Where are the Women in Information Technology?

Nancy Ramsey and Pamela McCorduck

Report of Literature Search and Interviews

Prepared by the Anita Borg Institute for Women and Technology

(www.anitaborg.org)

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Executive Summary

The issue of women's under-representation in information technology, whether in school, higher education, or industry, has been studied in many ways over several decades. Many of the studies which ask why women avoid IT, or if they enter the field, sooner or later fall away, make explicit recommendations to remedy the situation. However, the proportion of women continues to drop from a high of 40% in 1986, to about 29% at the end of 1999, and is still dropping.

The literature suggests that it is no mystery. Women who enter and remain in IT do so under extremely trying circumstances, which are almost entirely cultural. Given the strides that women are making toward parity in other professional fields, the question really must be phrased: what is wrong with IT that it can't attract and hold women?

However, that same literature fails to distinguish among the micro-climates of IT. Nearly 80% of jobs in IT are in the management information systems departments of non-IT firms, which are very different environments from the frontiers of scientific research, or the climate in start-ups. Since all these micro-climates are indiscriminately aggregated in nearly all studies, the recommendations these studies make might very well be misleading. We strongly suggest that NCWIT make explicit what kinds of micro-climates exist, and whether the absence of women is more or less uniform across the landscape.

In any case, the literature consistently reflects a series of cultural stereotypes that frame the issues by making tacit assumptions about women's skills, and by measuring those skills unfairly. Worse, women themselves often accept these stereotypes, and the entire work or learning atmosphere can be poisoned by them.

Despite these obstacles, some women succeed at the top of IT. Our interviews suggest that they are women with clarity of purpose and an unusually strong sense of self-worth.

The outlook for climate change is mixed. Women who know how to succeed in the old mode do well, but the disparity persists—indeed, may grow worse despite early interventions and the deliberate re-thinking by a few organizations that are making efforts to change their culture.

Other questions linger. Over the same decades that this issue of uneven participation has been studied, the United States has been at the forefront of the international field in IT. If women won't play the game as it's now played, what's the difference? Furthermore, if the field is shrinking (thanks to global sourcing and better productivity) why encourage women to enter this field? The NCWIT needs to provide thoughtful answers to these questions.

However, we perceive some dilemmas for NCWIT. Scientific studies are immature and may not provide a solid basis for change; and "best practices" in industry lack rigorous testing. We argue that the situation is so urgent that it might be better to seed experiments, make mistakes, and learn from them instead of waiting until everything is understood.

Thus we make recommendations for broader study, which include distinguishing among the micro-climates of IT and their consequent different requirements; answering the questions of whether IT really needs women, or whether women need IT; whether the problem is peculiar to the field itself; whether in fact the common wisdom is particularly wise with regard to the barriers women face in the field; what social psychology can contribute; what more women themselves can do; what the successful organizations have to teach; whether the field should be redefined; and, finally, who the stakeholders are, and whether leverage exists with them that has been underutilized in bringing about change, if indeed change is desirable.

Abstract.

A search of the literature, combined with interviews of successful women at high levels of the information technology [IT] industry and its academic counterpart shows that women are significantly under-represented across the field and have been under-represented since the field's beginnings, despite efforts to attract and retain them. We examine the very complicated reasons for this, including cultural issues in this most heterogeneous of fields; cultural issues in the larger world; and personal issues particular

to women. Social psychologists have just begun to propose theoretical underpinnings for these phenomena, but these theories are too early in their evolution to serve as a base for action.   Meanwhile, industrial organizations propose "best practices," rules of thumb that seem to work toward women's success in IT though rigorous testing of these is also absent. This paper asks some fundamental questions, and recommends topics that need further investigation.

1. Introduction.

Over several decades, a disparity between women and men has persisted in the recruitment and retention of women at all levels of information technology [IT], from girls' experience in schools, to the initial selection women make as undergraduate majors, to the absence of women in the highest corporate and academic positions.   But what was once only disturbing has now become a crisis, as the proportion of women in IT has dropped from 40 percent of the IT workforce in 1986 to about 29 percent at the end of 1999 and is still dropping.[1] For a number of reasons, this would be problem enough, but external events are also forcing the crisis.

A generally shrinking IT workforce in the U.S. faces brutal competition from abroad, including global sourcing, and many fear that the entire U.S. IT industry is in peril. It has been proposed that one way to mitigate these problems is to increase the participation of underrepresented groups, such as women. Persuasive evidence is also accumulating that well-managed diverse teams produce better solutions to problems than do homogeneous teams.[2] Here, better solutions would keep U.S. IT at the vanguard. This suggests one more reason for the field to make an effort to attract and retain women.

But why do women avoid IT or, if they enter the field, sooner or later fall away? Much information that can answer these questions already exists.

Our paper combines information from academic and scientific journals, and articles in the popular press, with insights offered in interviews with successful women who stayed in IT [Appendix A]. Information from industry groups such as the Information Technology Association of America (ITAA) has also been included.

Who has studied the problem? Different disciplines (psychology, anthropology, ethnography, and cultural and organizational theory), using different methodologies, have tried to explain this enduring disparity between males and females in IT, and if possible, offer a remedy. The methodologies differ in every way, from underlying theoretical models, to interviewing, to survey selection, and they seldom if ever make a distinction among the very different segments of the field, but they are generally internally consistent, and therefore informative.

The popular press reports are not, of course, scientific, but they are the public face of women in IT, and along with the videogame culture, they help form the first and lasting impression many girls (and their parents) have of the field. Moreover, though

these popular accounts may have little rigor or explanatory power, they reflect a troubling reality, and for that reason alone deserve attention.

Summary of the literature. If the results of this literature search can be summarized, it is that women who enter and remain in IT do so under extremely trying circumstances, circumstances that almost seem designed to wedge them from the work they love. These circumstances are almost entirely cultural: they arise in childhood and persist through education and employment.[3] They have nearly nothing to do with the appeal, challenge, and excitement of the work itself. Over the last twenty years, countless studies have demonstrated and decried this gender disparity, but the disparity persists.

Given the strides women are making in other fields such as medicine and the law, the question might justifiably be framed this way: what is wrong with this field that it can't attract and retain women?

