Increasing the Participation of Women in the Engineering and Technical Services Industries

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Abstract

Services have surpassed agriculture and manufacturing as the leading contributor to gross domestic product in the world today. As the global economy has become more integrated, and the demand for a workforce required to run service-focused organizations in an efficient manner grows, the level and variety of skills needed in this new service economy have also changed and grown. In particular, the growth rate of technology-driven service industries is significantly outpacing the growth in other service-oriented sectors. It has been argued that women in general possess many characteristics that make them optimal candidates to fulfill this workforce gap. However, the percentage of women enrolled in engineering, technology and related programs have been dropping. This paper attempts to create an awareness of the skills and job roles required for future labor workforce demands in the engineering and technology services industry and argues that these current and future roles makes them more appealing to women.

Keyword: STEM, Women in engineering, U.S. Education, IT services, Service industries.

1. Introduction

Services have surpassed agriculture and manufacturing as the leading contributor to gross domestic product in the world today. As the global economy has become more integrated, and the demand for a workforce required to run service-focused organizations in an efficient manner grows, the level and variety of skills needed in this new service economy have also changed and grown. Specifically; in regards to science, technology, engineering and math (STEM) fields, these changes have led to an increasing need for building "soft skills" in current and potential employees, essentially bridging the gap between technical and business skills. In one area of services, IT Services, there are thousands of jobs in the market that are left unfulfilled due to the lack of updated qualifications. There is a lack of awareness of this growing trend for current skills and available job roles, which needs to be addressed, especially by educational institutions. Of particular concern is the fact that female candidates, who constitute a significant portion of the potential work force, are not being utilized correctly. It has been argued that women in general possess many characteristics that make them optimal candidates to fulfill this workforce gap. However, the percentage of women enrolled in engineering, technology and related programs has continued to drop. Work performance traits that are generally viewed as feminine include

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relationship building, interpersonal communication, sensitivity, organization and the ability to anticipate. These skills are particularly well suited to the new, dynamic service industry where relationships between partners may become more important than quality of the product itself. This paper attempts to create an awareness of the skills and job roles required for future labor workforce demands in the engineering and technology services industry and argues that these current and future roles makes them more appealing to women.

2. Background

Today, for the first time in history, there are more people living in urban than rural areas[1-4], contributing to the significant increase in demand for services in the U.S., while agriculture and manufacturing are losing their shares. To meet this elevated demand, the number of service providers and hence the need for related research and work force development are also rising in the country. As with every industry, science, technology, engineering and math play an important role in the implementation and sustainability of service operations. However, career impediments based on gender, racial or ethnic bias deprive the nation of talented and accomplished researchers[5] and build barriers limiting the number of women entering the service businesses that require extensive science and technology background.

However, it is a well known fact that the future of workers in STEM positions will require a blended skilled employee. Having both technical and business related skills address the gap. A female candidate holding an STEM degree would be the most optimal candidate for companies such as IBM, for example.

This phenomenon is mainly caused by three reasons: (1) Influential organizations, including educational institutions, are not focusing on the growing importance of women enrollment in the technology-driven service industry and thus are not creating solution mechanisms to overcome this problem, (2) The gender gap in science participation in the United States is well documented[6] and it is shown that there is significant bias against female candidates, leading to a high attrition rate among women working in STEM fields, (3) There is lack of interest regarding STEM fields among female candidates.

The latter is mainly caused by the fact that the attributes required for success in technology-driven service related jobs are not clearly defined. Even though women tend to have a natural tendency toward improving society and making a difference in the world, they also tend to perceive science and technology related positions as positions that do not require team work, human interaction or personal communication skills[7]. Therefore, the majority of women avoid entering these fields through their careers. Today, successful women students mostly consider law, medicine and business as their future profession while giving less thought about engineering, technology or computing fields[8].

3. STEM Gender Gap

There are several reasons for the gender gap in STEM fields; even though institutional prejudice is more likely to play a contributing role in limiting the involvement of women in assumed masculine dominant areas. Educational or not, many organizations tend to favor men even though the basis of this decision is not statistically supported. Table 1 aims at listing major factors stereotyping some men and women traits and attempts to construct a scientific response to correct these misperceptions.

Table 1 Deconstructing Commonly Held Beliefs About Women in Science and Engineering[5, 7]

GIRLS/WOMEN	BOYS/MEN	RESPONSE
Identified with home (private)	Identified with work (public)	Many women scientists and engineers persist in their pursuit of academic careers despite severe conflicts between their roles as parents and as scientists and engineers. These efforts, however, are often not recognized as representing the high level of dedication to their careers they represent.
Unable to deal with difficulties	Able to deal with difficulties	The publication productivity of women science and engineering faculty has increased over the last 30 years and is now comparable to men's. The critical factor affecting publication productivity is access to institutional resources; marriage, children, and elder care responsibilities have minimal effects.
Collaborative	Competitive	Similar proportions of men and women science and engineering doctorates plan to enter postdoctoral study or academic employment.
Not very good at math	Good at math	Female performance in high school mathematics now matches that of males.
Ignorant of opportunities	[Aware of opportunities]	Although scientists like to believe that they "choose the best" based on objective criteria, decisions are influenced by factors—including biases about race, sex, geographic location of a university, and age—that have nothing to do with the quality of the person or work being evaluated.
Biologically governed (body)	[Able to escape biology] (mind)	On the average, women take time off due to childbearing responsibilities during their early careers. But, by middle age, a man is likely to take more sick leave than a woman.

