

## Women in Information Technology

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*There is a major concern about the drop of young women entering Computer Science degree programs and a drop in the participation of women in these information technology occupations. In all levels of educational institutions across the nation, girls and women remain under-represented in computer and information science studies and subsequently, the technological workforce. Serious consequences occur not only to women's overall potential, which is not fully realized, but also to the world's economy. This literature review focuses on women in information technology by addressing the shortage of women in information technology (IT), the theoretical perspectives of women in IT, barriers to women in IT, and strategies for recruiting and retaining women in the IT workforce.*

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The U.S. Department of Commerce projects that by 2006, not only will 50 percent of all U.S. workers be women, but also 44 percent of the U.S. workforce will be employed by industries that are engaged in producing or using information technology products and services (Newton, 2001). Information technology accounted for more than a third of the nation's real economic growth from 1995 to 1997 (U.S. Department of Commerce, 1999). The U.S. Bureau of Labor Statistics reports that approximately 137,800 new jobs in information technology (IT) occupations have been and will be produced each year from 1996 to 2006 (U.S. Department of Commerce, 1999). In addition, these occupations are experiencing a significant labor market shortage, while at the same time not attracting female participants at the same rate as in earlier decades (Camp, 1997). Female participation in the IT occupations has varied up to a high of approximately 35% in the early 1990s. From 1990 to 1999 the number of people in IT occupations have more than doubled and the female participation has dropped to approximately 27% (Information Technology Forum, 1999). This decline in female participation has caused concern, not only because of the low participation of women in IT occupations, but because there is a significant labor shortage in those occupations and the drop in participation of women further exacerbates the labor shortage (Freeman & Aspray, 1999; Information Technology Forum, 1999).

Information technology-related occupations include many different types of jobs – from data entry and computer operators to systems analysts to computer scientists. There is no generic IT job or IT worker. In the broadest sense, one could dispute that as the economy becomes more digitized, most of our jobs will involve the manufacture, operation, or use of equipment containing a computer chip; hence, all jobs will be IT jobs (Cooke, 2000). However, according to the U.S. Bureau of Labor Statistics (2003) the “core” IT occupations include: computer scientists, computer engineers, systems analysts and computer programmers. Workers in IT occupations design, manufacture, operate, repair, and maintain the IT infrastructure. The job options in the information technology field can be numerous and can lead to different levels of career growth.

Although women currently represent 47% of the total workforce, they comprise only 20% of the technology sector workforce (Catalyst, 2000; U.S. Bureau of Labor Statistics, 2003). At present women make up 30% of computer scientists, 32 % of computer analysts, 25% of computer programmers, 10% of IT directors, and 18 % of IT project leaders (U.S. Bureau of Labor Statistics, 2003). Women have entered the labor market in increasing numbers during the last few decades. Despite impressive gains in employment, women are still under-represented in the IT field. The world of IT is still dominated by men, and the imbalance becomes more striking at the higher rungs of the corporate ladder (Catalyst, 2000). Obstacles and gender differences have created a gender gap that is responsible for the narrowing pipeline of women in IT careers. The shortage of women in IT fields has made it more difficult for them to obtain management positions (Leever, Dunigan, & Turner, 2002). Women hold only 8.1% of executive positions (VP and higher) at major technology companies. One of the reasons for the scarcity of women executives at technology firms is simply that there are fewer women in the technology-management pipeline (Catalyst, 2000).

Recently there has emerged a concern about the drop of young women entering Computer Science degree programs and a drop in the participation of women in these occupations (Camp, 1997). In all levels of educational institutions across the nation, girls and women remain under-represented in computer and information science

studies and subsequently, the technological workforce (Balcita, Carver, Soffa, 2002). There are serious problems in attracting girls to engineering and computer-related fields and keeping them in the IT employment pipeline (Farmer, 1997). A limited number of studies and observations have been done to determine the cause of why women are deterred from continuing in the computer science pipeline (Farmer, 1997; Margolis & Fisher, 2002; Roberts, Kassianidou, & Irani, 2002). The American Association of University Women (1992) reported that even girls with high aptitude for math and science are less likely to pursue studies in science and technology than their male counterparts. Most women drop out of the engineering/computing pipeline when choosing an undergraduate degree. A 1995 report from the Office of Technology Assessment showed that out of a group of 2,000 students, 280 males and 220 females would have completed the necessary math and science courses to pursue a degree in computer science after high school. However, only 16% of the qualified females chose a degree in computer science, while 50% of the qualified males selected a career in computer science (Levenson & Klawe, 1995). Since the number of women at the bachelor's level affects the number of women at levels higher in the pipeline and in the job market, these facts are of great concern (Camp, 1997).