The landscape we survey is not entirely bleak. A number of firms and other organizations have recognized these problems—at Intel, being civil is considered a part of company culture, and at M.I.T., the institution acknowledged the problems of women faculty, and moved appropriately to correct the situation. However, two organizations stand out as pioneers in discovering ways to attract and retain women: IBM in industry and Carnegie Mellon in academia. Neither of these organizations has achieved parity between men and women, but they are further along than their peers, and one set of issues the larger study might address is what these two organizations are doing right; how to better understand and amplify that good work; and how to put it into practice elsewhere. Moreover, some women do enter, stay, and thrive in IT. Some of the most successful are the subject of our own interviews, and have been studied by others.[4]

Important caveats. Perhaps the most important caveat is that nearly no study we looked at distinguishes among the micro-climates of IT. That is, the climate in a small non-IT firm's management information systems (MIS) shop (where 79% of all IT jobs are, according to the Information Technology Association of America[5]) is very different from the climate at the frontiers of industrial research and development, which in turn is different from the climate at the frontiers of scientific research, which in turn is different from the climate in start-ups. They are frankly as different as driving to the mall is different from piloting a space capsule. The array of career possibilities in IT is wide, and each micro-climate suits a different kind of personality and temperament. Yet these micro-climates are lumped together indiscriminately, not only in censuses, but in generalizations about the problems and possible solutions to them. This may be misleading.

One of the most important contributions the NCWIT could make is to draw these distinctions clearly for the first time, making explicit what kinds of micro-climates exist, and whether the absence of women is more or less uniform across the landscape. This could disentangle gratuitous misogyny from essential characteristics of particular segments of the field. For example, MIS shops may sometimes have deadlines, but they

are a very different kind of deadline from those that drive projects at the far frontiers of industrial R&D. Or, every segment of the field appreciates initiative, but the initiative required to do academic research is quite different from the initiative needed in 79% of the field's jobs. Or, competition is the oxygen of the frontiers, but competition of that kind simply doesn't exist in 79% of IT jobs (though other kinds do, particularly the competition from global sourcing). The desire to illuminate these issues suggests a different way to study the problems of the under-representation of women in this complex and very heterogeneous field.

Another caveat. In 2000, the U.S. IT industry underwent a massive contraction, from which it is only beginning to recover.   The reasons for this are outside the scope of this report, but a result is that both men and women left IT during the period of 2000-2005 in significant numbers (or if students, saw it as a far less attractive future occupation). The main study will need to take this singularity into account in its research. Moreover, for a variety of reasons—global sourcing, increased productivity, employee healthcare costs—the employment outlook for IT is less rosy than it has been in a while, and demand is dropping: in 2003, employers expected to fill approximately 500,000 jobs; in 2004, they expected to fill only 230,000 jobs. [6] We think compelling arguments can be made that women should nevertheless be recruited to this shrinking field, but those arguments must be explicit.

2. What everyone "knows"—the cultural stereotypes in IT.

A consistent picture. One consistent finding of all studies around this question is that cultural stereotypes of gender skills, abilities, proclivities and proficiencies are deeply rooted in the academic and corporate cultures. Women as well as men share these stereotypes, sometimes subtly, sometimes offensively, and thereby reinforce them, to the disadvantage of women. Nielsen et al. describe the way women represent their work experiences as dualisms—home vs. work; IT work vs. emotion; intuition vs. analysis, and so forth.[7] Jost and Kay report how even "benevolent" sexist stereotypes contribute to justifying and maintaining the status quo.[8]

Foremost among these stereotypes is the assumption that women are better at human skills of "nurturing, emotional expressiveness and communication activities," whereas men are better at "instrumental and task-oriented assignments."

What instead seems to be true is that women can or must do both, while men are not expected to. As a newly posted systems engineer, Kay Young[*] was surprised by what she called the "engineering elitist view" her fellow engineers held: they knew nothing of their customers and cared even less. They believed that if they engineered the best systems possible, the customers would be satisfied. So Young found her niche, working with her company's actual customers and eventually moved into sales.[9] But this cultural

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[*] To protect their privacy, we have changed the names of the interviewees we quote directly.

assumption of what women are supposed to do best is not the most valued skill in IT, as we shall see in Section 3, How the Stereotypes Frame the Issues.

A widespread assumption that hampers women's professional development is that by virtue of being women, they cannot fully participate in work. For example, for women who have families, it's assumed they cannot travel or work irregular hours, though nobody imputes such limits to men's work.

In fact, sensitivity to work-life balance is increasingly important to both men and women, and has become a generational rather than a gender issue. But all women suffer from this cultural assumption, whether their workplace is the corporation or the university, by being denied advancement, denied line assignments, and left out of assignments that require travel and dedication to deadlines. (Catalyst, Kleiner[10]).

While it's true that women often shoulder more family responsibilities than men, and for some women, it's a key factor in accepting or rejecting an assignment, the presumption more than the reality tends to limit women's advancement, with their outside responsibilities a foregone conclusion. Moreover, as we have pointed out, in those 79% of all IT jobs that happen to be at non-IT firms, 24/7 dedication is the exception, not the rule.

Gloria Zachary deeply regretted leaving her extended family when a project she was working on was moved to another state, but she moved nevertheless.[11] Tracy Lee, a former vice president at a large computer manufacturer, knew from the beginning of her career that she would have children, hire good help, and continue working full-time. A good example of a woman with a strong professional identification, she was excited and challenged by her work, and felt her family's needs were well met. But other women agree with the stereotype, that women will not give up personal life in the drive to be a notable success.[12]

Some women argue that although long hours are sometimes necessary to meet a deadline, they are more often a status symbol, a sign of machismo, considered more important than the "soft work" of keeping a team together (another management skill that women are supposed to excel at). "The reward structure here rewards people for doing stupid things, then working 80-hour weeks to save the day."[13] Other women professionals report being mistaken for the librarian, or the receptionist.[14] A male engineer once asked Linda Osborne why he should even bother to talk to her, since she was only from human resources. In a rage, she laid out her outstanding engineering credentials, and got "more than enough" cooperation and respect.[15]

Social psychologists' findings. Tapia and Kvasny say: "The IT culture is described as largely white, male-dominated, anti-social, individualistic, competitive, all-encompassing and non-physical. This ascetic culture has strong in-group and out-group dualisms in which the needs of the disembodied intellect subsume emotional, physical and sensual needs. This dualism translates into expert and non-expert and to male and female behaviors, attitudes, and values."[16]

In short, the cultural stereotypes contribute to an environment in IT where women are consistently undervalued. These cultural stereotypes help support what is generally considered a masculine perspective, or culture, which dominates the organization and power structure throughout the IT and related industries and academic communities.[17]

These persistent stereotypes and their consequences, along with the stress endemic to a field that changes its technology rapidly and is highly competitive both inside and outside the organization, produce a climate of work and corporate culture that could be changed, but usually has not been.

