AC 2011-145: DEVELOPING LEADERSHIP ATTITUDES AND SKILLS IN WORKING ADULT WOMEN TECHNICAL GRADUATE STUDENTS: RESEARCH INTERVIEW RESULTS WITH ALUMNI

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Developing Leadership Capacity in Working Adult Women Technical Graduate Students Research Interview Results with Alumni

Abstract

While women continue to make progress in their overall representation in the business sector, there are many challenges that keep women from making advances in their careers as science and engineering leaders. Those professions that have long been male dominated are making the slowest gains. Even though female representation in the engineering profession is increasing, it is not at a rate that is fast enough. This paper looks at the issues that limit engineering women's opportunities for faster advancement, and shares information about a course in developing leadership capacity in women engineers, documenting progress based on interviews with alumni. Significant strides are being seen in the women that understand and practice effective leadership, and organizations that can create a supportive climate for their practice.

Background

In the U.S., it is no longer surprising or incongruous to see a woman as principal of a public high school, manager of a corporate department, dean of a university college, or anchor on a local newscast. Women have breached the barriers to such positions in concert with a general relaxation in traditional gender-role attitudes as well as changes in public perceptions of what leadership entails. Yet in contexts still defined in the public mind as requiring masculine qualities, women face tough barriers that stem from the difficulty of simultaneously transcending and accommodating to gender stereotypes. It is critical to understand some of these barriers in order to help women break them down and be determined enough to work their way through them. This paper shares some the stories of some brave young engineering women who are doing just that.

Catalyst Research[1] reports that there are 51.4% of U.S. women in management, professional and related occupations today in Fortune 500 businesses. Furthermore, they report that 14.4% are executive officers, 15.7% hold Board seats, and 2.4% hold the office of CEO. While these numbers represent ongoing progress for women, there is a sharp contrast with numbers for women in engineering professions and/or leadership roles.

Data on Status of Women in Engineering

When comparing data the overall progress of women in business to Engineering professions, one finds some interesting contrasts. Researchers from Catalyst and NSF both report interesting numbers. Catalyst conducted a study of women in the sciences[2] in 2009 that shows the following:

- Women are 28.2% of all management/administration professionals in science.

- Of scientists and engineers managers employed in business and industry in 2003, men on average have 12 subordinates while women have 9 subordinates.
- According to a survey of 42 chemical companies:
  - Only 9.2% of all 404 executive officer positions were filled by women; this has risen from 8.7% in 2006.
  - Women are only 12% of the 416 board directors. While this is an improvement since a 2006 survey where only 11.1% of its directors were women, it has not surpassed the 12.8% measured in a 2003 survey of board directors at chemical companies.

Another Catalyst 2009 study[3] was conducted with selected High Tech Companies. These were companies from industries, occupations and products in which cutting-edge, state-of-the-art technologies are being used. The Bureau of Labor Statistics has described "high technology" occupations as scientific, technical and engineering occupations, such as engineers, life and physical scientists, mathematical specialist, engineering and science technicians, computer specialist, and engineering, scientific, and computer managers. Note the percentages of women in several of these categories, as well as the earned degrees within those fields (Figures 1-4).

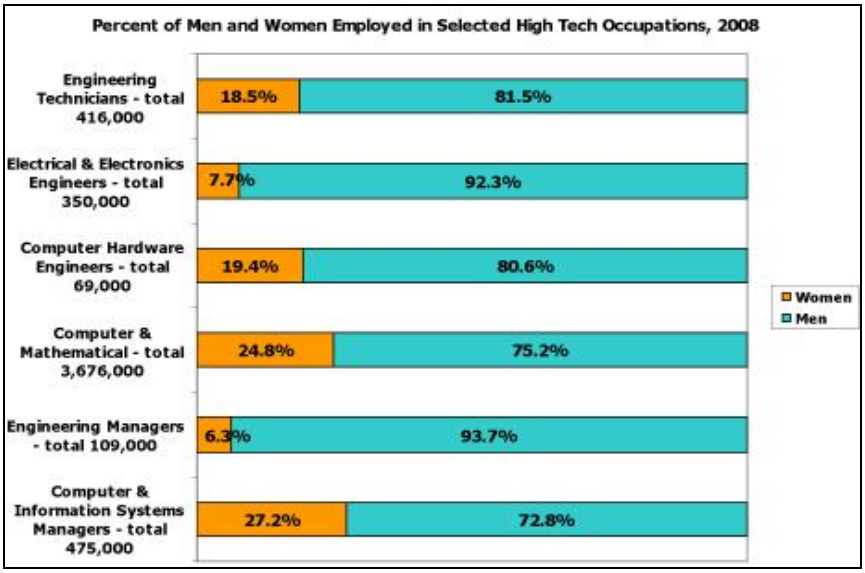

Figure 1. Percent of Men and Women Employed in Selected High Tech Occupations, 2008. Catalyst Research 2009.