This literature review brings about a better understanding of women in information technology by focusing on the shortage of women in information technology (IT), the theoretical perspectives of women in IT, barriers to women in IT, and strategies for recruiting and retaining women in the IT workforce.

### **The Shortage of Women in Information Technology**

The sweep of digital technologies and the transformation to a knowledge-based economy have created robust demand for workers highly skilled in the use of information technology. In the past ten years alone, employment in the U.S. computer and software industries has almost tripled. The demand for workers who can create, apply and use information technology goes beyond these industries, cutting across manufacturing and services, transportation, health care, education and government (Office of Technology Policy, 1997). Having led the world into the Information Age, there is substantial evidence that the United States is having trouble keeping up with the demand for new information technology workers (Office of Technology Policy, 1997). A recent survey of mid- and large-size U.S. companies by the Information Technology Association of America (ITAA) (2003) concluded that there are about 190,000 unfilled IT jobs in the United States today due to a shortage of qualified workers. In another study conducted by Coopers and Lybrand (1996), nearly half the CEOs of America's fastest growing companies reported that they had inadequate numbers of information technology workers to staff their operations.

Evidence suggests that job growth in IT fields now exceeds the production of talent. Between 1994 and 2005, more than a million new computer scientists and engineers, systems analysts, and computer programmers will be required in the United States—an average of 95,000 per year (Office of Technology Policy, 1997). Serious consequences occur not only to women's overall potential, which is not fully realized, but also to the world's economy that might have been shaped differently with more involvement from women in the area of technology. The consequences for the U.S. economy are significant (Halweg, 2002). The shortage of technology workers may cost as much as four billion dollars per year in lost production for the United States (*Valuing Diversity*, 2002). "If we continue to utilize the talents of American women – virtually half the population – at the level we are now, we will not have the workers we need in this country" (n.p.), says Arthur Bienenstock, associate director of science in the White House Office of Science and Technology Policy (Gaudin, 1999).

Unprecedented opportunity exists for IT professionals around the world; the field is experiencing a skills crisis that stems from the shortage of qualified IT professionals. This skills crisis is due, in part, to the fact that certain segments of the population are under-represented in IT. Among those under-represented are women. Despite significant growth in the IT profession in recent years, there remains a gender imbalance. The pipeline shrinkage problem for women in computer science is a well known and documented phenomenon where the ratio of women to men involved in computing shrinks dramatically from early student years to working years (Bryant & Irwin, 2001; Camp, Miller, & Davies, 1999; Camp, 2001; Camp, 2002; Davies & Camp, 2000; Freeman & Aspray, 1999; National Science Foundation, 2001; Thom, 2001). According to the Department of Commerce, only 1.1 percent of undergraduate women choose IT-related disciplines as compared to 3.3 percent of male undergraduates (Freeman & Aspray, 1999).

One of the most obvious patterns is that the percentage of women entering the computer science pipeline and earning the bachelor's degree in these IT fields has been dropping steadily since 1984. While the number of computer and information science degrees awarded decreased every year between 1986 and 1994, the decrease is occurring at a faster rate proportionately for women (Freeman & Aspray, 1999). This is in contrast to general trends in the graduation figures of U.S. colleges and universities during these same years, when the percentage of bachelor's degree recipients who were women increased from 50.8 percent to 54.6 percent. It is also in contrast to

the trends in scientific and engineering disciplines generally. The decrease in bachelor's degrees awarded to women has also affected the number of women in the graduate degree pipeline, contributing to the decrease in women completing a master's degree in the computer and information sciences area. The percentages at the doctoral level have stayed somewhat flat, with a reduction in the number of U.S. women apparently offset by an increase in the number of female foreign students entering the system at the graduate level (Freeman & Aspray, 1999).