An alternative theory proposed by Trauth, Quesenberry and Morgan, suggests that the under-representation of women in IT is neither owing to "essentialism" (women just aren't suited for technological work[18]) nor to social construction (women can do it but are hampered by social expectations). Instead they propose a theory of individual differences, that "women as individuals experience a range of different socio-cultural influences which shape their inclinations to participate in the IT profession in a variety of individual ways. Further, women respond in a range of individual ways to the social shaping of gender and IT work. Thus the individual differences perspective inhabits the middle ground between the essentialist and the social constructivist explanations of the under-representation of women in the IT profession."[19] Gallivan reports similar findings in the adaptation by IT professionals to technological change: individuals differ, and one size of re-training will not fit all.[20] This is early work, and it is unclear exactly what contribution these theories, however sound they might eventually prove to be, can make toward solving a glaring problem now.

3. How the stereotypes frame the issues in IT

People like me. Research across academia and industry consistently shows a widespread desire to be surrounded by "people like me", i.e. white male engineer/computer science stereotypes, and the consequent rejection of people who are different ("diversity" of women and minorities). This excludes women from the informal networks that enhance skills, and denies them the useful informal insights into the politics and power inside their organizations. (It's a very human desire that social scientists also succumb to: we note that nearly all the studies of women in IT are about professional women at the top of research and industry. Few studies address the situation of the 79% of regular IT workers, one exception being Lynette Kvasny's study of African-American women studying for computer certification.[21])

Stereotypes frame the assumptions and metrics. If individual exceptions are acknowledged, the stereotypes nevertheless frame assumptions about, and metrics of, women's performance. Women earn lower performance ratings in assumed male skills (instrumental and task-oriented assignments), leading to fewer promotions and lower pay. Their skills at "soft" tasks are undervalued because those skills are "natural" for women and thus don't count as an achievement.[22] Paradoxically, adequate performance by men in women's presumed skills (nurturing, emotional expressiveness and communication) is

considered exceptional, leading to better ratings, faster promotions and higher pay for them. Managers who hold unexamined stereotypical expectations will possibly grade their women employees as "less able" despite objective evidence to the contrary.

Penny Herscher, chair and CEO of Simplex Solutions, a Silicon Valley electronic design automation company, says: "I agree it's tough for women to advance in technology companies no matter if they're in engineering, marketing, or another discipline. I believe that is fundamentally much more about the fact that the culture and the measurement systems of many technology companies are set by white or Indian men. It's important to ask, how do you create a work environment that enables people to be measured and promoted purely on performance and production rather than on whether they walk, talk, or work like you?"[23]

Some psychological research suggests that other stereotypical assumptions provoke behavior that precisely reinforces those assumptions. For example, women believe that they must be twice as good to be considered equal, and that's often true. But meeting that standard demands additional time and attention to an assignment, while men's less rigorous work is finished first and is, ipso facto, considered a greater success, which can lead to better self-promotion by a male team member, and earlier advancement in the organization. Either way, it provides a beneficial wedge to men and begins the pattern of an uneven playing field.[24]

Penny Herscher acknowledges this, but says, "I fully acknowledge that I have to work twice as hard and be twice as smart as the man I'm competing with. So women must accept reality and not complain about it. Beat them at their own game, be better than them at what you do, and be vigilant. Be smarter and work the system; get to know the next level of management and make sure they know who you are."

Boorish behavior. Meanwhile, since men are not expected to have communication and "people skills," professional cultures are often tolerated that are highly, even grotesquely, competitive and frequently insensitive, juvenile, and offensive. While exceptions exist, behavior such as shouting and rudeness is often the norm, and asocial behaviors are accepted as the price for intellectual achievement. Gloria Zachary, by then a highly respected leader in the field, reports that a colleague once spit in her face with impunity. It was passed off as just 'Harry' being 'Harry,' and she should cope with that.[25] Ann McCurdy says that when her team started to celebrate the end of thousands of hours of work on a new software program, the office party turned into a food fight, an Animal House atmosphere that repelled her.[26]

Linda Osborne observes that the engineering culture is not a welcoming one. Despite corporate efforts, it is dominated by a rejection of ideas "not invented here", and a push to be the most innovative. It can be very hard driving. There is also an element of duck and cover rather than cooperation. Many women don't find this a culture they want to work or live in, and they migrate to other parts of the company, or even to other fields, where their engineering skills are highly valued (business, investment, etc.) "When your manager and the system only care and measure how many bugs you can get out of a

system rather than how you design a system so that it doesn't have bugs, you won't get credit or promotion." Women, she notes, tend to think in terms of prevention and getting it right the first time, the opposite of the standard IT technical culture.[27]

"People issues drive women out of technology," says Katherine Holloway, a director of university relations. Men resent women in the field and do little to make them feel comfortable. If there's a momentary change now with younger generations, women will soon face another reality. Approximately half of the engineering students in America today are foreign nationals and often their cultures do not share western norms for professional women and women as equals. Management tracks may seem more "peaceful" to women compared with the brutal competition for success and notice among IT engineers, she says. This drives women away from the technology, "the fun, technical stuff." Unfortunately, she sees the road from technology to management as one way, no return.[28] However, other women report they have successfully made the trip between technology and management several times.

Faced with this choice between the technology track and the management track, some women balk. "Why would you want to do management instead of technology, if you love it and have worked hard to get the training to do it?" asks Isabelle Loren. For women, the money, the power and influence of the management track aren't enough to compensate for the personal time they must give up, and the distancing from technology.

Roldan, Soe and Yakura describe "chilly" organizations and their effect on the retention and promotion of women in IT, and propose that a woman's perceptions of the "chill" level of a given IT organization affects the length of her participation in that organization.[29]

In IT, style trumps substance. A *Journal of Applied Psychology* report concludes that women are less willing to monitor their own self-image than men are. "Men are better at creating and managing impressions," the University of Pennsylvania psychologists claim, based on a meta-analysis of 136 independent studies dating back to the 1970s and involving a total of 23,191 respondents across all 136 studies, and published in 2002.

"While subjective performance appraisals are not intended to be prejudicial against women, they clearly favor high self-monitors [attention to image, and a talent for managing impressions upon others]. Performance appraisals are based on impressions, and high self-monitors—who are usually men—are better at creating and managing impressions." Low self-monitors, usually women, are less driven by social cues and more true to a consistent set of inner-directed values and principles.