Source: Adopted from Phipps (2007) and National Academies Press (2006).

Literature indicates that today the problem is hardly caused by the number of female students in engineering programs. Despite the fact that previous research points to most girls reporting a loss of interest in STEM around the age of twelve [9], there are now many studies reporting cases[10] where women enrollment is much higher than men in engineering societies. The collaborative environment of the activities arranged by these societies may be a contributing factor in the change.

Historically, about one-third of all bachelor's degrees have been awarded in science and engineering. Even though women are 56% of the college population, women earned only 19.5% of engineering bachelor's degrees in 2005[11]. Despite this high retention rate, in the long run we observe an increasing trend: Since 1970, the number of bachelor's degrees in science and engineering (S&E) awarded annually to men has fluctuated around 200,000, while the number of S&E bachelor's degrees earned by women has steadily increased, reaching parity (Figure 1) in 2000[12, 13].

Today, international data (EUROSTAT, 2004) suggest that women now constitute over 20 per cent of the student body in engineering and science subjects across Europe and in the industrialized world[14].

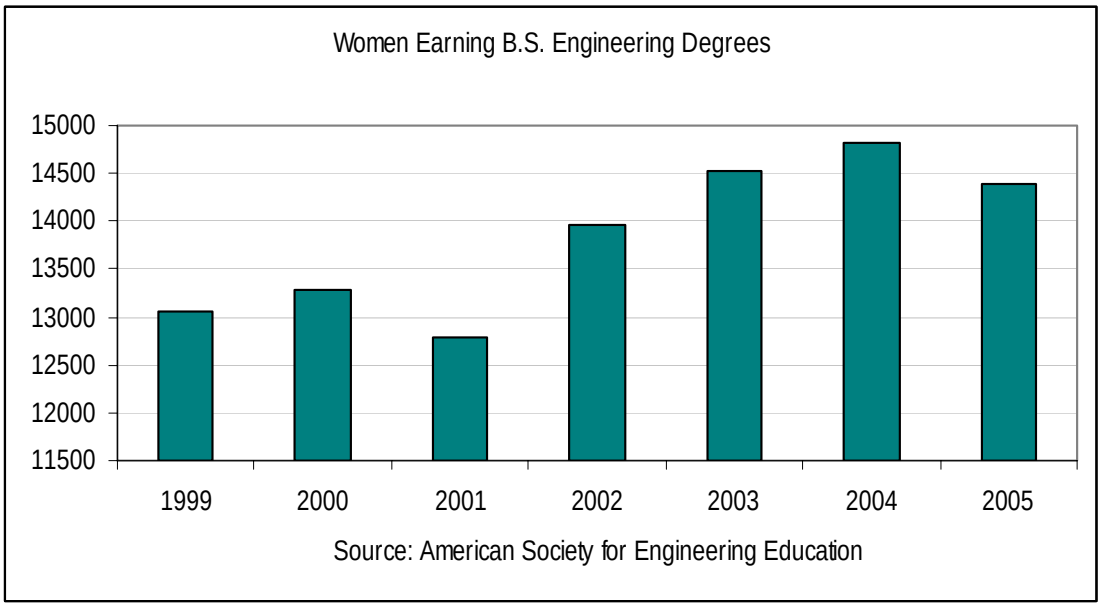

Figure 1: Women Earning B.S. Engineering Degrees[15]

4. Education – Industry Skills Gap

In addition to the bias, there is also a gap between the needs of industry and the skills that the engineering students acquire during their studies. Table 2 depicts engineering as the field that has the majority of graduates entering post-doc studies due to lack of employment opportunities compared to other disciplines. Restructuring of the curricula, infusing today's market needs into academia and producing qualified candidates can provide efficient solutions to this problem.

Table 2: Primary reason for taking current postdoc, by field: 2003[16]

Doctorate field	Additional training in doctorate field	Training outside doctorate field	Postdoc generally expected in field	Association with particular person or place	Other employment not available	Other
All S&E fields	21.8	14.2	30.7	18.1	11.6	3.5
Biological sciences	19.1	15.1	37.2	17.4	8.2	3.0
Chemistry	21.9	26.9	21.8	16.7	10.9	1.9
Engineering	26.3	12.9	18.4	8.2	31.2	3.0
Geoscience	12.9	15.5	12.5	25.3	29.1	4.7
Physics	22.1	12.1	36.0	21.5	2.0	6.3
Psychology	29.1	8.9	24.0	23.1	10.7	4.2

It is estimated that approximately 70 million baby boomers will exit the workforce during the next 15 years, with only 40 million new workers joining the workforce[17]. Table 3 shows the number of openings in the U.S. market for various IT Service related positions. The data were obtained by an independent search using hotjob.com, performed on April 24th 2007.

Table 3: Current IT Related Openings in the U.S.

Keyword	Number of Openings
Incident management	1,565
Database administrator	2,103
IT architect	4,260
Solution architect	5,220
Programmer	5,336
Computer operations	18,940
Problem management	39,157
IT service management	39,090
Systems management	73,300

Source: Paul Kontogiorgis, 2007.

The U.S. National Academies Committee on Maximizing the Potential of Women in Academic Science and Engineering[5] summarized their finding as follows:

1. Women have the ability and drive to succeed in science and engineering.
2. Women who are interested in science and engineering careers are lost at every educational transition.
3. The problem is not simply the pipeline.
4. Women are very likely to face discrimination in every field of science and engineering.
5. A substantial body of evidence establishes that most people—men and women—hold implicit biases.
6. Evaluation criteria contain arbitrary and subjective components that disadvantage women.
7. Academic organizational structures and rules contribute significantly to the under use of women in academic science and engineering.
8. The consequences of not acting will be detrimental to the nation's competitiveness

Wage discrimination is also another important factor why women tend to avoid entering STEM fields. Table 4 depicts the median annual salary of individuals employed in S&E occupations.

Table 4: Median annual salary of individuals employed in S&E occupations: Selected years, 1993–2003 (Dollars)[16]

Sex/race/ethnicity	1993	1995	1997	1999	2003
S&E employed	48,000	50,000	55,000	60,000	66,000
Male	50,000	52,000	58,000	64,000	70,000
Female	40,000	42,000	47,000	50,000	53,000

6. Conclusions

As the data presented demonstrate, there is a gap between the number of women entering STEM fields and the potential number who could be contributing in these areas. The types of skill sets needed have changed along with changes in the economy to focus more heavily on skills that women more typically possess such as organization, communication, and flexibility. There are a number of things that can be done to attract women to the field, and, more importantly, to get them to stay in the field. Several of these are discussed below.

As stated by the Committee on Maximizing the Potential of Women in Academic Science and Engineering, the National Academy of Sciences, the National Academy of Engineering and the Institute of Medicine[5]; increasing and sustaining women enrollment in STEM can only be possible by a collaborative effort rather than independent individual institutional projects. In this regard, university

leaders, such as university presidents, provosts, deans, department chairs, faculties and their senates should develop and implement regulations to promote women in engineering, technology and computing.

Professional societies and higher education organizations should develop and enforce guidelines to ensure that keynote and other invited speakers at society-sponsored events reflect the diverse membership of the society[5].

Industry also has a responsibility to accelerate readiness of the female workforce, which will help alleviate skills availability issues, and bridge the communication gap between IT functional jobs and business leaders' vision with academic institutions.

Honorary societies, funding agencies - including federal agencies and foundations, along with the congress, should take the necessary steps to encourage adequate enforcement of female workforce development.

Women are well positioned to make major advances in interdisciplinary research. They like to integrate across various academic fields and use multi-pronged, multi-disciplinary approaches. They work well in teams and are committed to connecting their research with societal concerns. Using interdisciplinarity to attract women, as well as other underrepresented minority groups into science, is only practical and ethical if it leads to stable and secure pathways through scientific and academic careers[18].

Additional research on the impact of media sources on girls' science self-concept is needed to develop effective interventions for encouraging girls, not only to see other women as scientists and engineers, but also to see themselves as future scientists and engineers[19].There is also no doubt that family-friendly policies help women to combine paid jobs with family work[20].

Even if evaluators feel that interpersonal skills are as important as technical skills, the recall for and actual weight given to technical skills (or other masculine-typed attributes) may be greater[21].

Women tend to quit their jobs due to male-dominant cultures[22]. This fact is also true for women working in the technology sector. For example, beyond interest in attracting women and girls to IT as a career option, the retention of women who are in the IT field is also of concern because women are more likely to leave IT professions[21].

As Carly Fiorina, the former CEO of Hewlett Packard stated, the ability to collaborate with others, the ability to communicate clearly, and the ability to see the forest and not get lost in the trees are skills that many women posses[23]. Unless these characteristics are perceived as attributes characterizing top performers, there will be a continuing bias against women in male-dominated businesses.

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Biographical Information

Dr. Elif Kongar received her BS degree from the Industrial Engineering Department of Yildiz Technical University, Istanbul, Turkey, in June 1995. In June 1997, she received her MS degree in Industrial Engineering from the same university where, she was awarded full scholarship for graduate studies in the USA. She obtained her Ph.D. degree in June 2003. She has been a research associate in the Laboratory for Responsible Manufacturing (LRM) at Northeastern University since September 1999. She has also been employed as an Assistant Professor by Yildiz Technical University till February 2006. Dr. Kongar is currently an Assistant Professor at Bridgeport University. Her research interests include the areas of supply chain management, logistics, environmentally conscious manufacturing, product recovery, disassembly systems, production planning and scheduling and multiple criteria decision making.

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