Research on the career development of women managers in general has referred to the existence of a "glass ceiling" or invisible barrier, which restricts advancement of women to top executive positions (Igbaria & Wormley, 1992). According to the federal government Glass Ceiling Commission (1995), whose mission is to identify barriers to the employment and advancement of women and minorities and encourage companies to build a diverse workforce, fewer than 5% of women are in senior-level management positions. The literature indicates that such a barrier also exists in the IT field (Camp, 1997; Laberis, 1992). If women do decide to pursue management positions in the IT workforce, a glass ceiling exists and they do not have an equal chance to reach these management positions (Leever, Dunigan, & Turner, 2002). Several authors have suggested that proportional presence of women in higher ranks where decision-making takes place will go a long way toward making the workplace conducive to women's needs, however, women in IT fields are concentrated at the lower and middle levels and are under-represented at the higher levels (Camp, 1997). As of 1997, only 2% of women in IT reached the executive status (Igbaria, 1997).

In one of very few research studies that have focused on women in IT careers, Truman and Baroudi (1994) concluded that the IT field may not be immune to the problems of gender discrimination. They found that women received lower salaries than men even when job level, age, education, and work experience were controlled. They also observed that there were a disproportionately high number of men in the managerial ranks. Furthermore, Igbaria and Baroudi (1995) investigated the impact of gender on job performance evaluations, job performance attributions and career advancement prospects. Although they did not find any significant differences in job performance ratings, they did find that women are perceived to have less favorable chances for promotion than men. Igbaria and Baroudi (1995) request for further research in this area and stated: "future research should explore the potential barriers to promotability among women who have aspirations to IT upper management and executive careers. We need to look at the reasons for the existence of the barriers and possible ways to overcome them" (p. 117).

The increased shortage of women in IT is not confined within the borders of the United States. Other studies, including work by the Stanford Computer Industry Project, document that there is a worldwide shortage of IT workers (Office of Technology Policy, 1997). Recent international studies indicate that in the next four years, women will continue to be massively under-represented in the networking field, despite a major shortage of skilled engineers in Europe that threatens to hamper the industry (Freeman & Aspray, 1999; Mayfield, 2002). At the end of 2001, only 5.6 percent of engineers in Western Europe were female and that number is projected to increase to 7.3 percent by 2004, reaching almost 94,000, and that is only a fraction of the number of people working in the industry, according to a report by International Data Corporation (IDC) for Cisco Systems (CSCO). By the end of 2002, there was a shortfall of approximately 80,000 skilled IT staff, according to IDC. Industries in other countries are facing similar problems, exacerbating the U.S. problem, since the geographic location of such workers is of decreasing importance to the conduct of the work (Office of Technology Policy, 1997). U.S. employers will face tough competition from employers around the world in a tight global IT labor pool. Thus, the United States cannot expect to meet its long-term needs through increased immigration or foreign outsourcing. Instead, the U.S. must rely on retaining and updating the skills of today's IT workers as well as educating and training new ones. More than ever before, women have a critical place in replenishing the shortage of IT workers.

### **Theoretical Perspectives of Women in Information Technology**

According to the National Science Foundation, there is agreement among researchers and scientists that systematic research efforts are needed to address the gender imbalance and under representation of women in IT (National Science Foundation, 2001). There is a documented need to study the gender imbalance in this field, this topic is both under-studied and under-theorized (Trauth, 2002). It is under-studied in so far as there have been minimal published papers in top IT journals on this topic. It is under-theorized in two ways. First, gender is seldom considered a relevant factor in socio-technical studies of IT in context (Wajcman, 2000). Second, gender and IT is under-theorized in so far as most of the published work focuses on data analysis rather than theoretical implications that relate to the existing body of gender, and gender and IT literature (Adam, Howcroft, & Richardson, 2001).

There are two dominant theoretical perspectives that are used to explain the engagement of women in information technology – essentialism and social construction. They offer insights on the issue of the under representation of women in the IT profession. Two dominant viewpoints are reflected in recent literature about

gender and IT. From these perspectives we can develop explanations regarding the participation of women in the IT profession. The essentialist perspective focuses on the presumption of inherent differences between women and men to explain the perception of IT as a male domain. The social construction perspective focuses on the social construction of IT as a male domain, which is interpreted as problematic with respect to the social construction of female identity.