In other words, personal independence and integrity, highly valued in other professions, and shown more often by women than men in these studies, is damaging to women in IT. "Our study is consistent with previous research that even a little inadvertent bias against women can hurt them a lot."[30]

Another aspect of this is that women expect that their good work will be seen and acknowledged without their need to promote or draw special attention to themselves, according to Isabelle Loren, a group leader at a semiconductor firm, whereas men seek out the promotions and the competition.[31] "Women must be pushed or encouraged or convinced that their participation will make a difference; that there's value beyond--and in--the money and power, both for them and for the company. They must feel that they make a difference in some valuable way. All this while a hundred men are lined up who want, are even hungry for, these positions."

We heard this reiterated in many ways, and it suggests that women desperately need training in how to promote themselves effectively, how to get over undue modesty about "Brand Me." At the same time, their male colleagues need training to recognize such self-promotion as appropriate to the field, and not some woman's outrageous "aggressiveness."

4. The prevailing climate in the field.

Persistent gender imbalance. Though we have spoken of micro-climates, some generalizations can be made about the overall climate of the field. Countless reports and surveys over the last two decades and more have regularly rediscovered the issue of gender imbalance in IT, and despite earnest endeavors, the prevailing climate has remained the same. Though women make up half the U.S. workforce, they are only 20 – 29 percent of IT professionals (figures from different sources vary). Only 10.6 percent of the top tier executives at computer companies in the Fortune 500 are women compared to 11.1 percent at non-computer companies. Women make up 8.4 percent of the boards of directors of these companies, compared with 9.5 percent of the boards of non-computer companies.

Women accounted for this minority of information technology workers in 2002, the same proportion as in 1996 (though lower than 1986) owing to the commonly cited barriers: long hours that conflict with family responsibilities, few female role models, and old-boy networks that are difficult to crack. Part of the main study's goals might be to probe beyond those commonly cited barriers, and ask if they aren't a more socially acceptable (or less troublesome) answer to surveys than trying to explain the difficulty of holding on to a professional identity in the face of systemic stereotyping, dualism, and devaluation.

Why women end in management instead of R&D. Ellen Sanchez, a former human resources director at a computer manufacturer, has pointed out some of the problems of gathering data—there are serious practical limits when examining these issues, owing to corporate and personal privacy policies. However, in her experience, good engineers who aspire to be great choose to stay on the engineering track, rather than moving to management. Though companies differ, the usual case is dual tracks for technology and management. But it is harder for women than for men to move up the technology career ladder. Peer voting for promotion as distinct from manager selection

tends to select "people like me," that is, not women, and it takes a strong corporate process and commitment to shatter that dynamic.[32]

This raises another problem of women who find themselves in management by default. It might begin because in a small task group, nobody really wants to lead the group, and so it falls to the sole woman. Women in our survey report different experiences this way—some say they have made the transition from the technology to the management track and back several times; some say it is a one way route, technology to management, with no going back.

However, every woman interviewed mentioned that she or any other manager had to keep up with the technology in order to maintain credibility, and if that must be on private time, so be it.

Kay Young, an entrepreneur, was a great success for a number of years because she was smart, took risks, and succeeded. She also learned "not to be a threat" by doing her job but not seeking credit, though she describes herself as "a Chihuahua with a bark." But even she reports running up eventually against what she calls "the old boys network", which she saw would never admit her as a full partner, so she left the large firm where she had begun her career to join a start-up.

Inez Brewster recalls "heavy sexual harassment" when she began work. At last she complained to her supervisor, a woman, who said: "This is your challenge. You'll run up against it again and again. Decide now you're going to deal with it as if it doesn't matter, and turn it around so that *you* get to stay in control." Brewster accepted the advice as a gift that gave her a "sense of my own personal power." Though that kind of advice would be unacceptable today, she feels it held her in good stead; playing by today's rules, it would not have benefited her as it did.

Like Gloria Zachary, Inez Brewster feels strongly that longevity with a project is vital to deep understanding—Zachary says ten years if necessary, Brewster says certainly three to five years, regardless of whether the project eventually succeeds. Failure teaches too. Again, this can conflict with some women's view of their other, non-work obligations. In Brewster's case, she acknowledges strong support, strong mentoring, strong training, all along the way in her career. She has felt challenged and supported. At this point in her career, she is confident she can compete and contribute, at the same time she is invested in the success of others willing to work with integrity.

It would seem that women who remain at the frontiers of IT R&D must have an extraordinary commitment, a professional identification so strong that it's virtually armor-plated to survive this generally adversarial climate.

5. Despite all this, some women succeed at the top of IT. What's their secret?

The women we spoke to have succeeded brilliantly at the highest levels of the field. Several of them cited the competition and the long hours to finish a project as a marvelous stimulant, a valued part of their professional lives. We want to make this explicit because the ideas that women don't like or can't thrive under competition, or prefer to avoid risk, or find long hours difficult, are simply more stereotypes.

For the fun of it. Tracy Lee, a former vice president, did it all for fun. No five-year plans, she simply followed where the challenges were. As she moved further up into management, she left hands-on technology, but always kept up with what was happening. When she felt "stuck" at her big firm, she moved to a start-up, where she was repelled by the infighting and game-playing that absorbed time and energy that could have been used to bring the product to market. Her old firm recruited her back at the vice-presidential level, an offer she gave much thought to, since she understood the situation "grew uglier the higher up you go." She discovered the truth in that: at the new level, a woman manager who had supported her was now an adversary; prima donnas abounded; and the lack of diversity made it worse. It had stopped being fun. She waited until a project was finished, and then resigned.

Take advantage of good influences and resist bad ones. Successful women in IT benefit not only from good mentors and a sharp appreciation of their own goals, they also benefit from corporate cultures that encourage them. For example, IBM believes leaders are made, not born, and women who understand that admire IBM and flourish there. But these exogenous circumstances go hand in hand with personal commitments to the work. Almost all the women interviewed spoke of the benefits of informal mentoring (as distinct from formal mentoring programs) where, as one put it, "it felt as if somebody was always looking out for me." Women who are successful in IT "have resisted in some way the influences, which discourage young women from entering IT and have persisted in developing their IT careers."[33]

Recognize and value your own goals. Gloria Zachary's personal passion for her specialty was critical to her success and happiness. Her professional identity was crucial to her sense of self, and she always thrived on work that was inherently risky.[34] Zachary even goes so far as to say that women are particularly suited for IT work, especially given the intense human bonding that takes place when a project is underway. In the days before "geeks and games blew the field open," she adds, it was widely assumed that women would work in the field—she has an old recruitment brochure from the 1950s addressed to "My Fair Ladies." The geek culture, however, is inherently anti-woman and makes the field less attractive than it was when she entered it.