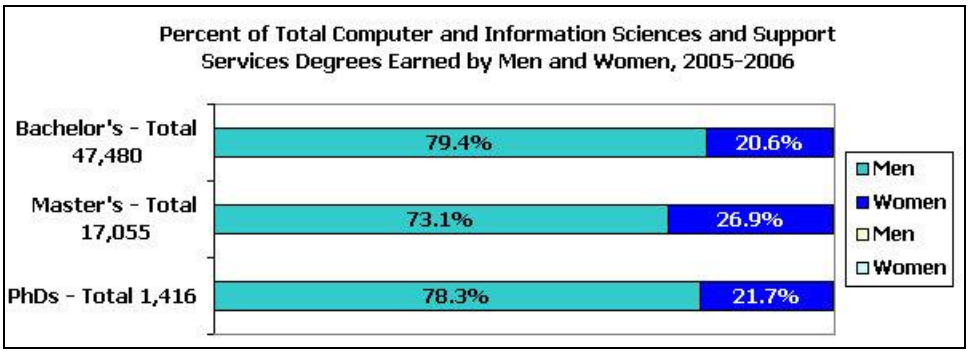

Figure 2. Percent of Total Computer and Information Sciences and Support Services Degrees Earned by Men and Women, 2005-2006. Catalyst Research 2009.

Figure 3. Percent of Total Engineering Degrees Earned by Men and Women, 2005-2006. Catalyst Research 2009.

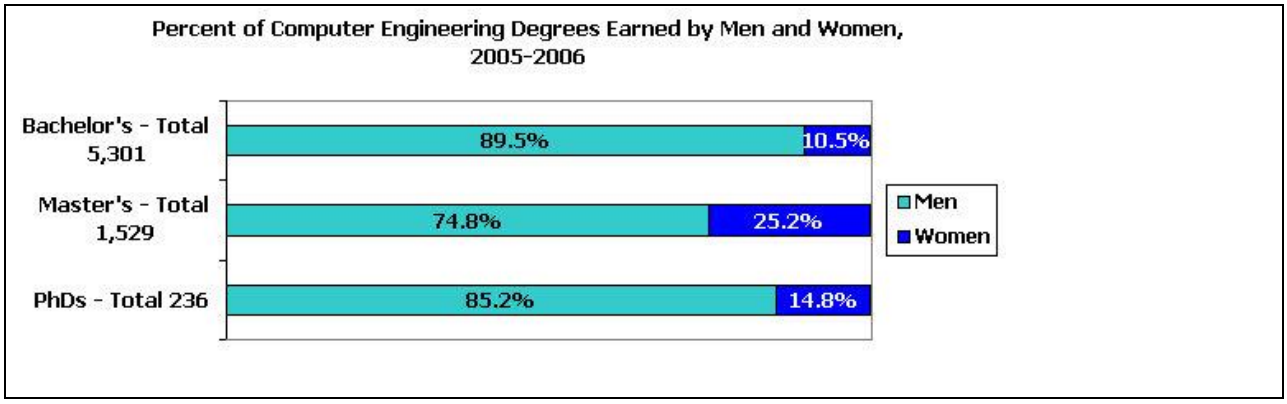

Figure 4. Percent of Computer Engineering Degrees Earned by Men and Women, 2005-2006. Catalyst Research 2009.

Statistics from the National Science Foundation[4] show that women constitute two-fifths of those (40%) with Science and Engineering degrees in 2005, but their proportion is smaller (30%) in most S&E occupations. This is reflected in the study of "high technology" companies as well.

However, NSF reports that more women than men have entered the S&E workforce over recent decades. Their proportion in the S&E occupations rose from 12% in 1980 to 27% in 2007. Women in the S&E workforce are on average younger than men, suggesting that larger proportions of men than women may retire in the near future, changing the gender ratios.

NSF data from the 2006 SESTAT[5] data shows that, of the five S&E degree fields included, the ratio of females to males is lowest for engineering. Yet the data also shows that the percent of females in management positions is highest for engineering.

The numbers of engineering graduates in the workforce by gender and years since bachelor's degree show an increase from 2% to 20% in the number of women in engineering over the past four decades. However, when viewed as a percent of total workforce engineers of their gender, female engineers in the 0-10 year post-bachelors period are nearly equal to the male engineers.

Because more young women than young men are attending college these days (in some areas of the country the gap is 54% to 46%), there is hope that more women may choose S&E disciplines and there the rate of participation may increase. Clearly, if we can boost participation in S&E related fields, particularly engineering, there will be increased opportunities for women to demonstrate their potential for assuming leadership positions.

Why the Slow Progress for Women Engineering Leaders

Drawing on a large and diverse body of research, a recent report documents eight research findings that provide evidence that social and environmental factors contribute to the under-representation of women in science and engineering. The rapid increase in the number of girls achieving very high scores on mathematics test once thought to measure the innate ability suggests that cultural factors are at work. Thirty years ago there were 13 boys for every girl who scored above 700 on the SAT math exam at age 13; today that ratio has shrunk to about 3:1. The authors of the report *Why So Few*[6] conclude that while biological gender differences may play a role, they clearly are not the whole story. These authors suggest that we must take a hard look at the stereotypes and biases that still pervade our culture. Encouraging more girls and women to enter science and engineering fields will require careful attention to the environment in classrooms, the workplace and throughout our culture.

Some of the findings in this large body of research show:

- Many girls and women report they are not interested in science and engineering. In a 2009 poll of young people ages 8-17 by the American Society for Quality, 24 percent of boys but only 5 percent of girls said they were interested in an engineering career. From early adolescence, girls express less interest in math or science careers than boys do[7]. Even girls and women who excel in mathematics often do not pursue S &E fields. Women are more likely to secure degrees in the humanities, life sciences, and social sciences than in math, computer science, engineering or the physical sciences, the reverse is true for men[8].

- Pajares[9] found that gender differences in self-confidence in S & E subjects begin in middle school and increase in high school and college, where girls reporting less

confidence than boys do in their math and science abilities. This coupled with a review of child vocational development by Hartung[10] found that children, especially girls, develop beliefs that they cannot pursue particular occupations because they perceive them as inappropriate for their gender.

- The workplace environment has been shown to be a major factor in women's decision to leave their S&E careers. Hewlett et al[11] research cites feelings of isolation, an unsupportive work environment, extreme work schedules, and unclear rules about advancement and success as major challenges. Also women's higher turnover in academia is mainly due to dissatisfaction with departmental culture, advancement opportunities, faculty leadership, and research support, Goulden[12] compared men and women in the sciences who are married with children and found that women were 35 percent less likely to enter a tenure-track position after receiving a doctorate.

- Several research studies (Wenneras and Wold[13], Valian[14], Nosek et al[15], and Trix & Penska)[16] point to implicit bias that negatively influences women's progress and participation in S & E fields. These implicit biases may reflect, be stronger than, or in some cases contradict explicitly held beliefs or values. There is a strong majority of women and men who implicitly associate males with science and females with liberal arts. Additionally, there is evidence of bias in peer reviews, showing that a female postdoctoral applicant had to be significantly more productive than a male applicant, helping to explain the lower success rate of female scientists in achieving high academic rank. While biases do change, the recent research studies show that gender stereotypes are clearly still at play.

- Recent research on marriage and family responsibilities, show that women are at a disadvantage if they have children[17,18]. In business and industry both women and men identify family responsibilities as a possible barrier to advancement, but women are affected differently than men by this "family penalty."[19,20] Among women and men with families, women are more likely to report that they are the primary caregiver and have a partner who also works full time. Women who left engineering were far more likely than men to cite time and family-related issues as their reason for leaving[21].

- Girls' achievements and interest in math and science are shaped by the environment around them. Studies[6] demonstrate the effects of societal beliefs and the learning environment on girls' achievements and interest in science and math. Other studies[22] show that girls assess their abilities lower than boys with similar past achievements. At the same time, girls hold themselves to a higher standard than boys do in subjects like math, believing they have to be exceptional to succeed in "male" fields.

Multiple factors, many not well understood, contribute to the under-representation of women and girls in S & E fields and therefore, multiple solutions are needed to correct the imbalance. We are clear that paying attention to the learning environment, the workplace environment, and the broader societal mindset gives us many opportunities to make corrections for the sake of full utilization of all talents.

Uniqueness of Women Engineers

It is risky to generalize when speaking to differences between women and men, therefore we must qualify the points we have chosen to make. Calling these characteristics "unique" to women does not mean that men do not have the same characteristics, or that they cannot be developed more fully in men. Many men do have these characteristics, but more often they are especially attributed to women's uniqueness.

First, one would have to identify the courageous stance that women are taking to enter into a male-dominated profession, given all the many pressures that work against them. Those women who do undertake this challenge are of a certain caliber of women: they are unafraid to break barriers, to demonstrate their courage, and to live out their passion for what they want to contribute in the world and why. They often have succeeded in their educational process to demonstrate their aptitude for science, math, and more technical analysis. This aptitude is very often not encouraged for women in elementary or secondary education; they are often handed different scripts from families, society, and their career counselors. Those scripts in the past have often led women to choose teaching, health services, or some career that is more aligned with caring for others. These scripts have long been part of the patriarchal society, and young women today seeking to break through the barriers know of the risks associated with finding new pathways, and are prepared to take on the challenges associated with new models. They are courageous, path-finders, and unafraid of risks. These characteristics benefit the whole engineering profession.

Secondly, much research has been compiled that suggests that women generally have more natural facility with relationship building. This is often seen in the early years of young girls in how they play with others, how they work at projects, and how they think[23]. This keen ability is nurtured throughout their development and is noticed in the workplace. Women often have a natural ability to build and sustain productive relationships within a group and across boundaries. This asset serves as a model for all of the engineering professionals. No real work can be achieved today without learning the skills and attitudes that require collaboration and teamwork; hence good relationships.

Because of women's strength in relationships, they are often organizational connectors, able to bring diverse ideas and peoples together to work together, plan together and build prototypes of new possibilities whether in products, in ideas, or in approaches for work design. They have an innate ability to see connections in ways that reflect systems thinking and functioning. They have a knowing of when something is missing or something is being excluded that needs to be part of the equation. They are more often than men able to demonstrate an introspective approach, are better listeners, and more collaborative and/or inclusive in their ways of leading[24,25,26].

Other commonly noticed female attributes are about seeing through a different lens, bringing forth new and/or different perspectives[27]. Much has been written about the unique wiring of the female brain and how she thinks differently, uses different approaches to arrive at conclusions, and often conducts her analyses with a different approach [28,29,30]. This applies also to her ways of communicating, more often from a right brain approach. These attributes are clearly assets for

all of the engineering profession in ensuring a more balanced approach is brought to the table of decision making, design, and thinking out of the box. This ensures there is more likelihood that innovative practices get recognized, heightened, and fully utilized.

Lastly, women tend to have and demonstrate more empathy in their emotional competence[31]. This more empathic approach is of great value in building teams, recognizing and valuing difference, bringing more new ideas to the table, and building understanding for unique approaches. Not only is their empathy valuable in being able to accurately read people and their motivations, but also is more demonstrative in their compassionate understanding. This competence brings much to the teaming process as well as effective leadership.

Why Women Make Good Engineering Leaders

Effective leaders today are those who are naturally collaborative, know how to think using a systems approach and function in that same manner, know how to fully use all peoples' strengths and capabilities for the sake of the team, the customer and the business outcome. Furthermore, the effective leader must be one who knows how to build and sustain relationships, reaching out to new people, across functions, and identifying the best possible configurations of talent to get the best business result. This leader needs to be someone who is self-aware and is prepared to make personal change before they are able to implement the organizational changes that are part of the leader's responsibilities. This requires an ability to be emotionally astute, knowing how to manage one's emotions and build relationships with others.

All of the earlier mentioned characteristics are reflective of those describing effective leadership attributes today and are often more readily found in intelligent women. Combine those with a willingness to take risks, to think outside of the box, and take courageous stands, it is easy to see why women make good engineering leaders. They have what it takes, and they are courageous in their pursuits to demonstrate their capabilities, if they are able to rid themselves of the notion that they must "act like a man" in the leadership process. They must develop a strong sense of self and nurture their unique attributes that are truly assets in the workplace of today.

Growth of Women in Engineering Leadership

The dilemmas outlined above, associated with slow growth of the representation of women in engineering leadership positions are many and complex. We know that making significant inroads into a male-dominated profession for women has been challenging for decades. However, there are indications that this is changing and much is involved in that change process. We tend to think multiple approaches must be considered. Some of these include:

1) Engage young girls early in life to take a passionate interest in science, math, and technical pursuits. Communicate to young students that they are valued for the effort, hard work, and learning from mistakes. Help them feel challenged to learn and grow, and overcome any fears that limit them.

   We tend to believe that encouraging young girls to enroll in science camps, engineering projects, and building specific models will engage those young minds and hearts about

what might be possible for them. Many places are beginning to offer interesting opportunities to do just that, and more parents are helping to expand the horizons of their daughter's dreams. Girls' camps aimed at building model airplanes[32], visiting manufacturing facilities that are making specific products of interest, parents enrolling their daughters in specific engineering courses at an early age are all supports that will begin to change the societal acceptance of expanding women's roles in all kinds of new endeavors.

2) Recruit more women into engineering and technical careers, supporting them in their choices in multiple ways. Help other recruiters to face any implicit biases that might be affecting their ability to see women as high achievers in S & E fields.

   More secondary[33] and post-secondary education institutions need to take a strong role in advocating for more women in science and engineering fields. This takes a deliberate strategy to influence young women to envision themselves in technical roles that are highly visible and attractive. Multiple levels of intentional strategic planning to make this happen involving educators and advocates are needed. Champions at strategic levels need to make the case that women's talents are necessary in these strategic roles.

3) Provide interested women with engineering and technical mentors early in their education and career choices. Expose young girls to models that stimulate their interest and passion.

   Educational programs as well as business supports need to be in place to provide girls and women with strong, capable, and encouraging mentorships early in their careers[34]. These mentors need to be carefully matched with women's needs and interests and given time and recognition to sufficiently engage the interested woman with action learning methods and/or other experiential learning activities that support her development and interests. Many Engineering Professional Associations are in place today to offer some of the best possible programs to help women feel valued, engaged and appropriately challenged in their roles.

4) Ensure organizations take a more active role in supporting women in their technical pursuits and their organizational roles, providing an environment that is supportive, flexible and enhancing of the females' interests.

   More and more organizations today are beginning to see the value that women can bring to their engineering and science professions and are taking a more deliberate and active role in supporting women in their roles[35]. This means at times offering them special developmental opportunities, providing them mentor support, and ensuring that challenging assignments and promotional opportunities are focused on full utilization of the female talent. More talent management strategies today are aimed at retaining women and ensuring that they are fully engaged in their organizational functions.

5) Actively influence the media, and societal views about women's talents, interests, and capabilities in the STEM professions.

This requires a broader societal approach to inform and educate the public regarding women's capabilities, exposing and making more visible the women engineering leaders in educational institutions as well as industry leaders. This over time can change the public perception of appropriate gender mix in a profession and offering role models for young women.

6) Learn about your own implicit bias, keeping those biases in mind, and taking steps to correct for your biases.

   Take the implicit association tests at https://implicity.harvard.edu to gain a better understanding of your own biases. Although implicit biases operate at an unconscious level, one can resolve to become more aware of how they impact decision making and notice when this is enacted in the work environment.

7) Raise awareness about bias against women in S & E fields.

   If the general population becomes more aware of the gender bias that is a reality in the S & E fields, they can interrupt the unconscious thought processes that lead to bias. If women in particular are aware that gender bias exists in these fields, it may allow them to fortify themselves and recognize that they are not alone.

8) Conduct organizational assessments of the climate for women in S & E fields.

   Often when women experience a negative climate, they report lower job satisfaction and are more likely to consider leaving their position. It is important for men and women alike to feel their organizations are concerned about the climate that provides for their health and well-being while they contribute to the organization's goals.

9) Provide women with powerful coaching and development processes so that they are equipped to be self-aware, able to stand in their authenticity, and become strong advocates for their own interests and pursuits.

   This strategy is aimed at both educational institutions and industry. Its intent would be to provide "best practice" leadership development programs that attract high talent women and prepare them to be authentic leaders, true to their own voices and passions, and taking a strong role in shaping their futures. More and more Universities and Engineering Professional Organizations are investing in women today and intending to support women's advancement in moving into leadership roles in science and engineering. Examples of this include the University of St. Thomas, other best practice companies such as Medtronic, Honeywell, Google, and Microsoft.

When enough attention is given to engaging women and their advocates at all levels and in all possible surrounding support organizations, there can and will be changed perceptions of gender based roles. There is likely to be significant positive changes to women's entrance into science

and engineering roles and they will be more likely to stay in those roles, exercising their leadership prowess.

Leadership Development of Female Engineering Graduate Students, University of St. Thomas

At the ASEE annual conference in 2004, a paper was presented[36] on the design of a series of courses (Leveraging Leadership for a Lifetime (LLL) that aimed to develop adult graduate students' leadership capacity and skills. The presentation of this paper discussed the philosophy undergirding the leadership development process and reported the results observed at that time. This highly experiential program was phased throughout their graduate experience of 3-5 years. Each student entered the series of courses undergoing five assessment instruments that measured their leadership competencies, their emotional capacity, their personality preferences, learning styles, and a profile of their life review. The resulting information provided the student with a full array of data that would be used in putting together their personal and professional plan for development. The remaining courses built upon this individual plan, integrating it with key exercises, knowledge and practice with team effectiveness, leading change in an organization, thinking broadly in systemic ways, better understanding global business and perspectives, and practicing communication, dialogue, and teamwork for building a collaborative leadership style. The environment for this learning was one of interaction, intentional team support, coaching, encouraging students to assess their own mindsets and beliefs, and expanding their learning environment to their homes, social organizations and their workplaces. Syllabi containing details of those courses are available at the School of Engineering website.[37]

Six additional years of results have been observed and documented. Longitudinal research, focusing on interviews with women and men alumni of the program, has been conducted and shows remarkable demonstrated growth in their leadership progress. Accelerated by intentional self reflection and the creation of lifelong learning roadmaps, these alumni are now living their plan and demonstrating their leadership. We had some hunches about overall outcomes, and planned to continue to monitor individual and collective outcomes as the students moved forward in their learning pursuits. We proposed documenting the students' stories of real-time learning and leading to help everyone know just how this process will affect life-long results. We have done just that, and now are able to assess the progress of men and women alumni.

At the time of the initial writing, students were excited about their learning pursuits, engaging others to support them and beginning to demonstrate their leadership talents as they learned, stretched and grew. They were feeling real strength and power in coming to better understand themselves, confronting any limiting beliefs and taking charge of their own learning outcomes. With an additional six years experience, the power of this approach in releasing *the leader within* is becoming much more clear and compelling. Alumni of this program are now convinced that this course has had a profound effect on the way they view the world as an interconnected system, on their role to lead and make a difference, and as a result has changed the way they think and act. The implications of this research for retaining women in engineering careers are significant.

Since 2003 through fall 2010, 160 students have completed the Leveraging Leadership for a Lifetime series of three courses and have graduated. A remaining 170 students are in process

with their completion, while new entrants are joining every semester. We now have a substantial number of alumni who are sharing their experiences with us, and demonstrating how they have grown and are emerging as leaders in their organizations and their communities.

Hearing from Female Alumni

During the year 2010, the authors interviewed over 50 graduate students to document leadership progress after graduation. Thirty of these students were women. These interviews form the basis for a book we have written on developing leadership capacity in scientists and engineers.[38] Some of these alumni graduated before the Leveraging Leadership courses were established. We wanted to see whether the leadership series was making a difference. While earlier students have developed leadership skills, the major difference we have observed is that more students are stepping up to leadership who have taken the course, their understanding of what leadership entails is more enhanced, and their leadership abilities are being developed more quickly.

The series of courses build on a base of self-assessments that include emotional competence, leadership potential, personality inventories, learning styles, and 360° feedback on leadership competencies. The initial course assumes that a leader must build a strong sense of personal awareness, how to lead personal and organizational change, and how to build effective teams. From this base, the learner is exposed to experiential practices and methods for putting in place his/her leadership practices and actions that inspire, serve and mobilize others to achieve significant organizational goals.

It is important to note that of all the graduate students who have completed their Masters programs, many of the top students were women. They became flourishing leaders in their chosen environments and demonstrated the kind of characteristics described earlier in this paper. We have chosen to share the stories of some of these many who have exercised their new found self-awareness and power.

Alumna Carol Jacobs is an engineer in a major industrial and consumer products company working in a group supporting retail products with tight timelines. Product managers assigned to the group were recently graduated MBAs who did not understand the corporate culture of being 'hands-on' with the product. Carol was responsible for seeing the technical aspects of the product were in order, but found herself also 'training' the product managers. Turnover in product managers was high and the team was suffering. She and the team were frustrated and at the end of their rope, but no-one was willing to speak up and 'rock the boat,' except Carol. She was willing to speak up for doing the right thing, putting her job on the line. She told their manager that changes were needed, people were burning out, and that she would leave if something were not done. The manager understood and worked with the team to make the needed changes. Things got better, with incoming product managers being informed of their role at the onset and becoming part of the team. This was a scary experience personally for Carol, but she had the courage to stand up and be heard.

As a quality engineer in a major medical device firm, Corrine Anderson found her first and most meaningful leadership role after attending training on Just In Time (JIT), a new concept at the time. She approached her boss, and suggested forming a grass-roots effort to implement in her

company. He said ‘go ahead’. She formed a team of interested colleagues, put a plan together to explain the goals to her team and then they just did it. She was passionate about change. The results were a 50% reduction in cycle time and large inventory reduction as well. For their work, the team won a company award. This initiative built Corrine’s confidence and she’s been unstoppable ever since.

Corrine always liked being ‘in charge’ as a youngster, but shied away from leadership roles as a young engineer. When she became a manager she found that suddenly she was in contact with other people of influence and was in a venue where she could be heard. She always had the courage, just did not feel she was in a place where people would listen to her. Corrine initially found that letting people take responsibility was a challenge for her and she continues to work on it. She now likes to delegate, believing that her team members come up with better ways of doing things than she can alone. She also notes that as people succeed, they get more passionate about their work.

As the leader of a small team in a medical device company, Ellie Fitzgerald was confronted with a situation where four team members each had different points of view on how to handle a specific situation. Ellie set up a two hour meeting and stood at the board, laying out the pros and cons to each approach by asking the team questions and documenting their responses. Doing this exercise systematically helped all the team members realize the appropriate path, and all she did was facilitate their discussion in a compassionate, empathic, and productive manner. The team agreed on one approach and all left the room feeling it was a win-win.

Earlier in her career, Ellie was a project manager who had constant personality problems with the quality manager. Nothing she did seemed to be right. She learned to understand the social style of this manager and through persistence and active listening broke down the communications barriers in three months. They are now enjoying a great working relationship as the result of Ellie’s perseverance.

Doing the right thing is a trait that pervades those interviewed. Marsha Salter was an engineer at a company that produces fluid handling equipment. She believes that to be a good leader one has to be ethical, do what is good for business and be able to sleep at night with your decisions. In one of those ‘do the right thing’ moments, she challenged a risk-averse decision being taken by her department and proposed a more creative approach. She convinced her manager and the team. There were no negative consequences and she has become more confident and bold in her stance.

Marsha grew up on a dairy farm, the eldest of 10 siblings. She understood that on a farm you have to make decisions and get the job done. In that environment you learn you can do just about anything you put your mind to, and for each challenge you come up saying ‘I’ve done it!’ She got off to a rocky start in her new role as a program manager at a medical device manufacturer. She was overwhelmed, and her first presentation went badly. She had to regroup and persist. Marsha was experienced and immediately recognized the problem; she was not viewing her audience as ‘customers’. She changed her approach, and it has gone well ever since. She comments, ‘remember, people are judging you for the job you are doing, it is not personal’.

Marsha has high respect for the team she leads, and she expects a lot. She frequently gives credit for success to others publically so they see it. When asked of what she is most proud so far in her career, she says it is helping others overcome obstacles. She creates an environment that reflects her belief that it is critical to have a systems view and a world view for success. She also is a big believer in American expertise and ingenuity and that if she creates the right environment, members of her team will make things happen

As a security analyst and information technology professional, Mary Ross has worked for a wide range of companies from medical device manufacturing, large retail sales and a major worldwide hospitality company. She has done very well and now, as a consultant, she has the ability to tell her clients the 'bad news' that is difficult for internal IT experts to do. However, she has really developed her leadership abilities through volunteer work in industry leadership roles. She serves on several national IT security related boards, shares her knowledge as a guest speaker and volunteers in running three conferences annually. Through these activities, Mary has developed an extensive network of thought leaders in their fields. In her consulting roles, she uses this network to draw many experts to the metropolitan area for speaker engagements and conferences. She continues to learn and strive to provide leading edge consulting in security risk management.

Bea Ellison is a project manager at a major innovative, high tech international consumer and industrial products company. She had early career successes leading a team of four in introducing a new product to market in a short time frame. She credited the success to great attitudes of the team members, being given adequate resources and having a strong market demand for the product. This and other successes led company leadership to recognize her potential, and she was assigned as lead of a team of three on a project requiring new technologies. Within six months, the team had expanded to 60 members. Bea was overwhelmed, and was sure she would not have been given this assignment if the company leaders had known that it would be such a sought-after product by customers. Given the communications challenges and the wide-spread involvement of so many team members from many different sites, she decided to do something rather unusual for her company and have a big team kickoff at corporate headquarters. All members attended a two day kickoff where they learned about the project background, heard from members and shared what she had learned from the last project she led: working collaboratively with the team to determine schedules, criteria for performance and articulate the roles and responsibilities of everyone. They were off to a great start. Team members gave fantastic feedback about the process. They felt the full engagement of the team was the right recipe for success and were thrilled to leave all on the same page. This project turned out to be a great growing opportunity for Bea.

Bea is now 'hungry' for leading more projects with greater and greater complexity. She loves straddling the technical and business management processes. She has developed a strong belief that her company could introduce more new products faster if it opened its design process. Bea developed a proposal, and has gone about meeting with top executives to embrace it. The passion she has ignited with previous successes, and the confidence and courage she has found, now are being manifested in her taking initiative to develop a strategy to change the culture of her organization. As a result of this forward thinking and cutting edge work, she is on the high

potential list and knows that her employer is good to supply her with challenges and to support her in taking on continually more challenging roles.

Carol Jacobs approach to creating her future is different. She has no long-term career master plan, but searches for new experiences that offer adventure. Her career evolves. She decided early on not to climb the management ladder. She was placed in a 'high growth' category, was in a supervisory roundtable, but didn't feel she would be effective at managing people. She is better at being a technical person in her view. The technical side too has a ladder, but it is more challenging. The management side had benefits of income and title, but formal status did not matter to Carol. She has become more interested in job satisfaction and would turn down a technical director job. Carol knows herself.

She has been specializing in being a generalist. Her level of influence on outcomes is high. She believes you don't need to be a manager to have influence, which she proves daily. She believes everyone has circles of influence. You don't need to know everything or be an expert; you just need to know who to go to.

No matter how seemingly different new experiences are, she builds on the experiences and the networks she has created in the past. She is a connector. There is no 'blank sheet of paper' approach to the future, but a thoughtful and strategic use of resources she has developed. Constantly thinking how she can adopt past experiences and personal networks to current situations, she taps into long-standing relationships to help her. She noted that it takes years to learn new processes and products. Each experience requires building a circle of influence and expertise. She sees her career as a series of overlapping circles of influence, with members of old circles coming into play again and again. It is fluid; it moves with time, it is a dynamic series of circles, constantly evolving, with old circles popping up at unpredictable times. She describes the use of previous circles of influence as follows: just because you have a square key and a round hole, you can 'mold' the key to fit. Old solutions can be modified to solve new problems. Build on what you have; you don't need to start from scratch.

Carol views the networks of people she has developed through past experiences as a series of overlapping 'circles' of influence into which she can tap. She was at first hesitant about being pulled into an international assignment. She loved diversity and culture differences, but it took her outside her comfort zone. She had always been told that she had 'issues' outside her comfort zone so, she thought, this would be a way to work on those issues. She found a way to challenge herself. She made her desire to continue in international work known to others and she fought for it. Carol knew why she was selected, saying 'I speak Chinese, I had a good track record and I had travelled there.' She also knew that many engineers do not want to travel, yet she did, so she sought opportunities that would set her apart. She has developed what she calls 'personal power'. She also knows herself well and does not want a formal management role, believing she is more effective exercising her personal power rather than exchanging it for position power.

These women's stories are just a few examples of women living out their passions, pursuing the careers that allow them to shine, feeling valued as an engineer, and demonstrating how they are taking charge of their lives, their dreams and their contributions. They have invested in

themselves and their organizations and are being model leaders for those young women around them, mentoring them and helping them to pursue their dreams as well.

Interview themes

Each person's story is unique, but several themes emerged from these interviews. These themes have been synthesized and show the following trends. These alumni have:

- Opened to a much more expanded sense of perspective; local, regional, national and global. They are seeing themselves as players at all levels.
- Become much more self aware and being able to view themselves as strong and effective leaders who know how to collaborate, mobilize resources and take action.
- Learned the skills to be authentic, real and collaborative as an effective leader.
- Developed a strong understanding of what and how to make effective change happen at a personal and organizational level.
- Understand that learning and leading go hand in hand; the journey to effective leadership is a lifetime learning and practice process.
- Built self confidence through a changed mindset, an intentional plan, and are stepping into courageous thinking, speaking and acting.
- A better understanding when one is engaged, in "flow", and working toward common goals as a group. The outcome is group resonance that is unstoppable and profound.
- Learned how to use a support group for one's advantage: a mentor, work colleagues, experts in the field, and personal supporters.

These themes are representative of the total population of graduates, both men and women; however, the females are more likely to point to increasing self-confidence and stepping into their own authentic voices.

Conclusions and Implications

It is clear to these authors that the leadership development program offered to these women in their graduate programs has made a significant difference. The women themselves have reported profound growth in their personal awareness, their emotional competence, their confidence in themselves and each other, as well as their newly found skills and techniques that are part of their daily leadership practice today. They have confronted their limiting beliefs, become aware of the biases that exist, and have begun to witness their own successes, learn from their mistakes, and are willing to take risks to keep pushing the envelope in their own learning agenda. They are on fire. Whether or not they have surpassed their male colleagues is not a relevant question, but they have realized they are accepted as talented contributors with their male peers, and have often been sought out to become a partner with the best of their male peers. Their male peers have grown as well in understanding a broader perspective that helps to make all thrive, grow, and learn. Both men and women live from their own authentic place and are not compromising themselves in their pursuits.

Outcomes of this program to date suggest that the investment in the development of these women has resulted in a strong ROI for their organizations. The leaders in these organizations

are quick to name the strides that have been demonstrated, have awarded many recognition for their contributions and are readily moving to promote several of these women to higher levels of leadership. The learners are poised for new challenges and they want to continue their learning and leading journeys, impacting and inspiring those around them.

This is what it takes to influence other young women to step up to their full potential. When women are suddenly recognized for their gifts and talents, other young women will be ready to join.

Recommendations for Industry and Educators

It is the authors' opinion that many creative opportunities exist for implementing something similar to what is reported here. These authors are prepared to help educational institutions think through a process that might be customized to serve their own clients. We are also prepared to help industry advocates design processes that not only support women, but work to change organizational perceptions and the environment that supports women. The possible creative designs might include some of the following:

- Initiate a development process that is customized and aligned with the needs and interests of those involved. Engage potential women participants in the design process.

- Incorporate a variety of experiential activities in the development process, including self assessment instruments, action learning projects, and reflective exercises that engage the participant in their own personal and professional plans.

- Launch a coaching/mentoring support process that will support the educational experience or the company environment.

- Incorporate the book written by these authors in the design process, using some of the many ideas and practices contained in the book.

- Work as partners with other resources within the organization that can support the development design, including counseling psychology experts, female leaders from other functions, and tested and proven exercises and practices from development designs in place for women in leadership.

- Involve some of the female role models within science and engineering to become champions of the design process, playing an intimate role in sharing their experiences, learnings, and philosophies for what it takes to demonstrate authentic leadership.

- Attend a workshop provided by these authors on "How to create your unique developmental experience."

The possibilities are many, and the need is great. The enormous technical challenges of this Century require that we attract and retain the best talent in S&E occupations. We need leadership

not only of the technical functions, but also of organizations in the private and public sector including education and government. There is no time to lose.

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