#### *The Essentialist Perspective*

Essentialism is the assertion of fixed, unified and opposed female and male natures (Wajcman, 2000). When applied to the IT realm, this viewpoint focuses on inherent differences between men and women to explain the differences in their relationships to IT (and, by inference, the participation of women in the IT profession). In doing so, it reflects an essentialist perspective that observed differences in men and women's behavior are attributable to inherent, group-level differences that are based upon bio-psychological characteristics (Trauth, 2002). The essentialist perspective has spawned research that views gender as a fixed variable that can be manipulated within a positivist epistemology. An example from the recent IT literature is the work of Venkatesh and Morris (2000) and Venkatesh, Morris, and Ackerman (2000). This research includes gender as a variable in the application of the technology acceptance model (TAM) to understand differences in individual adoption and sustained usage of technology in the workplace. Their findings lead them to suggest that men, as a group, make decisions about using technology based upon different criteria than women, as a group. They conclude that men are influenced by the usefulness of the IT whereas women are influenced by social factors.

Several researchers have employed the psychological literature on gender to guide their interpretations of the empirical data on the adoption and use of IT by the women in their studies (Adam et al., 2001; Tashakkori, 1993; Venkatesh & Morris, 2000; Williams & Best, 1990). Venkatesh and Morris (2000) drew upon a statewide attitudinal survey of California high school students conducted in 1982-1983, to support their conclusion that "women typically display lower computer aptitude...than men" (p. 119). Adam et al. (2001) provided an analysis of this perspective in their critique of research on gender and IT. They noted the perils of ignoring existing gender and technology literature, particularly recent literature in this area. They went on to argue that, "focusing on a background literature of psychology places too much emphasis on individual gender characteristics where a form of 'essentialism' may creep in." They believe that it looks only to psychological explanations of observations without giving attention to the influence of context. They point out that this perspective adopts a determinist stance with respect to gender.

#### *The Social Construction Perspective*

An alternative explanation for women's relationship to information technology (and, by inference, their participation in the IT profession) can be found in societal rather than biological forces. The literatures of gender and technology in general (for example, Cockburn, 1983; Cockburn & Ormrod, 1993; Wajcman, 2000), and that of gender and information technology, in particular (for example, Adam et al., 2001; Balka & Smith, 2000; Spender, 1995; Star, 1995; Webster, 1996) look to social construction theory (Berger & Luckmann, 1966) rather than biological and psychological theories. According to this view, the social shaping of information technology as masculine interacts with the social construction of femininity in such a way as to place IT outside the domain of women. The inference that can be drawn from this perspective about addressing the level of female participation in the IT profession is that the explanation lies in the social construction of the IT profession as "men's work" (Trauth, 2002, p. 101).

Von Hellens et al. (2001) focused on women who address their "odd girl out" status by developing coping strategies in their attempt to fit into this male domain. However, another school of thought within the social constructivist perspective focuses on the need to reconstruct the world of computing to become more of a "female domain." Webster (1996) is representative of this approach. Her focus is on the social shaping of female gender identity and the implication for women's relationship to workplace technologies. At the heart of the issue, she believes, exist structural inequalities between men and women in work and in their relationships to technology. Spender (1995) analyzed the role of women as a social group in cyberspace with the goal of increasing the number of women who employ the Internet. Her argument was that what will follow from increased female presence will be the influx of female values into this new virtual world. She concluded that the same would happen as more women enter the IT profession.

While the timing for increasing women's participation in information technology fields appears propitious, current literature indicates that the supply of women in IT is alarmingly low. Although there are theories as to why women are under-represented in IT, there are no definitive answers to the problem. Women have made significant strides in several fields—notably in the natural science, however, their participation in engineering, mathematics, and information technology remains persistently low (Fountain, 2000). Based on the unanticipated and strong

societal impact women have had on other disciplines, it seems reasonable to hypothesize that stronger representation of women in IT will have deep influence on technology outcomes and processes (Fountain, 2000).

### **Barriers to Women in Information Technology**

Under-representation of women in the IT workforce cannot be isolated to a single factor or barrier. Factors such as gender bias, lack of role models and mentors, perceptions, stereotyping, difficulty with work/life balance, and lack of corporate commitment all contribute to the under-representation of women in IT (Carver, 2000). These barriers are briefly described below.

Gender bias exists in the workplace for many women who are pursuing careers in IT. A male is more likely to be chosen for a position in a company when competing against an equally qualified female (Panteli, Stack, & Ramsay, 1999). Once in the workforce, many qualified women are assigned to menial tasks such as checking monitors and information retrieval, while men are left to perform the more choice and challenging assignments. Many women in IT also report that they have supervisors assigned to check their work, but men performing similar tasks are left alone to their own discretion. Harassment is also prevalent as women are still often viewed as inferior to men. In 1996, there were more than 15,000 gender bias or harassment suits throughout workplaces across the United States (Leever, Dunigan, & Turner, 2002).

Under-representation of women in IT leads to the inevitable “vicious cycle” or fewer professional role models and mentors for those who wish to enter the IT profession. Therefore, women may tend to view the IT profession as lonely and isolated or may find assimilation into mainstream networks of companies difficult due, in part, to a lack of common interests or a sense of just not belonging (ITAA, 2003). Frequently when women in IT look for support and mentoring through role models and social networks, they come up empty handed. Without the encouragement and guidance of role models and mentors, women in IT are left searching for support and are at a disadvantage (Balcita, Carver, & Soffa, 2002).

Much of the research on recruiting women into IT suggests that perception of the field of IT as unappealing (American Association of University Women (AAUW), 2000; Camp, 2001; Margolis & Fisher, 2002; Halweg, 2002). In a study conducted by the AAUW (2000), girls and young women reported technology-related careers unappealing because they were associated with jobs that were solitary, passive, and sedentary. The unattractive perception of information technology professionals in our culture continues to foster an image of a solitary and antisocial profession, dominated primarily by white males (Camp, 2001). The image of IT as a masculine industry may be causing women to reject IT as a viable career choice (AAUW, 2000).

In addition, to the image challenges that face the IT field, there are also limiting stereotypes that may affect the hiring and promotion of women. Among the negative stereotypes is the belief that women are not proficient in math, technology, and science, consequently this impedes the career progress of women in the IT field (Margolis & Fisher, 2002). Society regards males and females differently and has stereotyped associated traits such as assertiveness, confidence and achievement with men and not women. Employers seeking to fill positions in IT have placed value on masculine traits when seeking to fill positions in IT (Leever, Dunigan, & Turner, 2002).

The IT environment consists of long, irregular work hours as well as fair amounts of volatility. Women with spouses and/or children struggle to keep up with the fast-paced work environment as studies have shown that, unlike, men, they remain primarily responsible for family and home care (Powell, 1999). Long hours and heavy workload are not ideal conditions for women interested in combining work and family. Women constrained by their roles as working mothers may be disadvantaged in the IT work environment and unable to perform to expected time commitments.

Lack of corporate commitment remains a concern in the IT field. Companies lack consistent and proactive approaches to attracting, retaining, and promoting qualified women in IT (ITAA, 2003). Unfortunately, if women do decide to pursue positions in the IT workforce, a glass ceiling still exists (Camp, 1997; Laberis, 1992). Not only do women’s salaries trail those of their male counterparts, most of them do not reach management positions. As of 1997, women in IT only made 83 cents for every dollar that men earned and only 2 percent of women reached executive level positions (Igbaria & Wormley, 1992).

### **Strategies for Recruiting and Retaining Women in the Information Technology Workforce**

Changes in workplace culture are needed to remove the barriers that hinder women in information technology occupations. Bringing about organizational change effectively may be one of the most critical challenges facing organizations today (Kossek & Lobel, 1996; Norton & Fox, 1997). The under-representation of women in IT and those who manage to enter IT, but who are persistently excluded from the top level positions does little to change

the image of the IT culture. Due to the current skill shortage that the IT industry is facing along with the diversification of the IT occupations, there are excellent opportunities for women to enter the IT sector. However, if organizations want to attract and retain talented women into their IT workforce, they must do their part to develop and implement initiatives that will help women overcome the barriers to success that they encounter.