Being great at something is good enough. Kay Young moved swiftly up the corporate ladder, recognized the glass ceiling, decided that moving was likelier to be more productive than fighting, and left to join a start-up. She loved the heady successes and suffered the crushing defeats that characterized IT start-ups in the 1990s, but she now insists on a life with more balance than anytime before. She says she has learned that being perfect at something is a foolish goal—"being great at something is good enough." Unlike many men and women, she believes that you can go from engineering to sales and

then back to engineering if you're willing to adapt. Nora Bellamy reports that she has moved successfully between technology and marketing several times.[35]

Nielsen et al. report that women who successfully "adapt" to the masculinized domain of IT often succeed by using traditional female habits (attention to detail) to better perform so-called masculine tasks.   (They also point out that men are uncomfortable with these dualisms too, suspecting that they are caricatures—particularly the dualism that opposes work to home.)

6. The outlook for climate change.

Moving more women into the field. Dorothy Wilson, who is involved in studies of gender, minorities, and IT, is optimistic that changes must come, that engineers and computer scientists who have been able to live in "guy cultures" can and will learn "gender acclimatization", but it's essential to move to a critical mass of women in the field. This requires women as role models, and it requires institutional commitment to engaging and keeping women.[36]

Tapia and Kvasny advocate changes at the individual manager's level (informal mentoring, on-going training opportunities, mid-year raises, retention bonuses, and employee referral bonuses); at the institutional level (formal mentoring programs, diversity and multicultural training for all IT employees, hiring more women and minorities into management positions, etc.); and a change in attitude on the part of IT managers (expose women and minority employees to the same developmental jobs that have traditionally led to senior management positions for their white, male counterparts; support open dialogue to discuss perceived discrimination that could impede women and minority IT advancement, etc.).[37]

Women as CEO's. Penny Herscher, the Silicon Valley CEO, says, "Without question, if you get either women or enlightened men in the top positions, you can create a very different culture. The CEO sets the culture of the company and does so in many ways they're not even aware of. Every word a CEO utters affects the company culture." She adds: "It became very important to me to show that if you ran a company by what I think are some of the more female characteristics—more nurturance and better communication, to name two—you're focusing on the team, and you can build a really fun company. Simplex was a tremendously fun place to work."[38] Herscher, like Autodesk president Carol Bartz, also brought her children into the office, and emphasized the responsibility to family as well as to work in word and in deed.

7. Women who choose to study information technology.

Comparisons with other professional degrees. The percentage of women entering both the law and medicine has reached parity with men. Women receive more than half the number of bachelor's degrees in biology, and over 40% of the Ph.D.s in the life sciences. In chemistry, women receive nearly half the undergraduate degrees, and over

25% of Ph.D.s in the physical sciences. However, they receive only about 21% of the degrees in engineering, and only 20% of degrees in computer science and technology. A Ford Foundation survey of hiring at the nation's top universities showed that women hold less than 10% of engineering professorships in those schools.[39] However bad it has been, some surveys are showing a decline from even these paltry levels.[40]

Some conjectures about the disparity. It will not soon get better. Of the students who took advanced placement exams in computer science in 2003, just 14 percent were girls, down from 17 percent in 1997, according to College Board records.[41] Girls in secondary and middle school are often turned off by their introduction to computing-- video games, and geek-flavored programming classes.[42] Jane Margolis, the co-author of *Unlocking the Clubhouse: Women in Computing*, says, "Research has shown that our computer science culture reflects the domination of a small substrata of male students whose interests, preferences and concerns have become the expected norm. Interviews with women who are studying computer science, and those who dropped out, revealed the central connection they made between computing and what can be achieved in other arenas, such as medicine, environmental protection and other social concerns. Many women articulated an interest in 'computing with a purpose' as opposed to 'hacking for hacking's sake.'"[43] Both boys and girls surveyed lacked information about the nature of the work, and overwhelmingly perceived it as a masculinized domain—the females mainly saw IT courses as boring and difficult.[44]

Early interventions. Many interventions are underway for girls, for example, all-girl computer camps, girls' after-school computer clubs, support groups for girls, and Girl Scout encouragement through merit badges. But these are modest efforts to solve a big problem. Furthermore, some of these interventions are sponsored by the companies directly affected. (This raises a concern, perhaps unfairly, that companies focused on the quarterly bottom line will have little incentive to stay in for the long haul.) Small but possibly significant self-organized groups of cyber-feminists, known as "cybergrrls" are at work on the web, sponsoring sites, chat rooms and lists, and attacking the masculine aspects of computing that they consider oppressive.[45]

Thriving in the old climate. An example of someone who thrived in the old climate is Kay Young, who went to a leading university almost by accident. Though she was unprepared for the intensity of the experience, she praises the school for teaching her how to learn, but describes it as "a warped world." By that she means the intensity of the focus; and the lack of people skills in both the faculty and student body, who treated each other with less than generous interchanges. The experience humbled her, but also built her self-esteem, lessons she carries nearly thirty years later. Though her class was only 15% female, she did not feel particular pressure or unwelcome as a woman. She came to believe she'd been admitted because she was female, even though she was in the top rankings of her classes. A software developer at Apple, Kathryn Vandiver, told the *Sacramento Bee* that even in the 1980s, she had professors who discouraged her, and suggested she go home and have children.

Trying to bring about a new climate. Carnegie Mellon, on the contrary, has become a model of how to do it right. With no compromise to academic integrity, faculty and administration have made a conscious decision to change the culture.[*] They have supported women undergraduate and graduate students in forming the "Women at the School of Computer Science" Council, to create an atmosphere that encourages, stimulates, teaches, and earns the loyalty of all, women and men alike. The culture change might be summed up as hacking for a purpose, instead of hacking for the sake of hacking. It can be done.[46] Another example is MIT. Following on a study of faculty gender disparities the administration has made substantial efforts to correct the situation.

What if the entry barriers are obsolete? Wendy Cukier has examined IT in terms of institutional theory, which reveals how certain practices become widespread and taken for granted, regardless of links to actual performance or outcomes. The mathematics requirement is such an institutional practice. "Most studies suggest that differences in male and female mathematical performance are more a result of interest, confidence and socialization, than aptitude. International data confirms this. . . . Consequently, relying on mathematics as a barrier to entry and core skill in IT educational programs has the perhaps unintended consequence of excluding women who do not see themselves as mathematical. This is not to say that programs aimed at increasing the enrollment of women in mathematics are not worthwhile but merely that they reflect a particular construction of the IT profession and requisite skills which, in turn, reinforces institutional barriers to women who may be otherwise well-qualified."[47]

Also thanks to institutional practices, the shortage of IT workers is routinely translated by both government and industry into a shortage of engineers and computer scientists, even though managers, database administrators, programmers and web site designers are also in demand, and their education is not necessarily the same as those of computer scientists and engineers.

Many women who define themselves as IT professionals have not entered the profession via computer science or engineering, which suggests that multiple entry points need to be respected and encouraged.   We note once again the scantiness of data about women who go through certification programs only, or vocational schools, or enter the field in nontraditional ways.

That it might need to re-think itself is not entirely news to the profession. Caroline Henderson believes that the entire field of computer science needs to be redefined so that it goes beyond systems and theory and combines together with education and research. She would like to see social sciences become part of the training of technologists, so that a more inclusive kind of thinking and training exists, a change that would not only make it more attractive to women but also strengthen the field. Every field needs such a periodic review of its institutional practices, but for such a

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[*] Since the inception of computer science as a field 40 years ago, Carnegie Mellon has been among the top three centers in the world. Their re-thinking of the undergraduate and graduate educational climate is extremely significant.

review to have any credibility, it must be done by the field's own insiders. Outsiders can only contribute by offering hard data to be considered.

8.So what?

Over the same decades that this question of uneven participation by women in information technology has been studied (and we repeat, those studies are legion), the United States has been at the forefront of the international field. Thus the question arises: so what? If women won't play the game as it's now played, what's the difference? We're still number one.

A second question follows. If, as industry groups report, the field is shrinking (thanks to global sourcing and better productivity) why encourage women to enter this field?

The national stake. Right now the United States faces a unique convergence of circumstances that make the recruitment and retention of women into information technology a necessity, not a pious social luxury.   The federal government and several industry associations have already weighed in with ominous predictions of professional shortages now and in the future, despite the field's present contraction.

1. Owing to new restrictions by the federal government after 9/11, the number of foreign students coming to the U.S. to pursue graduate studies has fallen dramatically. It isn't at all clear that if these restrictions were eased, such students would return in the same numbers, since other countries, such as Australia, Germany and the U.K., are eager to have them and offer attractive incentives. Foreign students who came here to study computer science, engineering and telecommunications traditionally comprised a significant proportion, in some cases half, of all students in those fields.
2. Of those, many stayed on in the U.S. to work, and have been crucial to the field's success. However, the "reverse brain drain" suggests that the homelands of many of these IT stars, particularly China and India, are making such attractive offers to their overseas immigrants that a substantial number of émigrés, even though they are American citizens, are electing to go back and work in the countries where they were born.
3. Global competitiveness is a brutal fact. One author (McCorduck) was recently shown the architectural model of an entire branch campus of Fudan University in Shanghai (one of China's top five universities) that will be dedicated *only* to software development. China will be a formidable international competitor because of its sheer numbers, the honored place study has held for thousands of years, and because it also has a long tradition of superb entrepreneurship. India's government has loosened the restrictions that earlier fettered enterprises there, and we are already seeing a surge of start-ups that won't wait for the U.S. Brazil may be the next such incubator of raw talent. To put it another way, human capital development, especially tertiary

education, and R&D activity is rising rapidly from low levels in many countries.

4. *Roughly speaking, international trade almost always follows a trajectory:* technology is copied from the originators by other countries that imitate it cheaply, and flood the international market with these cheap imitations. Yes, these imitations are not as good as the originals, but they're good enough, they "satisfice," and seize chunks of the international market (and sometimes the originator's domestic market). The inflow of capital allows the copycats to begin originating, and the cycle begins again with different players. *The only response a mature economy can make is to innovate. Economists can show that in the pursuit of economic strength, innovation trumps capital or an educated labor force.*

5. Early scientific work of the last decade shows that a well-managed diverse team produces more innovative solutions to problems than a less diverse team (and teams excel over individuals).[48] The U.S. could wait until these early findings are set in scientific concrete, but it makes more sense to act on them right now. In fact, a diverse team has been a heuristic for many successful women in IT. "Teams benefit from complex, multicultural participation even though it takes skilled leadership to help cross barriers created by the inherent differences among the mix," says Norma Bellamy. Globalization and changing U.S. demographics also make that kind of integration critical to corporate success today, she adds.[49] It is interesting too that Lynette Kvasny's study of a small group of African-American girls shows that the alienation white middle-class girls and women feel from IT is not necessarily shared by African-American women, who see IT as a sure way out of poverty. She argues that exploring the differences as well as the commonalities that exist among women is crucial for increasing the participation of women in the IT workplace.[50]

The personal stake. Jobs in information technology might not be growing at the pace they once did (indeed, they are contracting slightly at present) but the field still offers challenges and gratifications to individuals. Why shouldn't women get in on the fun? "At the very least," says Jane Margolis, co-author of *Unlocking the Clubhouse Door*, "products are being designed that do not meet the needs of women." She adds: "More important, entire domains of the economy and our social lives are being crafted without the explicit infusion of the perspectives and experiences of half the population."[51]

9. The Dilemma for NCWIT.

Scientific studies are immature. Studies by social scientists of women and minorities in information technology are indicative, but so far inconclusive. For example, the theory of individual differences (different personalities) offered by Trauth et al.[52] is promising, but so early in its development that it is unlikely to be useful in solving the current pressing problem. Likewise, the structuration theory offered by Nielsen et al. also looks promising, but is not mature enough to build a program of action upon.[53]

"Best practices" lack rigorous testing. Organizations, professional associations, and internal corporate policies have constructed broadly accepted "best practices". But the trend lines have not reversed. We are forced to conclude that, as with recent business case research, either these "best practices" are not as effective as believed, or they are not thoroughly integrated into the corporate cultures and practices.[54] For instance, everybody declares that "mentoring" is essential, but successful mentoring is far from self-evident: the transaction requires sensitivity and receptivity on both sides. Another favorite is "role models" but our interviews suggest that that a female role model can be a two-edged sword for women.

Changing to these "best practices" is a monumental undertaking.[55]. Interviews show that when rigorously enforced and integrated they are effective. But the lack of genuine adoption across cultures is profound and the results are that women continue to leave. A September, 2004 study by Deloitte & Touche LLP, showed that six out of ten women in high-tech jobs, citing the glass ceiling, say they would choose another profession if they were starting a career today. Because of competition and legal issues, gaining access to internal corporate and academic institution studies is difficult. Nevertheless, deeper research on this, if daunting, is unavoidable.

Even with organizations that have begun to change, long-term studies are impossible so far to determine whether the changes they have made will transform the culture of the field, or the behavior of women in IT.

Above all, the vastly heterogeneous nature of the field needs to be taken into account.

Moving forward regardless. Given the lack of a solid basis on which to proceed, how can the under-representation of women in IT be remedied in the foreseeable future? Unfortunately, the situation is so urgent that the usual leisurely pace of scientific inquiry is a luxury the U.S. may not be able to afford. It is probably better to seed experiments, make mistakes, and learn from them, than wait for a cautious, undisputed, scientifically grounded program of action.

Moreover, much information is missing, and the job of the NCWIT must be to fill in the holes. We have presented what seem to us as the most salient lapses in the next section, Recommendations for Broader Study.

10. Recommendations for broader study.

1. No study we know of distinguishes among the micro-climates of IT and their consequent different requirements. The array of career possibilities in IT is wide, and each micro-climate suits a different kind of personality or temperament, and requires

different educational preparation. One of the most important contributions the NCWIT could make is to map these distinctions clearly for the first time, making explicit what kinds of micro-climates exist, and what each segment of the field requires in preparation, and for participation.   This would help to disentangle issues of misogyny from issues essential to the several natures of the field itself.

2. Given how successful IT in the U.S. has been without many women, who needs women? Over the same decades that this question of uneven participation by women in information technology has been studied, the United States has been at the forefront of the international field. Thus the question arises: so what? If women won't play the game as it's now played, what's the difference? We're still number one.

A second question follows. If, as industry groups report, the field is shrinking (thanks to global sourcing and better productivity) why encourage women to enter this field?

Both questions deserve thoughtful answers from the NCWIT, and one way to answer them would be to construct far-reaching scenarios that explore and illuminate the possibilities.

3. Is the problem something peculiar to the field itself? When women have come close to achieving parity in such fields as law, medicine and biology, what's wrong with the IT culture that it not only fails to attract and retain women, but the small proportion it once had is eroding? How have other fields, such as biotechnology, been more successful at attracting and retaining women? Is the under-representation of women approximately the same across all segments of the field, from bread-and-butter data processing to the highest reaches of academic and industrial research and development? Do the same problems exist internationally? That is, are women underrepresented in Chinese, Taiwanese or Indian IT?   If not, how have these cultures solved the problem? On the other hand, if these cultures exhibit the same disparity, can we use their imbalances as a competitive advantage by replicating those few but identifiable American centers, both academic and corporate, where women are attracted, stay, and flourish, such as Carnegie Mellon and IBM?

4. How wise is the common wisdom? Commonly cited barriers to women's success in IT are long hours that conflict with family responsibilities, few female role models, and old-boy networks that are difficult to crack. Part of NCWIT's goals might be to probe beyond those commonly cited barriers, and ask if this common wisdom isn't a more socially acceptable (or less troublesome) response women make to people taking surveys, rather than trying to explain the difficulty of holding on to a professional identity in the face of systemic stereotyping, dualism, and devaluation. If NCWIT can manage to honor the quite appropriate issues of members' privacy, the Systers on-line archives are a treasure trove of candid opinions about the difficulties of women in IT.

5. What can social psychology contribute? Social psychologists have proposed a number of theories to explain the disparity between the numbers of men and women in

IT, such as false dualisms, individual differences, or organizations that are "chilly" to women. Which of these-or which other theories-best explain the situation and suggest solutions to the problems?

Questions about nature vs. nurture continue to be raised. The existing literature is overwhelmingly persuasive that girls and women can cut the scientific and mathematical mustard, and very well, which is how the question has always been framed. But it still a fact that at certain decision points in their lives, many girls and women choose not to. For example, adolescent girls, who have excelled at math (and even exceeded their brothers) sometimes decide that other things, like social activities, are more important to them and diffuse their focus; undergraduate women make similar decisions; young career women likewise make such decisions on behalf of childbearing, etc. We have assumed that this is cultural-if the technological culture were less exasperating for women in particular, if the larger culture took the responsibility of providing superb childcare, then women would make different decisions about their lives. We do not know whether this is really true. Are these decisions to choose other paths nature or nurture, programmed in or socially determined? Some rigorous inquiry into questions like these is essential.

6. <u>What more can women themselves do?</u> Along with their technical training, women desperately need training in how to promote themselves effectively, how to get over undue modesty about Brand Me. At the same time, their male colleagues need training to recognize such behavior as appropriate to the competitive nature of the field, and not just some woman's "aggressiveness."

7, <u>What do the successful organizations have to teach?</u> IBM in industry and Carnegie Mellon in academia are two examples of organizations that are attracting and retaining a significantly larger proportion of women than their peers. Though women there have not reached parity, what can be learned from them and adapted elsewhere?

8. <u>Should the field be redefined?</u> A number of professionals in academia have begun to ask whether the traditional curriculum and training is actually germane to the field as it has evolved since its early days. This set of issues needs to be studied further, with inquiry into the "multiple entries" that several people cite as more typical of the field now than earlier. While training, especially at the university level, is properly the responsibility of the field's practitioners, presentation of concrete evidence that other kinds of skills are (also) in demand in this changed world of IT might help persuade those practitioners to re-think the highly abstract nature of the field as it is now conceived.

9. <u>Who are the stakeholders?</u> At some level we all are-the loss of this creative engine of the last fifty years would be a stunning blow to the U.S. economy. But at finer-grained levels, investors, whether equity holders or venture capitalists, have much to say about the companies they invest it. We don't suggest that organizational change is easy, or that it can be done in a spirit of mere generosity and fairness. But if crucial stakeholders are persuaded that better results can and will result from companies that

embody diversity, venture capitalists, for example, following their own economic interests, will bring pressure to bear for change.   NCWIT should explore this further.

Appendix A: About the Interview Group

Twenty (20) interviews were held, thirteen (13) were face to face and seven (7) were telephone. Nineteen (19) of the interviews were women, one (1) was male. The interviewees ranged in age from the mid-thirties to the mid-sixties. Fifteen (15) of the group had specific education of a BA and beyond in technology and related fields and currently work in corporate technical positions or have worked in technical corporate positions in the recent past. Four (4) of the interviewees are directors of programs related to women and IT and one (1) is a professional journalist covering the field of IT. Professional positions within the IT industry ranged from first level manager to highest level technical achievement.

A set of questions was developed (attached Appendix B) based on the language of the enabling grant of the study. They focused on the choices interviewees had made around their education, and career. Interviewees often volunteered information about their personal lives and the relationships between personal and professional lives. The full set of questions was shared with the interviewee at the outset of the interview.

While our original hope was to collect the same kind of data from each interviewee it quickly became clear that people chose to answer the questions in their own way and make some points at great length while choosing not to answer other questions at all. Thus each interview varies in the precise answer to the questions originally drawn but everyone did address the matter of their choices.

All interviews were written up from notes taken during the interviews.

All interviewees agreed to follow up interviews if desired.

Appendix B: Interview Format and Questions

- Review the purpose of the study.
- Permission to Record
- Agreement on non-reference without permission or review.

- Request brief resume of their career. (They may add beyond the formal here)

- What choices have they made along the way?
    - "What were the choices that kept you up at night?"

- Reasons for the choices?
    - Personal
    - Corporate
    - Other

- What are the key decision points?
    - Early
    - Later

- What choices have you seen other women make that might be relevant to the study?
    - Is there anyone you recommend we talk to as a follow up to that question?

- What barriers have you encountered?
    - How did you respond to them: cross/ resist/ stop there/ other

- In retrospect, what would have helped with your decisions?

- Can one keep the technical track and combine it with management?
    - Can one go back to Technology from management?
    - Can you influence Technology from Management?

- Do you need to keep up with Technology when you cross over into Management?

- What role was played in your decisions from
    - HR
    - Manager
    - Mentor
    - Family & Work Life Balance

- What personal characteristics make a woman best suited to IT work?

- Does your "Professional Identity" matter and how much?

Appendix C: Interview Summary

What did we learn about the choices technology women in IT make and how those choices influence their progress in IT? There are common qualities among the interviewees.

They **love technology** and related work and are committed to their work. Even if they are temporarily in a work situation which is not acceptable to them, they look for a way to get back on track in a way that enables them to do the work they love. They stay at work because they choose to find a way to make it successful. Similarly, family situations that are demanding may mean temporary adjustments in assignment or time at work, but they seek out a way to stay connected. The decision to stay connection, even at as little as 10 hours post maternity leave, have been critical in keeping them involved.

They **believe they are doing something worthwhile** and not just putting in time.

These **are women who would "make it" at anything**. While their personalities are different in many ways, each of the interviewees has personal characteristics of resilience, confidence and character that help them through the thicket of corporate culture and personal challenges. This has not always come easily for them but they have **learned to build on their successes and failures**. Those same characteristics allow them to **accept the assistance of others and make the most of both formal and informal mentoring.**

They are **leaders.** They have developed styles of leadership which are quite different from each other but each of them has a way of applying her gifts and talents in a way that **encourages others and moves toward goals**, even if those goals change rapidly and often as they do in IT.

There is **not a consistent pattern of family support** at an early age nor is there evidence that they received extra help in moving through the academic careers. Some have had severe challenges as single parents, or due to family separation but they knowingly choose to stay with it for the credentials and training they knew they needed.

They had **positive support at work** through planned leadership training or support from managers. They felt supported and appreciated at work and that kept them going. When that support faded they felt the loss and it affected their attitude toward staying with the company.

They expressed **loyalties to teams** both for the extended learning of a full cycle in product development and the personal relationships developed. Many expressed the importance of staying on projects for an extended period of time to take advantage of that cycle.

They developed **personal and professional networks** to give them outside support when the internal corporate systems were not enough.

Appendix D: Literature Search

Magazine Index:
>Index and abstracts from over 2,650 magazines plus full text for more than 750 magazines, many dating back as far as 1985.

Newspaper Index:
>Database of over 500 full text national and international newspapers.

NetLibrary:
>A collection of over 3,000 full-text electronic books online.

Books In Print with Reviews:
>Database of approximately 2.5 million in-print, forthcoming, or out of print books. The database alsocontains more than 500,000 full-text book reviews, updated monthly.

Dialog*
Factiva**
NSF Reports
Congressional Reports
Professional Journals
Universities
Emerald Press (Information Technology & People)
Josie Boss
Sage Publications (Women in Management)
Organization Studies and Reports:
>ITAA, ACM WIT, WITI, Catalyst, AAAS, AAUW, NAE, Encyclopedia of Gender and IT, University of PA School of Information Scie3nces and Technology The Pennsylvania State University

*Dialog:
>FILE 7: Social SciSearch
FILE 11: PsychINFO
FILE 13: BAMP
FILE 75: TGG Management Contents

**Factiva
>Boston Globe
Business Week
Fast Company
Forbes
Harvard Business Review
Los Angeles Times
New York Times
News & Observer (Raleigh-Durham)
Newsweek
San Francisco Chronicle
San Jose Mercury-News
Sloan Management Review
Technology (MIT)
Time

USA Today
Wall Street Journal
Washington Post
Wired
Working Woman

Sample Web sites:
Amazon.com
cmu.edu (Carnegie Mellon)
fordfound.org (Ford Foundation)
ITAA.org (Information Technology Association of America)
NCRW.org (National Council for Research on Women)
NSF.gov
Purdue.edu
Slate.com
Stanford.edu/group/IRWG (Stanford Institute for Research on Women and Gender)
WITI (Women in Technology International)
Zdnet.com (Dan Farber)

As the Bibliography indicates, much research was done through follow-up on footnote citations of publications included in this search.

Endnotes.

[1] Andrea H. Tapia and Lynette Kvasny, Recruitment is Never Enough: Retention of Women and Minorities in the IT Workplace, *SIGMIS '04*, April 22-24, 2004.

[2] Norman L. Johnson, Collective Problem Solving: Functioning beyond the Individual. Los Alamos National Laboratories, November 1998. http://ishi.lanl.gov./Documents_1/NLJsims_AB_v11.pd

[3] The literature is wide and deep. See, for example, Tor Busch, Gender differences in self-efficacy and attitudes toward computers. *Journal of Educational Computing Research*, 1995, vol. 12, 147-158, which finds that "the most important predictor of computer attitudes is previous computer experience and encouragement. When controlling for these variables, we find no gender differences on any of the three CAS subscales—Computer Anxiety, Computer Confidence and Computer Liking;" or David Gefen and Detmar W. Straub, Gender Differences in the Perception and Use of E-Mail; An Extension to the Technology Acceptance Model, in *MIS Quarterly*, vol. 21, no. 4, December 1997; or Richard M. Felder, Gary N. Felder, Meredith Mauney, Charles E. Hamrin, Jr., E. Jacquelin Dietz, A Longitudinal Study of Engineering Student Performance and Retention. III. Gender Differences in Student Performance and Attitudes, *Journal of Engineering Education*, vol. 84, no. 2, 1995, which shows that women in the study entered chemical engineering with credentials equal to or better than those of the men, but exhibited erosion relative to the men in both academic performance and confidence as they progressed through the curriculum, a result that shows, according to the authors, that women in engineering school face obstacles that keep them from competing with their male counterparts on an equal footing…attributable to a variety of social factors rather than intrinsic sexual differences.

[4] Sue H. Nielsen, