rarely had the lead scientist picked up on the emotional undercurrents that led to the friction. Another example is an ongoing lack of recognition among founders in the biotechnology sector that leaders in the industry require broader and additional "softer skills" [4] and that they may not be the best person for the CEO's job.

The Author was reminded of this again when speaking with a scientist at a conference. We were discussing the role and value of 'soft skills' in leading and managing teams of scientists and he told me that even when they are working on a collaborative project, they are not really collaborating - they are always looking for the advantage, that 'something' that will give them an edge over their colleagues. He knew that such actions worked against achieving great team results, however said this was all part of the need to be seen as an independent thinker and what he needed to do to receive recognition for his work. This was important to him since it affected his status and resources. Given the growing importance placed on collaboration in the work environment [20], this attitude can lead to serious problems for teams and multi-disciplinary projects.

Pfeffer and Sutton [17] have identified the "tendency to treat talking about something as equivalent to actually doing something about it" as one of the main barriers to turning knowledge into action. And academic training does place a lot of importance on speaking knowledgeably on your subject area. As well, writing papers is a requirement and reinforces the idea that once you speak or write on something, you're done. However being able to speak or write eloquently on leadership and what makes a good leader does not, in itself, result in an improvement in leadership. The Author once worked with a business owner who couldn't understand why he wasn't achieving the level of response he wanted from his employees to his concept of participatory management. He felt his employees were the problem, since he'd taken all the Leadership courses available at both the University of Ottawa and Queen's, plus a few others, and had stood near the top of the class every time. However on observing him during meetings and speaking with his staff, it was soon apparent that while he could talk and write about what a good leader was, his attitude, behaviour and actions remained unchanged - and he couldn't see that he hadn't changed as far as his employees were concerned.

A literature survey supports the Author's experience. Once a science trained professional moves into a leadership role, or has to deal with people not like him or her, the majority of his/her training and work experience conspires against the very actions that are now needed to succeed in achieving results with and through others. And the ability to 'know' about what makes for good leadership is of little help and can't replace the years of conditioning that support his/her own natural tendencies.

Area 3: Academia and Workplace Culture

When people enter the sciences, whether in an educational or workplace setting, they discover a culture that:

* supports traditional pay, promotion and recognition systems based on individual excellence
* is still based on a rigid hierarchical chain of command
* sees science as serious business - with little time for idle chit-chat or relationship building
* places high value on technological fixes, discounting non-analytical approaches to problem solving
* does not consider that there is a place for emotions in the workplace
* is still somewhat reluctant to accept women as equals
* places a high value on mental activity, reaching conclusions and making presentations (of a very technical nature, of course)
* too often sees peer reviews as an opportunity to raise ones own profile rather than provide constructive feedback
* looks for individual excellence, where working on a 'team' is avoided as a potentially career limiting move.

The atmosphere created in many science and technology based organizations is definitely not conducive to the development of a people centric leadership approach. The belief that competition is good, both internally and externally, to promote innovation, efficiency and higher levels of organizational performance is widely accepted, in spite of research that shows such practices not only harm the 'losers', but everyone with a stake in the organization and undermine the overall ability of the companies to turn knowledge into power [16]. Other barriers to new styles of leadership include long-standing institutional, structural and cultural practices. Hesselbein has identified 12 such barriers to leadership in general [21]. It takes courage to 'name the moose on the table' and it takes even more courage, especially if you're a woman, to confront such institutional barriers.

Not mentioned above are the additional barriers that women in the SETT professions face. These include: the negative impact of an exclusionary male-oriented corporate culture which still does not accept women readily, especially in leadership roles, nor supports women's advancement in general; myths about women's talent, ambitions and commitments; the pressure to conform to "masculine" styles; the feelings of isolation from lack of role models and networks; stereotypes and preconceptions about women; the reluctance of managers to take risks with women in line positions; the lack of career planning and planned job assignments; and exclusion of women from the informal channels of communication. These have all been identified by Catalyst [14] [22] [23] [24] [25] and others [26] as barriers to advancement, including the assumption of leadership roles. These barriers to advancement not only make it more difficult for women to take part in leadership development programs but increase the difficulty of their implementing any changes when they get back in the workplace. A recent Catalyst study[27] found many

reasons to support improved conditions for women in the high tech sector however it has been the Author's experience that any suggestion of implementing new procedures which originate with a woman and could be construed as 'touchy-feely' by male counterparts are still all too often not taken seriously.

The impact of the workplace culture on transfer of training can not be over-emphasized. An example of this was experienced by the Author when she took part in a highly acclaimed leadership development program while working in a government research organization. Participants were drawn from a wide variety of locations and senior management participation was both limited and perfunctory. On returning to work after the course, the Author found little support to implement new ideas. Those who had not taken the course had neither the time nor the interest to hear about a new way of working. There were even suggestions that the proposed new methods of leading were 'too touchy-feely' to really work in the male dominated research environment. Eventually attempts to 'do things differently' were abandoned in favour of 'this is how we do it here' accepted methods. This and similar personal experiences illustrated how difficult it was to make changes when you were the only one supporting them.

A search of the literature provided evidence that these experiences were not an aberration. Stolovitch [16] confirms what the author had observed - that utilization of new skills can be hindered by lack of support back on the job, lack of post-training performance monitoring, lack of resources and time and lack of incentives to apply new skills and knowledge. He further states that without the appropriate pre- and post-training interventions and support mechanisms, workplace training, like the Spanish or French you were taught in high school, soon dissipate into the morass of other unmemorable events. Gilpin-Jackson and Bushe [11] also found this to be the case with leadership development programs, with peer-pressure to conform to pre-existing norms a major impediment to the transfer of new skills. Their work indicated that having a critical mass of participants in the program was important, while the most important factor in transferring the leadership training was the number of other managers who received the training and evidence that the managers themselves made use of the new skills.

The workplace environment and culture is also generally not conducive to helping science and technology professionals understand the role feelings and emotions play in the workplace, not just in achieving better business results and attracting and retaining top talent, but also in things such as higher morale, motivation and commitment. Goleman states that people take their emotions to work and that emotions are more powerful than intellect, in spite of the fact that many organizational cultures place a high value on intelligence devoid of emotion [13]. Additional research reported by Goleman [28] has also shown that emotions are contagious and not only act as the glue that holds people together in a team but also gains their commitment to an organization. Therefore any culture that tries to eliminate emotions in the workplace will severely limit the performance potential of their employees. Goleman further states that the best leaders are set apart from the rest by their ability to understand the powerful role played by emotions. Since most leadership development programs do not address the role of emotions, many

science based professionals will continue to be at a disadvantage when it comes time to step into a leadership role.

Area 4: The Brain's Natural 'Hard-Wiring'

Research has shown that our brain functions pretty much the same way it did a thousand years ago, with much of what we do the result of unconscious decisions our brain is hard-wired to make to reduce the pressure that comes from constant change and adaptation. Cooper [29] explains that this inherent reaction to such pressure is a deeply embedded survival mechanism "designed" to have us "do whatever is necessary to avoid stress, minimize pain, eliminate surprises, fend off uncertainty, and resist change.".

This ancient survival response shows up as:

* a strong resistance to change - anything that will move one out of their comfort zone is seen as a threat by our brain
* a continuing reliance on years of training in analytical skills as the basis of a science professional's automatic response
* discounting of new information that does not support previous learning
* a search for evidence to support the existing way of doing things and current beliefs
* a tendency is to operate on automatic pilot, relying on what worked in the past.

Given our hard-wired bias against change, how 'good' a particular leadership development program is will make little difference, since the majority of them are based on learning facts and concepts - not in how to make changes and take action. And as another frustrated technical expert I coached lamented to me - "I've taken all the leadership courses available but it hasn't made any difference - people still won't do what I want!" In fact, while he had excelled in the courses, he had not changed his behaviour. As a result he continued to get what he'd always gotten - low morale, little participation, unproductive meetings and increasing friction. Compared to training for the technical part of jobs, learning the emotional competencies that make for a great leader is a much harder task. Goleman's work shows that "emotional learning demands a more profound change at the neurological level; both weakening the existing habit and replacing it with better one [19].

Discussion

Many scientists and technical experts want to become better communicators and leaders. Unfortunately most programs lack the support needed to translate the new skills into appropriate behaviours in the workplace, the support that is crucial if they are to move their knowledge into action. Ford and Weissbein have said that not more than 10% of U.S. training expenditures actually resulted in transfer of new skills to the job [30]. So it is little wonder that leadership is still an issue in spite of the fact that leadership development is big business, worth over $12 billion in the US alone[31]. In fact the most systematic study ever done on the return on investment from leadership training found

that one well-respected week-long seminar for the top level executives of a pharmaceutical company not only produced no improvement but actually resulted in a slight negative effect. The executives were rated, on average, less effective in a range of emotional competences than before the seminar [19].

Given the hurdles which must be overcome for training of any kind to have an impact it should come as no surprise that leadership skills, especially those involving emotional intelligence/soft skills, are in short supply in the SETT communities. Research in Latin America, Germany and Japan revealed that failed managers almost always scored high in IQ and subject matter expertise, while in every case their fatal weakness was in emotional intelligence – exhibited by arrogance, over-reliance on cognitive abilities and disdain for collaboration and team work [19]. A fundamental component of emotional intelligence is awareness. And while by nature excellent observers, science and technical professionals do not observe their own actions and reflect on the impact they have on others. Yet this one action can significantly increase their emotional intelligence and effectiveness as leaders. This is where traditional leadership development programs so often fail. They are designed around the traditional concept of delivering information and facts, but because intellectual learning differs from behavioural change in fundamental ways, as outlined in Goleman's work [19], the models of education for each differ significantly. What is needed are programs that support the learning of new skills in small doses combined with real life experience and practice over an extended period of time. Additionally, efforts must be made to remove institutional and cultural barriers and provide ongoing support, feedback and encouragement. In cases where managers don't feel that they have adequate time to fulfill these roles, an arms length mentor or executive coach can provide the necessary support. People need to know that their efforts are recognized and valued by their organization. For those interested, a complete listing of guidelines for developing emotional intelligence training has been developed by Goleman [19].

Experience has shown that with adequate support, science-based professionals can step back and observe and reflect on what is actually happening, versus what they want to happen, and quickly identify what behaviours need to be changed and what they need to do to get the results they want. While not every science professional will want to move beyond the bench the exponential growth of information limits what any one person can achieve on their own - to be successful, they must develop the ability to work interdependently with others. Additionally, to be more effective in taking their expertise to a wider audience requires an improvement in communication and leadership capability. Without ongoing support, whether from their organization, their manager or an external coach, much of the money spent on programs to develop these areas will continue to fall short of achieving the hoped for results.

While the Author's experience has been primarily with the male segment of the SETT communities, the findings should be of special interest to this audience since the very nature of the competencies identified as important for leaders in the 21st century provide women with an excellent opportunity to build on their strengths and their successes. Emotional intelligence, not technical expertise or book learning, is what will make or

break future leaders. And, while women are not "smarter" than men when it comes to emotional intelligence, it has been shown that, on average, women are more aware of their emotions, show more empathy, and are more adept interpersonally. Each of us has a personal profile of strengths and weaknesses with respect to emotional intelligence [19], it is up to us to discover our strengths and how we can use them to bring out the best in ourselves and others, making our weaknesses irrelevant. Women tend to be more interested in self-development than most men and have an advantage because they are more adept at networking and speaking about feelings. These skills can provide the foundation from which to build the support so important to developing the competencies necessary for successful leadership in the 21st century.

There is an opportunity here to help women in the SETT community take their performance to new heights by providing them with programs that not only help them learn new leadership and communication skills, but also provides them with the support necessary to put the new knowledge into action, building the new habits they need to bring people together and create the combined synergy that produces results that go beyond the merely additive. A good source of ideas and case studies of commendable corporate initiatives can be found in the Catalyst report "Cracking the Glass Ceiling: Strategies for Success" [23]. A pro-active approach to providing more effective leadership development programs that address the barriers identified in this presentation can ensure that the women and men with the science and technology expertise needed in the 21st century are not sub-optimized because of their natural leanings, their training, their workplace culture and their hard-wired brain reactions.

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Life Transitions and Career Path: An Alternative Perspective Regarding the Recruitment, Development and Retention of Women

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Introduction

Organizations continuously strive to maximize efforts in terms of the recruitment, development and retention of organizational members. This is especially true in organizations that are looking to: increase workforce diversity; resolve impending labour shortages; and maximize their return on investment in human resources in an environment of increasing competition for talent. Finding innovative ways to address these challenges is an ongoing concern for organizations.

Much has been written on work-life balance as well as organization programs and policies that serve to support aspects of our private lives that impact work. However, little has been written about life transitions and how they affect career development and career path. Career development refers to the progression through work. Traditionally, this involves the development of skills and an increase in the level and scope of responsibility. Career path refers to the route or track, for example, job changes and/or interruptions. Life transitions are defined as periods that are part of adult development. Life transitions are age related and women and men have similar transition patterns, however, women and men experience different transitions. For the majority of organizational members, career development and life transitions occur in tandem. Both influence the other and each has its own rewards, challenges and barriers. However, life transitions experienced by women are significantly more complicated than those experienced by men especially in terms of career development and path.

For close to three decades, women have established themselves as permanent contributors to organizations yet continue to be under-represented in strategic positions. In light of impending labour shortages resulting from the retirement of older workers and fewer younger workers to replace them, organizations need to maximize existing human resources. However, traditional career trajectories and cultural age norms serve as barriers for women striving to advance within organizations. This is particularly relevant for organizations that invest in programs targeting women. The responsible organization is one that recognizes the complexities of women's life course that influence career choice and path, and seeks to find ways for women to realize their career goals and potential.

In this paper I examine the intersections of career development, career path and life transitions that influence recruitment, development and retention of women. I identify the "on-ramps", "off-ramps" and "push-and-pull" factors that relate to career development and life transitions. Finally, I discuss potential programs that serve to create an organizational culture that recognizes the intersection of life transitions, career and the

utilization of skilled resources. This is particularly important for organizations that are male dominated and tend to over-look and/or under-utilize the talent of their female members. I investigate these organizational issues within the framework of career and adult development theories. I suggest that career theory is gendered and thereby has traditionally neglected factors that influence a woman's career development. Incorporating adult development theory, which too has historically gendered roots, reveals neglected factors that provide a broader perspective of women's careers that are relevant to recruitment, development and retention. A note to the reader; although my article looks at women and career, it is by no means generalizable to the experiences of all women, however, I believe that this discussion will lead to further inclusive and diverse perspectives. By better understanding career development in relation to life transitions, we are better able to create support systems that assist organizational members in reaching their full potential. In addition, as members of organizations being more aware of our own life transitions, we are better able to request and facilitate the creation of those support systems.

I begin with an overview of career theory and two current career models, and describe how women's careers have been neglected. Next I review adult development theory, focusing on life course transitions that impact career. Then I discuss factors the influence and impact career decisions and advancement. Finally, I discuss the responsibilities of the organization in terms of the career development and advancement of midlife women. Within these frameworks, I present women as an untapped resource of skilled talent and the potential contribution they have to make to organizations.

Career Theory

Development of Career Theory

According to Hall and Lerner[18], career can be defined in many ways, for example, "advancement within a framework over a period of time, the practice of a given profession, a sequence of related positions over an extended period of time, or a life-long sequence of role-related experiences", (429). Super and Hall[37] define career as "the externally judged sequence of positions during the course of pre-occupational, occupation, and post-occupational life" (334). Arthur, Hall and Lawrence[1] define career as "the evolving sequence of a person's work experiences over time" (8) incorporating the "ways in which we see and experience other people, organizations, and society" (Ibid.). In general, the term 'career' suggests a sequence of work experiences and time. Career theory has evolved into a trans-disciplinary field involving psychology and sociology[2]. Collins and Young[7] suggest that career theory is a hybrid without organizing principles that reside at the intersection of economics, sociology and psychology. Super (cited in Herr[20]) states that rather than a single theory, career theory is a "segmental theory, a loosely unified set of theories dealing with specific aspects of career development taken from development, differential, social, and phenomenological psychology and held together by the self-concept or personal construct theory" (241). What is evident is that the notion of career and career theory is a dynamic construct reflecting historical and societal contexts.

The underpinnings of career theory began with Super's 'life-span, life-space' approach, which initially augmented the trait-and-factor theory – a matching paradigm fitting individual skills and organizational needs – that dominated vocational guidance textbooks in the early 1940's[34] and considered a the cornerstone of career theory[3]. Super proposed that "individuals progress through five stages of career development across life-span"[14: 320]. Very briefly, these stages include: 1) growth, when an individual is initiated into the world of work, 2) exploration, where the individual gathers information about themselves and the work world, 3) establishment, when an individual is concerned with advancement, 4) maintenance, during which time an individual is focused on maintaining their self concept and job status, and finally, 5) disengagement, when an individual develops a self-image and –concept independent of and separate from work[14]. This approach attempts to acknowledge that people "live in multiple-role environments in which work roles, family roles, educational and community roles vary in their demands on and significance for different persons and within different developmental periods" [20: 239]. Super addressed "how career behavior comprises different sets of development tasks stimulated by contextual demand with which persons are observed to cope in different life stages" (239) by creating the Life-Career Rainbow, later the Archway, that graphically illustrated life span, roles and the interaction between the individual and society.

Over the years, Super's 'life-span, life-space' approach continued to be revised. In 1997, Herr[20] suggested areas where Super's approach required refinement; some of which are relevant to this discussion. First, more attention was required on gender issues as women continued to be absent from career development theory. Second, more attention regarding obstacles, barriers and messages that affect the career behaviour of women was needed. Third, more focus on older adult workers was required, as the original research focused on adolescence and young adults. These refinements reflect the historical context in which Super's career theory emerged, the 1940s and 50s; a period characterized by traditional gender social roles and family structures. By 1984, when the Life-Career Rainbow appeared, the influence of the equal rights and women's movements were changing organizational demographics. In 1990, the Archway appeared. The Baby Boomers, those born between 1946 and 1965[35], were between 25 and 44 years old and entrenched in organizations.

One early critique of career theory, by Collins and Young[7], described the concern that the 'objective' career was emphasized thereby overshadowing the 'subjective' career. "The objective career is generally used to refer to the observed progress of the individual through organization or occupation, while the subjective career generally refers to a more individual perspective"[7: 841]. They suggested that because the subjective experience was neglected, the "perceptions, feelings, and values of the individual, and the relationship between job and the rest of life, are ignored" (Ibid). Collins & Young[7] considered the subjective experience, as well as the interplay between subjective and objective experience, important components to career. The protean career and boundaryless career models attempt to bridge this gap.

The Protean Career

The protean career model describes a career orientation in which the person, not the organization, is in charge; where the core values of freedom and growth are driving career decisions, and where the main success criteria is subjective (psychological success) rather than objective (position and/or salary)[17,33]. Key attitudes include work satisfaction and professional commitment as opposed to organizational commitment emphasized in traditional careers . Two career 'metacompetencies' – adaptability and self-awareness – help individuals to be more protean[17] and "equip people to learn from their experience and develop any new competencies on their own" (6). The Career Orientation Index measures protean orientation according to two main factors or attitudes: value-driven and self-directed[4]. Briscoe and Hall[4] describe four primary categories of career through a protean lens: dependent, reactive, rigid, and protean.

> "A person who is neither values driven nor self-directed in terms of career management would be considered 'dependent', as they are really unable to define priorities or behaviorally manage their career on their own. A person who is not values driven but who is self-directed in career management would not ultimately have the perspective to guide his or her own career sufficiently, Such a person would be 'reactive'. And people who are values driven but not self-directed, not able to adapt to the performance and learning requirements of their career – cannot be said to be able to fully shape their own career. We would define such as career orientation as 'rigid'. Those with 'protean' career orientation on the other hand are both values driven in defining their career priorities and identity, as well as self-directed in adapting to the performance and learning demands of the career. Such people are thus more able to lead themselves and others. Are more capable of continuous learning and thus 'transformational'[4].

Those individuals who did not exhibit these attitudes were "more likely to 'borrow' external standards, as opposed to internally developed ones, and be more likely to seek external direction and assistance in behavioral career management as opposed to being more proactive and independent"[6:31]. The protean career model claims to address the influence of environmental factors and sees this approach to career as a means of transversing unpredictable and changing extraneous factors. Hall and Briscoe[17] also found that protean career orientation was unrelated to gender but correlated with mobility – movement within and/or between organizations and positions.

The Boundaryless Career

The boundaryless career can be considered along the varying levels and interdependent dimensions of physical (objective) and/or psychological (subjective) career mobility or changes [4,36]. The term 'boundaryless' refers to the "independence from, rather than dependence on traditional organizational career arrangements"[36:20]. Unlike the protean

career that tends to indicate whether one is 'protean' or not, the boundaryless career is not an either or proposition but rather the degree of mobility exhibited by the career actor along both the physical and psychological continua" (Ibid: 23). Sullivan and Arthur[36] describe four types of boundaryless careers. The first type has low levels of physical and psychological mobility. This is a career requiring specialized knowledge applicable to one employer. In this case the physical boundaries (employer) and psychological boundaries remain the same. The second type has high levels of physical mobility but low levels of psychological mobility. This is a career that crosses physical boundaries (employers) but psychological boundaries remain the same (same job). The third type has low levels of physical mobility and high levels of psychological mobility. This career is identified by an individual with high expectations regarding their own employability without changing employers. The fourth type has high levels of physical and psychological mobility. This career crosses physical boundaries (multiple employers) as well as psychological boundaries (multiple jobs).

According to Sullivan and Arthur[36] varying levels of physical and psychological mobility can be attributed to career competencies reflecting 'ways of knowing'. These ways of knowing "involve an individual's motivation and identity (knowing why), skills and expertise (knowing how) and relationships and reputation (knowing whom)" (Ibid: 25). Like physical and psychological mobility, these ways of knowing are interdependent and those with greater levels in all ways of knowing report greater levels of perceived career success as well as internal and external marketability.

Unlike Hall[17], Biscoe et al[5] and Sullivan and Arthur[36] acknowledge a gender difference in how women and men enact careers as a result of social and psychological factors. They also found differences in relation to work/family balance, mentoring opportunities, work policies, work outcomes in terms of promotion, stress and career satisfaction. In general, women have less freedom to engage in physical mobility, while men have less freedom to engage in psychological mobility.

Combining Protean and Boundaryless Career Models

Briscoe et al[5] took an empirical approach to measure the correlations between the protean and boundaryless career models. Using a questionnaire, they assessed self-directed career management, values-driven career attitude and a boundaryless career mindset, which they describe as an ability to navigate "the changing work landscape by enacting a career characterized by different levels of physical and psychological movement"[36:31] as well as mobility preferences. Conducting three studies involving a sample of undergraduates, part-time MBA and EMBA students, and executives, the results indicated that the protean and boundaryless career models were distinct yet related constructs. This produced sixteen combinations or profiles. They suggested that these career profiles can then be used for personal and career counseling by identifying developmental areas of challenge and opportunity. However, results were not consistent across the studies suggesting that perhaps the diversity within the various samples influenced outcomes. As well, the first study did not track gender or age. Briscoe et al[5] note "the fact that the constructs under study seem to vary across career stage and context seems to imply the possibility that

these are indeed attitudes and not underlying personality traits or related individual differences" (44). They go on to suggest further investigation examining how attitudes are influenced by social identity, organizational culture, education, and aging.

Although Briscoe and Hall[4], Briscoe et al[5] and Sullivan and Arthur[36] acknowledge the need for further research, both the protean and boundaryless career models, as well as Super's career development theory, while attempting to capture the complexities of career, neglect the significant influences of gender, life course and age on career. The need for more research incorporating these and other socio-economic factors is not new[2,3,9,12]. The following section, focuses on life course and the impact of various life transitions on career. This discussion is meant to augment and expand the notion of career and career theory and to be more inclusive of the complexities of our lives from age and gender perspectives.

Adult Development Theory

Life Course

Many researchers agree that to understand the processes and dynamics of career requires the integration of adult development concepts[9,12,13,22,28,29,39]. However, adult development is a relatively new area of research having been over-shadowed by child development and the idea that once a person reaches adulthood, development is fairly complete[29]. For example, five of the eight stages involved in the process of ego development proposed by Erikson, and based on his training with Freud, occur in childhood[10,11,29,39]. Adulthood is now recognized as a dynamic and complex period of interplay between an array of factors[23,29]. Wortley and Amatea[39] state that "how an individual meets the world and any period of life cannot be anticipated without attention to the social, cultural and historical factors that defines his or her life alternatives" (477). They suggest that adult development involves the interaction between four arenas: career, family, intimacy, and inner life. Each encompasses a sphere of interest or activity related to a specific set of needs as well as a means of organizing life changes. Levinson[29] states that adult development is a multidisciplinary field spanning the domains of personality, social structure, culture and biological functioning. Over-laying adult development is the notion of life-course, "the evolution of an individual life from beginning to end"[29:3] and "to study the life course it is necessary to look at an individual life in its complexity at a given time and to delineate its evolution over time" (4). Thus, adult development is both context driven and age-related.

Age and Transitions

Neugarten[22] states that, "social scientists are interested in two broad themes or aspects of aging. The first is how any society functions as an age structure and how changing age distributions over time affect economic, political and other aspects of social organization. The second is how attitudes and roles change over the life cycle of the individual or in cohorts of individuals" (13). In 2008, these themes are particularly relevant to

organizations in terms of human resource management as the leading edge of the Baby Boom generation approaches retirement age resulting in a potential labour shortage.

Although each individual life is unique, there appears to be age-related patterns to the human life cycle. Erikson[10] and Levinson[29] determined that the life cycle is composed of phases, periods or eras of change, each with it's own particular "bio-psycho-social character, and each makes its distinctive contribution to the whole"[29:17]. Moving from one era to another involves a transition or structure-changing period, the primary tasks of which are to "appraise the existing structure, to explore the possibilities for change in self and work, and to move toward commitment to the crucial choices that form the basis for a new life structure in the ensuing period" (25). According to Levinson[29], these transition periods generally last about five years and overlap with the previous and upcoming era. As per Levinson's theory of adult development[28,29], the first era is childhood extending from birth to roughly 22 years of age. The second era is early adulthood from 17 to 45 years of age. Transition from childhood to early adulthood occurs between the ages of 17 and 22. Levinson[29] describes this;

> "adult era of greatest energy and abundance, and of greatest contradiction and stress. Biologically, the twenties and thirties are the peak years of the life cycle. In social and psychological terms, early adulthood is the season of forming and pursing youthful aspirations, establishing a niche in society, raising a family, and, as the era ends, becoming a 'senior member' of the adult world. This can be a time of rich satisfaction in term of love, sexuality, family life, occupation advancement, creativity, and realization of major life goals. But there can be crushing stresses, too: we undertake the burdens of parenthood and, at the same time, of forming an occupation; we incur heavy financial obligations when our earning power is still relatively low; we have to make crucially important choices regarding spouse, family, work, and lifestyle before we have the maturity of life experience to choose wisely. Early adulthood is the era in which we are most buffeted by our own passions and ambitions from within, and by the demands of family, community, and society from without" (19-20).

The third era is middle adulthood from 40 to 65 years of age. Transition from early to middle adulthood occurs between the ages of 40 and 45. According to Levinson[29], during the era of middle adulthood:

> "our biological capacities are below those of early adulthood but normally still sufficient for energetic, personally satisfying, and socially valuable life. Unless our lives are hampered in some special way, most of us during our forties and fifties become 'senior members' in our own particular worlds, however grand or modest they may be. We are responsible not only for our own work and perhaps the work of others, but also for the development of the current generation of young adults who will soon enter the senior generation. It is possible in this era to become more maturely creative, more responsible for self and others, more universal in outlook

> and less tied to narrow tribal values, more dispassionately purposeful, more capable of intimacy and sensual loving than ever before. Unfortunately, middle adulthood is for many persons a time of progressive decline – of growing emptiness and loss of vitality" (20).

Levinson[29] defines the underlying pattern or framework of a person's life as the life structure composed of relationships with others, the interplay of those relationships and the evolution of those relationships over time. Interwoven with these relationships are external aspects – events, social contexts, roles, influences – and internal aspects – subjective meanings, motives, conflicts, and personal qualities[29]. Within the life structure framework are periods of entry, culmination and transition. The culmination of early adulthood occurs between the ages of 33 and 40. The primary developmental task of this period is to "form a structure within which we can try to establish a more secure place for ourselves in society and to accomplish our youthful dreams and goals"[29:26]. Mid-life transition occurs between the ages of 40 and 45 when one comes to terms with the end of youth, per se. Entry into middle adulthood occurs between the ages of 45 and 50 when we establish a place in a new generation. Transition to age 50, occurring between 50 and 55, is a time to reappraise entry into middle adulthood and engage in internal as well as external exploration. The culmination of middle adulthood, ages 55 to 60, is a time to realize the aspirations and goals of the midlife era.

Developmental tasks during an era include building and maintaining life structure, while transitional tasks include termination, individuation and initiation. Termination and initiation involve reflecting on the previous era and making choices/decisions about the ensuing era as a whole. Individuation involves progressive internal change. Levinson[29] sees the process of individuation, or separation-individuation, as continuing well into adulthood, rather than simply an aspect of childhood development as per Freud and Erikson. With greater individuation, "we have a clearer sense of who we are and what we want", "we draw more fully on our inner resources (desires, values, talents, archetypal potentials)", "we are more autonomous, self-generating, and self-responsible" as well as "more integrated and less rent by inner contradictions"[29:32].

Adult development theories, like career theories, have been largely created according to middle-class, white male norms[12,13,22,39]. Although women and men experience similar age-related patterns of life structure development and transition, how life structures are formed differ due to multiple factors that interact with gender. According to Gallos[12], for example, differences are "further expanded when cultural expectations, marital practices, childbirth and rearing, organizational policies, and institutional practices are added to the picture" (127). In general, women face a different set of opportunities and a more compounded set of problems than those seen by men that makes the process of evaluating life choices more difficult and more complex.

Women and Career

To begin, it is important to recognize that 'women' is not a homogenous group, however, I believe similarities exist between women regardless of ethnicity, cultural context or

socio-economic status, and for the purpose of this particular discussion, I seek tolerance in describing women and career in less heterogeneous terms. In general, "phases of development for women do not have the linear and predictable quality that male life patterns suggest, nor is the process of evaluating life choices as straightforward or singularly focused on work and career"[12:118]. It appears that today, in Canada and the U.S., women's experience in society is more diverse than at any previous time in history, yet women continue to struggle with family, career and traditional social expectations. Levinson[29] suggests that this is in part due to the entrenchment of the traditional marriage enterprise, the goal of which includes children, family life and the continuance of traditions defined by the family of origin. This enterprise also has a well-defined division of labour, specifically, "the woman/wife/mother serves primarily as homemaker, caring for the young and centering her life predominately in the nuclear (and, when possible, extended) family" while "the man/husband/father, in contrast, serves as provisioner, devoting himself mainly to outside work and bringing back the resources needed to sustain the family"[29:40]. Levinson[29] suggests that "when women enter the public work world (something they have done in all societies), this principle [traditional marriage enterprise] strongly shapes and limits their engagement in it" (41). Career development as viewed through life course brings into focus the challenges women face.

To learn more about the nature of women's adult development, Levinson[29] studied the life stories of women who identified themselves as homemakers or career women. Using a biographical approach, Levinson[29] sought to further the area of adult development particularly in terms of gender differences. The homemakers varied in their experience with work outside the home including no work experience, part-time unskilled and semi-skilled work. They also varied in their approach to work outside the home. For some, it was a financial necessity and not a source of satisfaction or meaning in their life, while for others, work outside the home became increasing more important. The career women in the study represented the first wave of women whose central component to their life was not family. Interestingly, half these women were unmarried and more than half were child-free. Levinson[29] noted that within both groups was an internal image of the 'traditional homemaker figure' as "reflected in the culture, the family, the occupational and other social institutions, and the psyches of individual women and men" (49). However, among the career women was an internal image of the 'anti-traditional figure' with an 'anti-traditional dream'. This 'dream', described as a vague sense of self in the world, of imagined possibilities, which originated in childhood and developed through adulthood, was of "an independent, competent woman who was taken seriously by herself and others, who was not mindless or selfless, and who would have reasonable balance of work and love/marriage/family in her life[29:265].

During the entry life structure phase of early adulthood, Levinson[29] found that work was the central component for most career women, however, the traditional tasks and key choices related to love, marriage and family were still prevalent as well as the associated problems and stresses of balancing these with career. During the age 30 transition period, these career women went through major changes in work, workplace, income and career path. Levinson[29] identified this time as a turning-point in life course for women. In some cases, it was the arrival of the first child that initiated the age 30 transition. Gallos[12] noted

that for these women there was the "exhaustion of balancing multiple roles" resulting "in cutting back on either professional work or parenting, leading to a sense of unsettledness and personal inadequacy" (121). For those women who were child-free, there was the pressure of social clocks, both biological and career[39].

At the midlife transition period, around age 40, Levinson[29] found that, again, the career women were faced with major life choices many having struggled with the traditional homemaker figure, the anti-traditional figure and the anti-traditional dream. Part of this struggle was coming to terms with the notion of the 'successful career woman'. Levinson[29] describes this notion as a cultural myth complete with a character hero engaged in a heroic struggle, journey or quest. The idea that if a woman worked hard and exhibited superior performance, in the end, she could 'have it all' – career, marriage and family[29] – and by the age of forty; that timeline (career clock) based on a linear career path and male career norms[31]. Like their male colleagues, self-esteem, and to some extent identity, was tied to career success (or failure). Along this path, the career women who had children, had carried the primary responsibility of the household and children while their husbands 'helped'. These women felt a mixture of "acquiescence, resentment and inner conflict"[29:370] but felt that as their children got older and their careers advanced, their lives would become more stable and satisfying. This hope and the reality of the mythical successful career woman came more into question as these women transitioned into midlife. However, it should be emphasized that the career women who were child-free were not exempt from these transitions. Gilbert[15] points out the diversity of women's lives at midlife.

> "Some women in their 40s and 50s are peaking in their careers, others have returned to school after rearing children, and others are struggling as single parents in competitive workplace for which they may not be prepared educationally. Still others are having a first child or are caught in the 'sandwich' of caring for children at home and aging parents (110).

In addition to this variety are the ways in which women approach and adjust to this life phases. Therefore, it is necessary to integrate multiple perspectives and sociocultural factors when investigating women to capture the processes that influence how women construct their reality[30]. For example, to do justice to the nature and complexity of identity structuring among women, Hornstein[22] suggested the need for a dynamic model or framework that incorporated multiple role commitments. This allows us to look at "changes in the pattern of organization of an individual's life structure across diverse life stages, and variability across individuals with respect to the type of pattern each employs"[22:553]. Horstein[22]
used this approach to study the place or degree of involvement in employment within the life structure of midlife women.

The study involved 96 college educated midlife (46-51 years of age) women. Each woman was categorized based on her involvement in employment from her time of graduation to mid-forties into one of three groups: I) *continuous low involvement*, defined as not engaged in paid employment after marriage or after having had children, worked

sporadically at part-time jobs or worked continuously on a part-time/volunteer basis, II) *shift from low to high involvement*, defined as having spent several years child-rearing, working in low-level or volunteer jobs and then shifting toward greater involvement in employment during their late 30's or early 40's, and III) *continuous high involvement*, defined as a continuous, stable, full-time paid work with a strong career orientation throughout early and middle adulthood. In terms of marital status, the groups did not differ significantly, although the women in Group II had fewer children than the other groups. The women were asked to graph the level of involvement, based on a five point low-to-high scale, on five different roles (worker, mother, wife, volunteer and self-expression – activities pursued on an individual basis such as artwork) at five different age points (22, 27, 32, and 42). Involvement was defined as "a psychological commitment to a particular set of activities which taken together constitute a social role"[22:557]. According to Horstein[22:557], "by asking subjects to indicate their level of involvement in each role at a number of different age points, variations in the pattern of role commitments could be determined". Group I showed a pattern of high involvement in both the mother and wife role, although between the ages of 27 and 42, there was a statistically significant decrease in involvement in the mother role and a statistically significant increase in involvement in the volunteer and self-expression roles. There was a steady pattern of low to moderate involvement in the worker role. Group II showed a high but decreasing involvement in the roles of mother and wife, an increase and then a striking decrease in involvement in the volunteer role paralleled by an inverse pattern of low and then high involvement in the worker role, and a steadily increasing involvement in the self-expression role. Between the ages of 27 and 42, there was a statistically significant decrease in involvement in the mother role. Group III showed a consistently high involvement in the mother, wife and worker roles, and a slowly increasing involvement in the self-expression role. Between the ages of 27 and 42, there was a statistically significantly increase in involvement in the worker role as well as the self-expression role. Groups I and II were statistically more likely than Group III to graph the mother role and wife role, except at age 22 and 42 when there was no statistically significant difference across the groups.

The women were also asked to report on their feelings during their early 30s (early adulthood transitional period) and early forties (entry into middle adulthood transition period). In their early 30s, Group I scored statistically significantly higher on "feeling needed by people" and higher on "worried about the children" compared with Group III. Group III scored higher on "rebelling against constriction" and "feeling powerful" compared with Groups I and II, and statistically significantly higher on "having a wide perspective" compare with Group I. This perhaps reflects the anti-traditional figure and anti-traditional dream identified in the career women in Levinson's study. Group II scored lowest on "feeling confident" "feeling powerful" and "a sense of being my own person" yet highest on "searching for who I am". This appears to indicate a sense of uncertainty or lack of focus. Interestingly, although Group III appears to have had a clear sense of who they are and a broad perspective on their lives, they also scored significantly high on "looking old" compared to the other groups. Reflecting on their early 40s, there was no statistically significant difference in how the women felt,

although Group III continued to score highest on "rebelling against constriction" and Group II scored highest on "feeling worried about the children".

This study points to some interesting findings that address relevant issues of women and career. First, in terms of reflecting on feelings during their early 30s and 40s, Group III (continuous high involvement) did not report any major changes. They continued to have a broad perspective, feeling powerful, confident, having a sense of being their own person, and rebelling against constriction, although they did report feeling more needed by people, which could reflect the 'sandwich' effect. Second, it appears that for these women, the centrality of employment in their life structure was consistently apparent across a variety of measures with a degree of integration in multiple arenas. Group I (continuous low involvement) also appears to have established a stable focus around which they incorporated other arenas, as well as developing a positive, confident, self-image. Group II (shift from low to high involvement), however, indicated major changes in sense of self as well as life structure. What this indicates is that no one model of stability versus change in identity can take adequate account of the variability among women.

These studies generate some interesting ideas regarding women involved in organizational careers. At this time in history, women take for granted the centrality of work in their lives yet continue to struggle with the aspirations, and expectations, of a 'successful' career and the responsibilities of family. In addition to these life course challenges, age norms come into play with regards to woman and career.

Women and Age

According to Lawrence[26] "age norms are the ages viewed as standard or typical for a given role or status by the modal group of members of a social system" (211). Age norms involve judgements of age-typical behaviour and as this definition suggests, age norms occur by modal agreement rather than consensus thereby allowing for a range of agreement within a group. As a form of social norm, age norms include expectations and sanctions (implicit and/or explicit) and influence behaviour. Lawrence[26] points out that age norms are embedded within interdependent social systems each with its own normative systems, for example, people's age expectations and notions of appropriate ages emerge, in part, from inherent characteristics of biological development. Age norms vary because while development provides physical boundaries, it does not precisely determine behaviour at given chronological ages, eventhough, age norms are highly correlate with biological age. Finally, age norms are particularly relevant in terms of career and women as biological age norms intersect with career and organizational age norms.

Lawrence[24,25,26,27] found that career age norms exist within organizations and adherence or deviance from these age norms result in certain consequences or sanctions. For example, employees who are younger than an age norm for a particular position, are considered 'ahead of schedule' and tend to receive higher performance ratings while employees who are older than an age norm for a particular position, are considered

'behind schedule' and tend to receive lower performance ratings. In addition, organizational demographics of age distribution also influence age norms. For example, if younger employees occupy lower rungs of the ladder and older employees occupy higher rungs, this distribution can become an organizational age norm[27]. In addition, age norms create behavioural expectations. For example, young employees are expected to be "idea producers, hotshots, and enthusiastic as well as inexperienced, immature, and arrogant" while middle-aged employees are expected to be "more mature and experienced as well as stuck in their careers and resentful"[27:988]. Thus, age norms can lead to stereotypic and discriminatory behaviour.

Age norms can be particularly discriminatory for women for three reasons. First, career age norms emphasize a steady, and preferably quick, rise through the corporate hierarchy. This expectation can be especially limiting for women whose careers have been interrupted or delayed because of child-bearing and rearing or perhaps derailed as a result of the 'maternal wall'[8] or the expectation of pregnancy. Second, adult development age norms serve to create expectations regarding women's behaviour in terms of life structure that often compete and collide with career development age norms. While midlife men, for example, may have experienced continuous, uninterrupted career development, midlife women may be ready to refocus efforts on career development after a period of family building. Thus, the notion of 'ahead of schedule' and 'behind schedule' is problematic for women as well as the stigma of career interruption[38]. Finally, social attitudes towards age are gendered. Women, in general, are judged more harshly than men not only from a physical perspective but also from a biological perspective in terms of reproduction and the attitudes toward maternity and menopause. In essence, women experience the interaction and interdependence of age norms, gender norms, life structure norms, and career norms, all that serve to challenge women's careers, to a greater extent than men. So then, how does the stress of these factors manifest within organizations?

Why Women Leave

Current research indicates that 37 percent of highly qualified women from business, banking/financial sectors, and academia, experience some kind of interruption during their career[21,42]. Fifty-eight percent of highly qualified women utilize flexible work options. The 'pull' factors involved in the decision to leave for a period of time overwhelmingly include responsibilities for children and elders. Thirty-eight percent of women aged 28 to 40 and 50 percent of women aged 41 to 55, cited the need/want to spend more time with children. Thirty-one percent of women aged 41 to 55 cited the need/want to spend more time with parents or family members. Behind these decisions are gendered social stereotypes that continue to place women in care-giving roles. Interestingly, in the more male dominated industries, women cited more 'push' factors contributing to their decisions[21,42]. Fifty-two percent of women in the banking/financial sector did not find their careers satisfying and twenty-six percent felt that their careers had stalled[12,42]. Associated with this was a perceived lack of opportunity and recognition.

Other studies[39,40,41] take a different perspective that contribute to potential 'pull' factors but that also lead to decisions to leave. For example, Valcour[39] examined work control

and work complexity as factors contributing to work-family balance. Valcour found that increasing work control as well as work complexity increased work-family balance satisfaction yet for two different reasons. Increasing work control allowed employees, particularly women, to manage their time more effectively thus contributing to overall psychological and physical well-being. Increasing work complexity, on the other hand, contributed to learning problem solving skills and task management skills, again, serving resource management and overall psychological and physical well-being.

Hammer, Bauer and Grandley[40] examined the signs of cross-over stress between work-and-family and family-and-work. They identified work interruptions, lateness and absence as potential signs of cross-over stress. The sample for this study included both women and men since families are relational units. What they found was: 1) interruptions at work predicted work-family conflict for both wives and husbands, 2) lateness to work was predicted by work-family conflict for wives but not husbands, 3) husbands absence from work was predicted by their own family-work conflict. The study also showed that the wives' level of family-work conflict decreased as the husbands' level of 'help' increased. Hammer et al[40] suggest that signs of stress – interruptions, lateness and absence – may in fact be coping behaviours rather than an indicator of work withdrawal. And that these coping behaviours could potential help to improve work attitudes by helping to decrease stress caused by work-family and family-work conflict. Lack of organizational support can exacerbate conflict, stress and coping behaviours.

Cohen[41] examined non-work domains – family, community and recreation – and values and their influence on work attitudes and behaviours. Cohen[41] emphasized the importance to recognize individual differences between central life values as work related or non-work related and the influence these differences have on the perception of organization policies and practices. The study illustrated that non-work domains can be a potential coping mechanism or outlet for work stress as well as a potential source of additional stress and conflict. Overall, Cohen[41] found an interaction between non-work values, organizational support of non-work domains and withdrawal cognitions. Essentially, for those employees who placed a high importance on non-work domains and values, perceived organizational support for non-work domains and values decreased cognition withdrawal from work. Interestingly, the same was found with employees whose central life values were more work related as well.

Organizational support appears to be the common factor among the studies described. What implications does raise for organizations, and in particular, the recruitment, development and retention of women?

Organizational Implications

I began this discussion by reviewing career development theory and describing two current career models – boundaryless and protean – that place the individual rather than the organization at the centre of career development. I suggest that given the gendered nature of career theory and the complexities of women's lives, organizations need to take

more responsibility regarding the development of women's careers. This is for four reasons. First, organizations built on male paradigms create barriers and challenges to women's advancements. This is manifested in the absence of women in senior leadership positions within organizations. Therefore, organizations need to be responsible to ensure that cultures, internal social structures (networks and mentoring for example) and career norms are inclusive to gender – and other diversities for that matter. Second, organizations have tended to overlook the multi-dimensionality of women's lives aside from offering maternity leave – some organizations also offer flexible work schedules and limited job sharing. Organizations need to address the female life structure to support women throughout their career taking into account the significance of female adult development. This includes speaking to woman about their career and life aspirations and expectations, and, most importantly, tracking outcomes and career trajectories. Therefore, organizations need to be responsible for determining how they can serve women to realize their career goals. A critical part of this is nurturing women's ambition[21,42]. Third, performance evaluations, ratings and annual goal setting should go beyond objective metrics. Organizations need to take a proactive approach acting as liason between employees and opportunities within the organization as well as creating appraisal systems that account for the life structures of women. This is especially important for women returning to their career after a period focused on family building, trying to balance family and career responsibilities or exploring new career options. Fifth, organizations need to remove the stigma of career interruptions as well as flexible work arrangements. This will benefit both women and men. Finally, women in general represent a potentially untapped resource of talented and skilled employees[21]. Organizations need to take responsibility to maximize the potential of all employees; women represent under-utilized talent as well as potential mentors and coaches for younger employees.

Conclusions

Organizations are responsible to maximize the talents and skills of human resources. Women have established themselves in the labour force yet continue to be under-represented in strategic positions. Traditional career development based on gendered career theory and models as well as the complexities of women's life course and discriminatory age norms serve as barriers for women striving to advance within organizations. Women take for granted the centrality of work in their life yet women represent organizational members who are often under-utilized and/or overlooked as a resource of skilled talent. To illustrate the complexities of female adult development, women's life course and the impact on career, I reviewed two studies based on the stories of women.

I concluded that organizations need to be accountable for four tasks with regards to recognizing the potential of women: 1) ensure that cultures, internal social structures and career norms are inclusive to gender, 2) determine what the organization can do for women to realize their career aspirations and expectations, 3) take a proactive approach acting as liason between women and organizational opportunities, and 4) tap into women as a group who tend to be overlooked and under-utilized. In light of impending labour

shortages and competition for talent, organizations cannot afford to overlook this potential resource.

Because of the multiple and multi-faceted roles women juggle, they have a more complex and non-linear career path that influences their choices and definition of success. Women represent typically half of all organizational members. They are educated and ambitious. Losing experienced and skilled personnel is expensive. Organizations have the capacity and knowledge to make the necessary changes to create an environment that supports the potential of women and all its members.

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All Work and Some Play Made 600+ Successful Janes!

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Abstract

Women in Science and Engineering Newfoundland and Labrador (WISE NL) developed the Student Summer Employment Program (SSEP) 18 years ago, aiming to improve the participation of young women in science, engineering, technology and mathematic careers by increasing their awareness of careers in these fields, and by showing them that these careers can be exciting and rewarding. SSEP has provided over 600 paid summer jobs and has mentored these female Grade 11 (Level 2) high school students hailing from all regions of Newfoundland and Labrador. A recent SSEP program review, funded by NSERC/PromoScience, has shown that the program has been very successful (97% of SSEP participants go on to post-secondary education versus 76% of the general female population; 49% pursue careers in science, engineering and related careers compared to 24% of the general population; high rural 70% and aboriginal/special group 11% participation). The report identified primary strengths, weaknesses, opportunities and threats (SWOT) of SSEP and made recommendations to address these issues.

This presentation will highlight the educational, work skills, mentoring, social and personal growth benefits that SSEP has provided. "The SSEP is a fantastic program! The program is why I chose to do engineering, a career which I love. The only downside to this program is that not enough girls have the opportunity to do it!" This quote from one SSEP past-participant sums up both the program's success and limitations. Most of the SSEP graduates have gone on to successful industry careers, therefore, WISE NL has begun to actively seek alternate government and industry sponsors (e.g. oil and gas, mining) to help support and expand the program. Bridging with other educational and community programs (e.g. WISE UP Girl Guides, new SSEP Labrador Project) and creating a support network at the university level for graduates of SSEP will also be discussed as potential strategies to mentor these young females through different life stages and to further enhance the program.

1.0 Introduction

1.1 Need for Evaluation

This evaluation was conducted to assess if and how the WISE Student Summer Employment Program (SSEP) has been successful, to verify the current need for the program and to make recommendations for future offerings of SSEP. This evaluation aimed to also answer key questions often asked by supporting agencies and to validate future plans/needs to financially secure SSEP. Women in Science and Engineering Newfoundland and Labrador (WISE NL) has been the administrator of SSEP for the past 17 years, a program which was inspired by a similar program in Alberta. It has had many funders and supporters along the way, including: Memorial University of Newfoundland;

Human Resources Development Canada/Service Canada; the Natural Science and Research Council of Canada; and the NSERC/Petro-Canada Chair of Women in Science and Engineering, Atlantic Region.

1.2 WISE NL and SSEP Background

Women in Science and Engineering Newfoundland and Labrador (WISE NL) is a non-profit, volunteer organization which was founded in 1988. It aims to improve the participation of women in science, technology, engineering and mathematics careers by increasing awareness of these professions as rewarding and exciting options for women. WISE NL also provides mentoring, professional development and networking opportunities to facilitate the success of women in these fields, and advocates for equitable workplaces. WISE NL is a member of the Canadian Coalition of Women in Engineering, Science, Trades and Technology (CCWESTT), with representation in various other professional organizations (e.g. IEEE, PEGNL). WISE NL activities have included primarily the SSEP program, along with conference organization [(1)], award winning educational videos [(2,3)], a poster series, news articles, publications [(4)] and presentations. Another internationally successful publication [(5)] built on outcomes of the CCWESTT and WISE NL conference, and the CWSEA mandate.

The Student Summer Employment Program was begun in 1990 and has placed more than 600 young women in job placements, working with more than 200 supervisors. The program provides paid 8-week summer jobs in the areas of science, engineering, technology and research at Memorial University of Newfoundland (MUN) and other partnering organizations, targeting female Grade 11 (Level 2) high school students from throughout Newfoundland and Labrador. At the beginning of each year, supervisors and job placements are recruited from various sectors of MUN (e.g. Faculty of Science, Faculty of Engineering and Applied Science, Medicine, Ocean Sciences Centre, NRC Institute for Ocean Technology, and the Fisheries and Marine Institute in St. John's; Sir Wilfred Grenfell College and Forestry Canada in Corner Brook). WISE NL also applies for funding to support the SSEP program and the job placements through HRSDC/Service Canada and other sources (e.g. PEGNL, MUN Faculties, Medicine, Fortis Education Foundation, Technip Canada Ltd.). Information application packages are then sent to all NL schools, to encourage Grade 11 females to apply for these job placements, particularly young women from rural and aboriginal populations. Student applications are reviewed on the basis of academic achievement, a written essay and recommendations from two teachers.

The objectives of SSEP are: 1. To provide young women with experience in scientific fields, 2. To encourage young women to consider careers in those fields, and 3. To show young women careers in scientific fields can be exciting and rewarding. Based on the WISEST program at the University of Alberta, SSEP was founded by Dr. Faye Murrin and Carolyn Emerson, initially both in the MUN Faculty of Science (Biology Dept.), and was administered by them for the first 14 years. In recognition of their efforts in developing and directing WISE SSEP, they received the 1994 Michael Smith Award for Science Promotion in Canada.

From its inception SSEP has had a close relationship with Memorial University, through the provision of administration, financial and in-kind support for the program and its coordination. For example, the university has provided human resources and payroll services for the program, and the Department of Biology (1990-2002) and the CWSEA (2003-present) have arranged for or provided office space for the Program Coordinator/Administrator. SSEP has continued to operate within the university, as the vast majority of student placements are within this research environment and most of the supervisors hold positions at the university.

The active WISE NL chapter, with its successful SSEP program, was an important factor contributing to the success of the application from MUN to host the inaugural NSERC/Petro-Canada Chair for Women in Science and Engineering, Atlantic Region (CWSEA), held by Dr. F. Mary Williams (1997-2001) and continued under the tenure of the current chairholder, Dr. Cecilia Moloney (2002-present). As the current term of the chair ends in 2009, WISE NL needs to formalize its relationship with the CWSEA and to solidify its relationship with Memorial University, as did the WISEST program under the University of Alberta.

WISE NL has continued to administer the SSEP Program through its Directors and part-time summer coordinators: Dr. Faye Murrin and Carolyn Emerson (1990-2003); the CWSEA Assistant to the Chair, Caroline Koenig (2004-present); and the recent full-time Program Administrator, Mercia Conway (2006-present). In addition to MUN and CWSEA support, WISE NL has received primary funding for SSEP through programs offered by the federal department of Human Resources and Skills Development Canada (HRSDC, also known as Service Canada). This program has provided wages for the student participants and, until 2006, for the SSEP Student Coordinator's salary. SSEP also applied for and received two grants (2002-2004 and 2005-2007) from the Natural Sciences and Engineering Research Council (NSERC) through its PromoScience program. This funding primarily provided operational budgets for SSEP, but in 2006-2007 a portion of this funding also provided salary for a Program Administrator and for this SSEP program review. In recognition of the continued success of SSEP, WISE NL has recently received new funding from the Provincial Government of Newfoundland and Labrador to support its full-time administration position. It has also received a renewal of its PromoScience funding, with one of its new mandates being to enhance its Labrador and aboriginal component.

As the 20th year of SSEP approaches, the WISE NL Executive Board realized that it was time to examine the strengths, weaknesses, opportunities and threats (SWOT) of the program to verify the need for the program, and to make recommendations for SSEP and its future legacy. The following sections describe the major findings of this evaluation report completed by Hollett and Sons Inc. [(6)] and WISE NL.

2.0 Methods

Funding to support the evaluation of the SSEP program was granted by NSERC PromoScience, with additional funds and personnel provided by WISE NL. The Terms of Reference for this study were developed by the Evaluation Committee of WISE NL, which included past and present executive members. A Request for Proposals was sent to independent consultancy companies, with Hollett and Sons Inc. (referred to as HSI in rest of paper) being selected and contracted to complete the WISE SSEP evaluation.

The evaluation, conducted between February and August 2007, included qualitative and quantitative data gathered through primary and secondary research. This included: SSEP summary reports, SSEP applicant and supervisor files, reports from previous evaluations and conferences [4, 7,8], interviews (i.e. other organizations, groups and individuals), surveys (i.e. SSEP past participants and SSEP supervisors from the years 1990 to 2006), relevant literature and a SWOT analysis. The web-based survey/questionnaire was developed by the HSI, in collaboration with WISE NL. The SSEP Program Administrator searched the SSEP archives to locate past participants and supervisors, and initiated contact to seek permission for HSI to approach them independently to complete the on-line survey and/or interview. Surveys were completed by 96 past participants (81% response rate) and 36 supervisors (49% response rate). The data from the surveys were analysed by HSI, and will be held in confidence by HSI and WISE NL. In some instances data analysis separated the 2002-2006 group from the whole survey population, since these past participants were generally still completing post-secondary education. Three interviews and one focus group were conducted with SSEP staff, members of the WISE NL executive board and past members. Also, communications and interviews with other organizations offering similar female-focused programs to SSEP provided information about their experiences, challenges and strengths.

3.0 Results

3.1 SSEP Past Participants

Demographics: Of the respondents, 74% were from rural Newfoundland and Labrador, with 7% self-identifying as aboriginal, 1% representing immigrants, 2% being members of visible minorities and 1% being persons with disabilities.

How They Learned About the Program: Most respondents (70%) learned about SSEP from either a teacher (41%) or Guidance Councillor (29%), with some getting information from promotional materials, such as posters or ads in newspapers (6.5%) or a friend (5.4%). When asked if there were other ways, suggestions included in-person presentations or internet sites popular with their age and gender, such as YouTube, MySpace, or Face Book.

Motivation to Apply to the Program: The primary motivator (67.7%) to apply was to pursue further education in science or engineering after high school, with “curious about career options” being a close second reason. Also, respondents indicated the desire to experience Memorial University and there is a perception that SSEP is a positive item to have on their resume.

Satisfaction Ratings with SSEP: All respondents (100%) would recommend SSEP to others, and 84% would be interested in supporting or mentoring future SSEP participants. One past participant captured the satisfaction in the quote, "I think it's (SSEP) a wonderful way to interest young women in considering a career in science and engineering and to build their confidence. Imagine a summer job where you actually contribute to a real scientific research project and learn things you didn't even know were done in the world of science - and get paid for it!" [(6)] Also, SSEP is presently experiencing the phenomenon of having early SSEP participants now being university and industry professionals, who are actively supporting SSEP student job placements and related WISE NL activities.

Accommodations and Residence: Since over 70% of SSEP participants are from rural NL, the study asked questions related to accommodations and residence. During the past few years, SSEP has discontinued the residence component due to the cost of administering the program and related liability issues, but the study was to assess its relative importance and to consider options to reinstate the program. Approximately 34% of rural SSEP participants stayed in MUN residence, with 70% of those saying that it improved their overall experience of the program and 29% would not have attended SSEP if residence had not been an option. To quote one past participant, "Staying in residence allowed me to communicate with other students in the program. We did everything together. For a student from small town Newfoundland, having the chance to interact with other females with similar interests allowed me to see others who have similar aspirations." [(6)]

Education since SSEP: When asked about their education accomplishments since participating in SSEP, 89% had gone on to complete some type of post-secondary education, and if the 2002-2006 group, who are generally still enrolled in post-secondary studies, are excluded, then 97% of past participants have gone on to successfully complete education such as: bachelor's degrees (53.8%), masters degrees (8.6%), college (7.5%), other diplomas/certificate programs (5.4%), post-graduate studies (5.4%), other programs (4.3%), apprenticeship programs (3.2%), doctorate degrees (1.1%). This very high success rate of SSEP participants compares favourably to a follow-up survey of 2001 high school graduates in NL conducted by the Department of Education, which found that in the year following graduation only 76% of young women in the general population had gone on to post-secondary education [(9).] Most SSEP participants indicated that they had pursued studies in areas of: Medicine/Health Care (28%), General Science (21%), Arts (13%), other (12%), Engineering (11%), Business (9%), Mathematics and Computer Science (7%).

Nine respondents identified themselves as being aboriginal, from visible minorities or being persons with disabilities. Their education attainment was no different than the other graduates from the SSEP program.

Employment since SSEP: When asked about their employment since SSEP and post-secondary education graduation, most currently work in science, engineering and related

careers, such as: Medicine/Health Care (49%), Engineering (20%), Science (11%), Information Technology (6%), other technology fields (6%), Skilled Trades (6%), Mathematics (3%). Most indicated that they plan to continue to seek employment in these areas. If the 2001-2006 group (i.e. presently still attending post-secondary studies) are compared to earlier SSEP participants, then there was a 7-10% increase in response for plans to pursue careers in medicine, science and engineering.

Of those who did not pursue a career in science, engineering or technology, 65.9% indicated that they had developed other interests or that SSEP had made them realize early that these were not options of interest for them. But 95.5% still felt that SSEP was a worthwhile and positive experience.

Impacts of SSEP on Past Participants: Most past participants indicated that SSEP had either some (48%) or significant (36%) impact on their decisions concerning post-secondary education and career goals, with only about 13% indicating that it had no influence. When asked what they gained from SSEP, the most frequent responses were: Sense of responsibility and independence (84%); Introduction to university life (82%); Increased self-confidence (82%); Friendship and networks (77%).

The results for respondents self-identified as being aboriginal, of visible minorities or persons with disabilities showed even stronger ratings of these critical self-esteem factors. These included: Sense of responsibility and independence (100%); Introduction to university life (100%); Friendship and networks (100%); Increased self-confidence (90%).

Need for SSEP and Recommendations: Almost all respondents (98%) thought that there was a need to continue to provide opportunities for young women to explore careers in science and engineering, and 99% felt that SSEP was an effective way of doing this. Recommendations included: more employment placements in other areas of the province (58%); more personal choice of final employment placements; other workplace tours and information sessions.

Seventy percent (70%) of past participants thought that the experience of women in science and engineering is different now than it was ten years ago, with 0% thinking it was the same and 30% not being sure. Of those who indicated that the experience was different, 89% thought that there was a greater acceptance of women and 87% thought that there are a greater number of women with careers in science and engineering. All aboriginal, visible minority and persons with disabilities (100%) believed that there was now a greater acceptance of women. Only 46.9% thought that there were fewer barriers for women.

3.2 SSEP Supervisors

How Supervisors Learned about SSEP: Most found out about SSEP through a colleague (23%), a WISE NL member (20%), a dean or administrator (17%), and promotional materials (13%).

Satisfaction Ratings for SSEP: Most supervisors (83.3%) felt that SSEP was the correct length of time (duration 8 weeks), 100% indicated very high satisfaction (i.e. excellent and good ratings) with the overall program, and 96.7% said that they would recommend the program to their colleagues. Some supervisors did recommend that they have more input into the ultimate selection process for the student – supervisor job placement match.

Impact of Being a Supervisor: Most supervisors felt that students contributed positively to their work (73%) and the work environment (70%). Supervisors indicated that being able to provide information and encouragement to the young SSEP students had a positive impact on them (63%). They believed that as supervisors they increased: participants' knowledge, skills and self-confidence (93%); their sense of responsibility and independence (87%); introduction of the students to university life (80%), career related information (77%). A quote from one supervisor summarizes this as "Many of my past students have been from smaller communities and have felt intimidated about entering a large post-secondary institution as well as uncertain about what types of careers are available to women. Being part of this program has allowed me to be a role model for these young women, something I feel very proud of." [(6)]

Some supervisors did indicate some negative impacts from being involved in SSEP, such as time commitments required to do a good job of mentoring the young students, the lack of flexibility in summer months to take leave for conferences and holidays, and variability in student quality/personality. Recommendations of the supervisors included more involvement in the selection process for the student placements, recognition of their role, provision of accommodations for students requiring this option, and more workplace tours and information sessions for the students.

Most supervisors (87%) thought that the experience of women in science and engineering is different now than it was ten years ago. Of that group, 80.8% felt that there is perceived to be a higher awareness among young women of career options in science and engineering.

3.3 Research on Women in Non-Traditional Fields

According to Statistics Canada the percentage of women in traditionally female dominated fields (67%) has remained unchanged between 1996 and 2004[(10)]. There has been an overall increase in the proportion of women who hold a university degree and women now make up the majority of full-time students in Canadian universities[(10)]. However, despite the overall increase in the number of women attending university, women continue to account for a smaller proportion of the number enrolled in mathematics and science faculties. The number of women in these faculties has increased over time, but the majority of growth occurred between 1972/73 and 1992/93. Not surprisingly then, women still account for a small number of professionals in these occupations and there has not been a significant growth in numbers over the past 20 years.

According to Statistics Canada, in 2001-02, while women make up the majority of university students, women made up only 30% of all university students in mathematics and physical sciences, and just 24% of those in engineering and applied sciences[10]. There is growing concern in Canadian universities and industry, since more recent statistics indicate that levels in some fields are dropping. Engineers Canada data, reproduced by CCWESTT[11] and other engineering organizations[12], show a steady decline since 2002 for female undergraduate enrolment levels in engineering programs, from over 20% down to 17.5% in 2005; the absolute numbers of women have also declined by 7.0% over the past five years while those of their male peers have increased by 14.6%.

The same situation is true for Community Colleges in Canada. Women make up the majority of the students overall, but only constitute a small proportion of the mathematics and computer science programs (24%), and engineering and technology programs (15%)[10].

It is a similar case with women in employment. Women remain very much a minority among professionals employed in the natural sciences, engineering, and mathematics. In 2004, just 21% of professionals in these occupations were women, a figure which has changed little since 1987 when women accounted for just under 20% of professionals in these highly technical fields. In addition, it is unlikely that female representation in these occupations will increase in the near future, because, as reported in the Statistics Canada report[10], women continue to account for relatively small shares of total university enrolments in these fields.

Over the past 20 years there has been a significant increase in the number of women pursuing post-secondary education, however, this has not coincided with an influx of women into non-traditional fields. Therefore, as discussed in section 3.1, there appears to be a gap between reality and the perceptions of SSEP past participants in relation to perceived acceptance rates and actual career numbers of women in science and engineering.

3.4 Other Programs and Organizations

In terms of other Science, Engineering, Trades and Technology (SETT) programs, SSEP is unique in its model and mandate. There are other programs in Newfoundland and Labrador focused on encouraging girls and women to consider a career in sciences, engineering, trades and technology, but none are like SSEP, none are directed to the same age group of girls and none provide job placements. There is a spectrum of programs (see Figure 1), addressing females from age 10 to adulthood.

Figure 4. SETT Programs for Females in Newfoundland and Labrador.

Age Group	10-12yrs	12-13	14-15	16-17	18+
Program	GETT	Girl Guides Science	Techsploration	SSEP	OTT/ University

					mentoring
Organization Sponsor	WRDC	WISE UP	WRDC	WISE NL	WRDC/ WISE NL

The only program comparable to SSEP is the Women in Scholarship, Engineering, Science and Technology (WISEST) program in Alberta, from which the SSEP program drew its original inspiration. However, WISEST differs in that it is a funded part of the University of Alberta and does not struggle as much annually to ensure it has operating and administrative funds. It faces many of the same challenges as SSEP, such as: recruiting supervisors; ensuring aboriginal women are attracted to and supported in the program; competing with all of the other types of opportunities for this demographic group; ensuring that administration has support and ongoing funding.

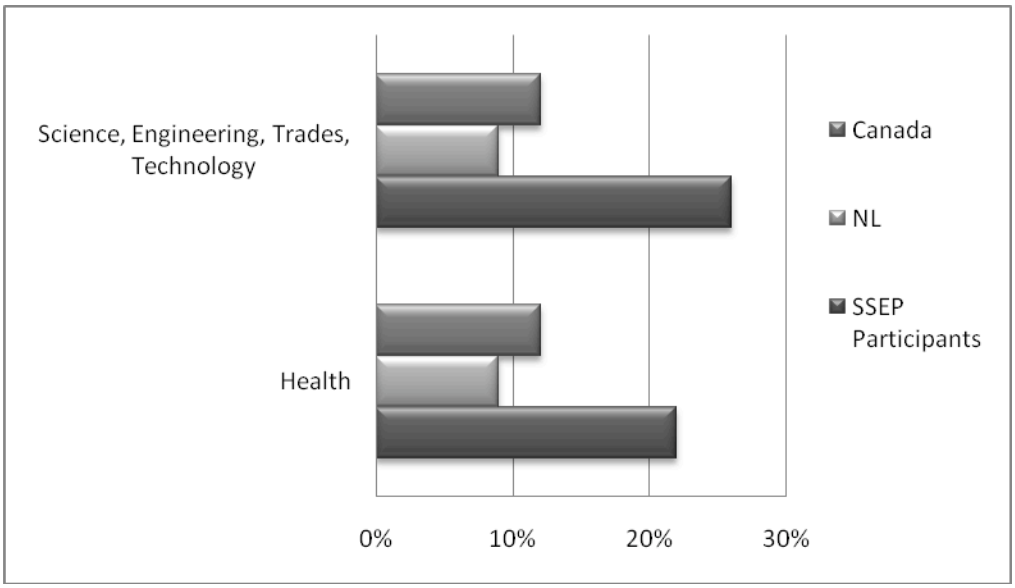
3.5 SWOT Analysis

3.5.1 Strengths

Support of Past Participants and Supervisors: Conducting the SWOT Analysis revealed that 98% of past participants and 93% of supervisors indicated that they felt there is a need to provide opportunities for young women to explore careers in science and engineering, with 99% of past participants and 96% of supervisors responding that SSEP was an effective way, and indicating their interest in supporting and mentoring future SSEP participants.

Proven Model and Track Record: Although the data are not directly comparable, a review of 2001 Census data[9] on women 15 years and over in both Newfoundland and Labrador and Canada suggests that SSEP participants are more likely than the general female population to pursue careers in science, engineering and related fields. A higher percentage of past SSEP participants (22%) indicated they are currently working in a health related field, compared to 9% of the female population in NL and 12% nationally.[9, 13] For other science, engineering and trades occupations, approximately 26% of past SSEP participants are in these fields compared to 9% of women in the province and 12% nationally[9, 13], as illustrated in Figure 2.

Figure 2. Comparative SETT Occupation Rates of Canadian, NL and SSEP Participants.



In addition, participants of SSEP indicated high ratings of the relative value of SSEP (95.5%) in influencing education and career choices, and the various indices of increased knowledge/skills, responsibility, independence, self-confidence, friendships, networks, university life knowledge (77-93% ratings, see results section).

Memorial University, other educational institutes and corporate industry have also gained from the success of SSEP. Enrolment into various programs and post-secondary completion rates have been higher than for the general NL/Canadian student populations. Also, many of these graduates have gone on to be corporate models.

Impacts on Females from Aboriginal/Minority/Disabilities and Rural NL: The impacts and satisfaction rates on young women from aboriginal, visible minorities and those with disabilities has been considerably higher than those of the general SSEP population, with high rates of attraction and retention in SETT post-secondary education and careers. This is in contrast to the norm for the general NL and Canadian populations.

3.5.2 Weaknesses

Organization Capacity of WISE NL: The lack of stable funding and full-time staff has made the program vulnerable, especially when changes in criteria for available funding occur. This has limited the ability to grow and enhance the program.

Discontinuance of Residence Component: A substantial portion of females from rural NL indicated reliance on and the preference for a residence option. Liability issues, as experienced by many volunteer organizations, have placed further financial constraints on administering the program. Changes in NL population demographics, from rural to urban centers, has decreased reliance on the residence component over the years, but continued attraction and retention of young rural and aboriginal females will probably necessitate some provision of alternate accommodations.

Potential Disenfranchisement of Supervisors: The success of SSEP has been dependent on the willingness of supervisors to contribute job placements, support, mentoring, and considerable personal time and effort. As discussed in the results section, supervisors have identified negative versus positive aspects of supervising SSEP participants, with some indication that researchers/professors in the early stages of their careers are less likely to involve themselves in activities not related to credit towards their careers.

Little Attention to the Glass Ceiling: Reports concerning SETT as education and career options have suggested that the participation rates of females have been declining in recent years. SSEP participation rates are above NL and national rates, but are still below the critical population mass percentage (i.e. 33%) that is generally accepted as indicating equality and parity. There is still a mismatch between the realities of female participation rates versus perceptions that women have no barriers.

3.5.3 Opportunities

Development of a Network of Supporters: WISE NL is well-positioned to formalize and develop the networks and partnerships they currently maintain on an informal or *ad-hoc* basis. These include: formalizing of its relationship with MUN and CWSEA to strengthen its full-time yearly commitments to the administration of SSEP; developing regular communications and a database of past participants of SSEP, particularly as their career and organizational networks grow; enhancing the networking capacities of its Board members; formalizing relationships with other like-minded organizations to strength its gender mandates and its lobbying powers.

Working Outside Funding Sources and Guidelines: Changes in federal and provincial funding criteria provides significant challenges to WISE NL as it seeks yearly funding to support SSEP. Its membership, successful SSEP graduates and other professional organization connections, as well as the positive feedback from this study, enhance the opportunities for WISE NL to attract new industry and other partners to support the program.

3.5.4 Threats

Limited Public Awareness: Two things set SSEP apart from other science and engineering programs: SSEP focuses on young women at the high school level and it addresses the under-representation of women in non-traditional fields. Interviews and focus groups with staff and board members indicate there is a perception among the general public that significant numbers of women are currently entering non-traditional fields and there is no longer any need for women-focused programming in this area.

However, this is not supported by the research. Information presented by Moloney[14], as sourced from the Canadian Engineers for Tomorrow, 2005 and 2006, indicate that Canadian undergraduate engineering enrolment for women reached maximum levels of 20.6% in 2001 and have been steadily decreasing since that time. Another 2007 article in

Maclean's Magazine[15] showed similar statistics, with female student engineering enrolment in about 45 Canadian engineering schools ranging from a low of 4.7% to a maximum of 38.1%. Only one school had above the critical 33% proportion deemed appropriate for the population, with 35 schools having less than 20% female representation.

Women are continuing to enrol in education programs leading to careers in traditionally female dominated fields. It is important for WISE NL to be able to communicate this to the general public in order to gain public support for the ongoing need for a program such as SSEP.

Demographic Change: Shifts in the NL population from rural to urban centers will affect the SSEP recruitment demographics. Consideration of strategies to include more students from urban regions, targeting at-risk groups, expanding the age/grade range, and expanding to other provinces of Canada are just a few options.

Liability: WISE NL will need to address liability issues related to SSEP the participant's workplace, travel, participation in field work and non-related outings, residence and others. WISEST has overcome this through its University of Alberta partnership, and SSEP could similarly access appropriate insurance coverage and waivers from the Memorial University formal partnership.

4.0 Recommendations and Conclusion

Recommendations: To guide WISE NL to address its weaknesses and to enhance its strengths and opportunities, recommendations include:

1. Developing a strategy to improve the financial sustainability of SSEP. This should include securing funds from other agencies, formalizing the partnership with MUN and CWSEA, and identifying other potential corporate and organization partners.
2. Building a formal network of supporters including SSEP graduates, supervisors, industry sponsors, WISE NL board and members, and other champions of the program.
3. Enhancing the positive components of participation for the SSEP supervisors including giving them recognition for their contributions and encouraging the university to provide them with credit towards their career advancements, and giving them the opportunity to provide more input into the student selection process.
4. Developing and implementing a communication strategy to both promote the SSEP program and raise public awareness about the situation of women in science and engineering.
5. Developing a strategy to enable SSEP to address the challenges posed by demographic changes.
6. Developing a component in SSEP to present the data on the continued gender imbalance of SETT fields in terms of education and employment.

7. Addressing liability issues related to accommodations, work environment, field work and other outings.

Conclusion: This SSEP evaluation has found that past participants, supervisors, WISE NL members and other associates think very highly of this program and are very supportive of its continuance. As a model SSEP has been very successful in that past participants are more likely to pursue post-secondary education and are more likely to enter science, engineering, technology and trades fields than young women in the general population. They have a higher rate of education completion and they successfully transition to professional careers in their chosen fields. The program builds on both personal and knowledge-based skills that carry them through life.

WISE NL needs to develop strategies to address current shortfalls in terms of both human and financial resources, to secure long-term sustainability of the program and to enhance its mandate. This study has verified the continued need for programs such as SSEP and that its format is a successful model.

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WinSETT / Becoming Leaders Workshop – Career Success: Skills and Strategies

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Introduction

Progressive science and engineering organizations are committed to the fair representation and advancement of women in their workplaces. Despite many policies and practices, however, women are still typically underrepresented in senior positions and leave organizations at higher rates than men particularly at mid-career levels.[1, 2] For example, a seven-year US study found that women in science and engineering occupations are twice as likely as men to leave these fields to pursue other careers.[3]
Companies and institutions invest significant resources in the recruitment, hiring, training and development of their employees. Australia's Commonwealth Scientific and Industrial Research Organization found that it *cost roughly four times as much to continually hunt for and train replacement staff than it did to provide optimal conditions for job satisfaction and motivation of existing personnel.*[4]
Creating workplaces that support, offer development opportunities for, and retain women employees provides a return on the organization's investment in valuable human resources and saves on the high costs of this differential turnover. The employer who supports women in the workplace will also have a competitive advantage in attracting and retaining the 'best and the brightest' from an increased pool of talent and will become an 'employer of choice'.[5] [For more information on the economic benefits, see *Increasing Women in SETT: The Business Case*.[6]]
On the employee side of the equation, clearly there are rewards for women working in science and engineering fields with careers that are very likely interesting and financially rewarding. Such careers also have the potential to be much more: to put women in leadership roles, bring added recognition and satisfaction, and place them in a position to make a positive difference. For, as women succeed at each stage of their careers, they influence the people around them, their leadership grows and very importantly, they point the way for other women.

Women in SETT / Becoming Leaders Partnership

The Canadian Coalition of Women in Engineering, Science, Trades and Technology (CCWESTT) embarked on its Women in SETT (Science, Engineering, Trades and Technology) Initiative to effect change at the institutional level to increase the participation and advancement of women in SETT fields in Canada. In 2008, the WinSETT Initiative is delivering products and services to industry in four sectors, including oil and gas where the retention of women has been noted as an issue. One pilot service being offered by WinSETT is a workshop for early to mid-career women scientists and engineers in the oil and gas industry with the objective of increasing retention and strengthening leadership potential.

This WinSETT offered workshop is aligned with the successful Becoming Leaders™ series of workshops based on the internationally lauded book Becoming Leaders: A Practical Handbook for Women in Engineering, Science, and Technology, a new version of which will be published in April 2008.[7] The handbook is a concise and highly accessible resource on a range of topics significant for women professionals and students in science and engineering, and those who support their progress. The handbook and workshops are successful because they were developed by women scientists, engineers, technologists and students from our own experiences and perspective, with strategies that work. The Becoming Leaders Career Success Workshop has been previously delivered effectively to a number of audiences including most recently on several occasions to mid-career women scientists and engineers in the Federal Public Service.[8]

Becoming Leaders Career Success Workshop: Skills and Strategies

The underlying rationale for the workshop is that in career development, both the choice and the responsibility rest in large measure with the individual. She decides on the career path, the cost-benefit and work-life balances, and the personal style with which she is comfortable. Supporting her includes helping her to identify a range of options, raising awareness of both external and internal factors, and giving her the confidence and motivation to advance.

While at first glance the workshop seemingly undertakes to adjust the women to the workplace instead of to improve the work environment for the women, the aim is not to 'fit' the women, but to give them the tools to effect change, particularly in the interactions which involve them. There are also additional complementary resources available for managers and leaders to support the progress of women in their organization.

The workshop introduces the participants to the question of what and who controls individual career success, and addresses the reality that women often face special challenges in 'being heard' and gaining promotion. The session provides awareness of the subtle factors that impact our careers. These gender schemas are the sub-conscious beliefs about sex differences that all of us have – beliefs which "affect our expectations of men and women and how we evaluate their work and performance as professionals".[9] These schemas result in women accruing a series of small disadvantages which see our career paths diverge from our male peers. With that key understanding, the workshop then provides the tools and builds confidence to advance women's career success, however we define it. 12th CCWESTT Conference May 29-31, 2008 Guelph, Ontario

Information is presented interactively in a manner that encourages participants to relate it to their own experience. Reinforcement occurs when participants recognize common experiences which, since they are in a minority in the workplace, they often have not realized were common and

characteristic for women. Participants learn about high value skills such as effective communication, organizational awareness, career planning, networking, and negotiating strategies, which will ensure recognition for their achievements and improve access to professional advancement.

The initial Women in SETT Becoming Leaders Career Success Workshop is being delivered in Calgary in late April 2008 to two dozen women engineers and scientists in the early to mid stages of their careers in the oil and gas sector. Dr. F. Mary Williams, leader of a major government research facility, senior author of Becoming Leaders, and the first NSERC/Petro-Canada Chair for Women in Science and Engineering for the Atlantic region, will facilitate the session. The session will also provide an opportunity for participants to hear workplace tips and personal strategies from more senior women with a variety of experiences in these fields. It is intended that participants will strengthen networks in their organizations/industry and will continue to benefit from supportive and mentoring relationships to progress in their careers. Evaluation and outcomes from this workshop will be presented at the CCWESTT Conference and will enable CCWESTT to make any modifications for future expanded delivery of the workshop to industry stakeholders in several locations across Canada.

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