Mentors and role models are of vital importance to women's advancement in IT. However, women in IT may find it difficult to find mentors through the same informal mechanisms used by men, especially since individuals tend to mentor people who are very much like them and the IT field is predominantly male (Camp, 2001). A study conducted by (Catalyst, 1993) revealed that involvement in a mentor relationship alleviate the stress felt by many professional women by increasing their self-confidence and reducing their sense of isolation and powerlessness in a male-dominated company. Because having a mentor is critical to advancing in IT, especially to management positions, organizational leaders need to create formal mentoring programs that provide structure and help maximize opportunities for all employees, especially women who may otherwise have trouble obtaining a mentor (Ensher & Murphy, 1997).

Women in IT who progress in their careers may be impeded by their having to prove their technical credibility again and again. This may be the result of stereotyping of women's abilities as well as the perception that promoting women is riskier than promoting men. The perception that the competencies and traits associated with success in IT are male attributes is also prevalent (Mendoza & Johnson, 2000). Changing these perceptions requires long-term vision and is a challenging task, which needs to be implemented gradually with joint efforts from individuals from all levels of the organization (Catalyst, 2001). It necessitates a social and ethical responsibility for these individuals to work together to address these issues that have contributed to forming a male-dominated IT work environment. The change must come from well-established organizational policies and initiatives that encourage and support the recruiting, hiring, retention, and advancement of women in IT (Lever, Dunigan, & Turner, 2002).

Issues of work and family balance are also of paramount concern to women in the workforce. Therefore, organizational policies and benefits such as extended parental leaves, part-time work options, on-site child care facilities, and greater scheduling flexibility are needed. Access to quality, reliable, affordable child care is key to the retention of working women with children (Mendoza & Johnson, 2000). Policies and practices that help women overcome the difficult obstacles to success have a positive impact on the career development of women in IT over the long term (Catalyst, 2001).

Furthermore, rapid changes in technology demand new skills and render existing skills obsolete. Continuous training and development are vital in the IT industry. One way that human resource development (HRD) professional's can help women in IT achieve is to ensure that training and career development programs are more accessible to them and more adaptable to their needs. For example, training and development programs should be comprehensive enough to incorporate the needs of women employees with family responsibilities. Therefore, they should provide training opportunities for women returning from maternity leave, as well as women who work on a part-time or flexi-time schedule or telecommute (Panteli, Stack, Ramsay, 1999). Technological advancements open up new opportunities to HRD professionals for innovation in their training programs. For example, HRD professionals could provide online training to women who work remotely or from home. As IT is becoming one of the growing job markets, organizations needs to accommodate more effectively women in the workforce by rethinking career development and training programs, and thus building a healthier and more supportive work environment for women (Panteli, Stack, Ramsay, 1999).

Women must overcome the stereotypes presented by society as well as the conceptual role of women as a result of socialization. These obstacles and gender differences have created a gender gap that is responsible for the narrowing pipeline of women in IT careers. The shortage of women in IT fields has made it more difficult for them to obtain management positions. In order to reverse the diminishing number of women in the IT fields, a combination of organizational strategies and changes in perception are required. If these barriers are removed, it is likely that more women will consider careers in the fast-growing and lucrative field of information technology.

## References

- Adam, A., Howcroft, D., & Richardson, H. (2001). Absent friends? The gender dimension in IS research. In N. L. Russo, B. Fitzgerald, & J. L. DeGross (Eds.), *Realigning research and practice in information systems development: The social and organizational perspective*. Kluwer Academic Publishers: Boston, MA.
- American Association of University Women. (1992). *The AAUW report: How schools shortchange girls*. Washington, DC: AAUW Educational Foundation.

- American Association of University Women. (2000). *Tech-savvy: Educating girls in the new computer age*. <http://www.aauw.org/2000/tech/>.
- Balcita, A., Carver, D., & Soffa, M. (2002). Shortchanging the future of information technology: The untapped resource. *SIGCSE Bulletin*, 34(2), 32-35.
- Balka, E., & Smith, R. (Eds.) (2000). *Women, work and computerization: Chartering a course to the future*. Kluwer Academic Publishers: Boston, MA.
- Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. Doubleday: New York, NY.
- Bryant, R. E., & Irwin, M. J. (2001). 1999-2000 taulbee survey: Current and future PhD output will not satisfy demand for faculty. *Computing Research News*, 5-11.
- Camp, T. (1997). The incredible shrinking pipeline. *Communications of the ACM*, 40(10), 103-110.
- Camp, T. (2000). *Technology/circuits*. Retrieved May 4, 2003, from <http://www.nytimes.com/library/tech/00/07/circuits/articles/27wome.html>
- Camp, T. (2001). Women in computer science: Reversing the trend. *Syllabus Magazine*. Retrieved March 14, 2002 from <http://www.syllabus.com/syllabusmagazine/magazine.asp?month=8&year=2001>
- Camp, T., Miller, K., & Davies, V. (1999). *The incredible shrinking pipeline unlikely to reverse*. Retrieved March 14, 2002 from [http://www.mines.edu/fs\\_home/tcamp/new-study/new-study.html](http://www.mines.edu/fs_home/tcamp/new-study/new-study.html)
- Catalyst. (1993). *Mentoring: A guide to corporate programs and practices*. New York: Author.
- Catalyst. (2000). *MBA graduates in information technology*. New York: Author.
- Catalyst. (2001). *Leadership careers in high tech: Wired for success*. New York: Author.
- Carver, D. (2000). *Research foundations for improving the representation of women in the information technology workforce*. Retrieved May, 2003, from: <http://nsf.gov/search97cgi/vtopic>
- Cockburn, C. (1983). *Brothers: Male dominance and technological change*. Pluto Press: London.
- Cockburn, C., & Ormrod, S. (1993). *Gender and technology in the making*. Sage: London.
- Cooke, S. D. (2000). *The information technology workforce*. Retrieved May 2, 2003, from [http://www.cisp.org/imp/april\\_2000/cooke/04\\_00cooke.htm](http://www.cisp.org/imp/april_2000/cooke/04_00cooke.htm)
- Davies, V., & Camp, T. (2000). Where have women gone and will they be returning? *The CPSR Newsletter*, 18(1). Retrieved March 14, 2002 from <http://www.cpsr.org/publications/newsletters/issues/2000/Winter2000/index.html>
- Ensher, E. A., & Murphy, S. E. (1997). Effects of race, gender, perceived similarity, and contact on mentor relationships. *Journal of Vocational Behavior*, 50(3), 460-481.
- Farmer, S. (1997). *Diversity & women's career development*. Thousand Oaks, CA: Sage Publications.
- Fountain, J. E. (2000). Constructing the information society: Women, information technology, and design. *Technology in Society*, 22(1), 45-62.
- Freeman, P., & Aspray, W. (1999). The supply of information technology workers in the United States. *Computing Research Association Report*. Retrieved March 14, 2002, from <http://www.cra.org/reports/wits/cra.wits.html>
- Gaudin, S. (1999). *The critical shortage of women in IT*. Retrieved June 2, 2003, from <http://www.nwfusion.com/news/1999/1122women.html>
- Glass Ceiling Commission. (1995). *Good for business: Making full use of the nation's human capital*. Washington, DC: Author.
- Halweg, E. (2002). *Gender strategies in recruiting and retaining women in information technology*. Retrieved January 18, 2003, from the WorldCat database.
- Igbaria, M. (1997). Status report on women and men in the IT workplace. *Information Systems Management*, 14, 44-53.
- Igbaria, M., & Baroudi, J. (1995). The impact of job performance evaluations on career advancement prospects: An examination of gender differences in the IS workplace. *MIS Quarterly*, 19, 107-123.
- Igbaria, M., & Wormley, W. (1992). Race effects on organizational experiences and career success among MIS managers and professionals. *MIS Quarterly*, 16(4), 507-529.
- Information Technology Association of America (ITAA). (2003). *Report of the ITAA blue ribbon panel on IT diversity*. Arlington, VA.
- Information Technology Forum. (1999). *Women and minorities in information technology*. Hampton, VA.
- Kossek, E. E., & Lobel, S. A. (1996). *Managing diversity: Human resource strategies for transforming the workplace*. Cambridge, MA: Blackwell Publishers Inc.
- Laberis, B. (1992). Barrier breaker: Katherine Hudson. *Computerworld*, 20-22.

- Leever, S., Dunigan, M., & Turner, M. (2002). The power to change is in our hands. *The Journal of Computing in Small Colleges*, 18(2), 169-179.
- Levenson, N., & Klawe, M. (1995). Women in computing: Where are we now? *Communications of the ACM*, 38(1), 29-30.
- Margolis, J., & Fisher, A. (2002). Unlocking the clubhouse: *Women in computing*. Cambridge, MA: MIT Press.
- Mayfield, K. (2002). Retrieved December, 19, 2002, from <http://www.wired.com/news/women/0,1540,48733,00.html>
- Mendoza, E., & Johnson, K. (2000). *Diversity as America's competitive edge in science, engineering and technology*. The congressional commission on the advancement of women and minorities in science, engineering and technology development. Washington, DC.
- National Science Foundation (2001). *Information technology workforce (ITWF) program announcement*. National Science Foundation, Arlington, VA. Retrieved from <http://www.nsf.gov/search97cgi/vtopic>
- Newton, S. (2001). Breaking the code: Women confront the promises and the perils of high technology. *Women's Studies Quarterly*, 29, 3-4.
- Norton, J. R., & Fox, R. E. (1997). *The change equation: Capitalizing on diversity for effective organizational change*. Washington, DC: American Psychological Association.
- Office of Technology Policy (1997). *America's new deficit: The shortage of information technology workers*. U.S. Department of Commerce: Washington, DC. Retrieved June 10, 2003, from <http://www.ta.doc.gov/reports/itsw/itsw.pdf>.
- Panteli, A., Stack, J., Ramsay, H. (1999). Gender and professional ethics in the IT industry. *Journal of Business Ethics*, 22(1), 51-61.
- Powell, G. (1999). *Handbook of gender and work*. Thousand Oaks, CA: Sage Publications.
- Roberts, E., Kassianidou, M., & Irani, L. (2002). Encouraging women in computer science. *SIGCSE Bulletin*, 34(2), 79-83.
- Spender, D. (1995). *Nattering on the net: Women, power and cyberspace*. Spinifex Press Pty Ltd: North Melbourne, Victoria.
- Star, S. L. (Ed.) (1995). *The cultures of computing*. Blackwell Publishers: Oxford.
- Tashakkori, A. (1993). Gender, ethnicity, and the structure of self-esteem: An attitude theory approach. *Journal of Social Psychology*, 133, 479-488.
- Thom, M. (2001). *Balancing the equation: Where are women and girls in science, engineering, and technology?* The National Council for Research on Women: New York, NY.
- Trauth, E. M. (2002). Odd girl out: An individual differences perspective on women in the IT profession. *Information Technology & People*, 15(2), 98-118.
- Truman, G., & Baroudi, J. (1994). Gender differences in the information systems managerial ranks. *MIS Quarterly*, 18, 129-141.
- U.S. Department of Commerce, Office of Technology Policy (1999). *The digital work force: Building infotech skills at the speed of innovation* (OTP). Washington DC.
- U.S. Bureau of Labor Statistics (2003). *Occupational outlook handbook*. Retrieved April 20, 2003, from <http://www.bls.gov/oco/ocos042.htm>. U.S Department of Labor.
- Valuing diversity* (2000). Retrieved June 14, 2003, from <http://www.microsoft.com/issues/essays/11-15diversity.asp>
- Venkatesh, V., & Morris, M. G. (2000). Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and user behavior. *MIS Quarterly*, 24(1), 115-139.
- Venkatesh, V., & Morris, M., & Ackerman, P. (2000). A longitudinal field investigation of gender differences in individual adoption and usage of technology. *Organizational Behavior and Human Decision Processes*, 83(1), 33-60.
- Von Hellens, L., & Nielsen, S., & Trauth, E. M. (2001). Breaking and entering the male domain: Women in the IT industry. *Proceedings of the 2001 ACM SIGCPR Computer Personnel Research Conference*.
- Wajcman, J. (2000). Reflections on gender and technology studies: In what state is the art? *Social Studies of Science*, 30(3), 447-464.
- Webster, J. (1996). *Shaping women's work: Gender, employment and information technology*. Longman, London.
- Williams, J. E., & Best, D. L. (1990). *Measuring sex stereotypes: A multinational study*. Sage Publications: Newbury Park, CA.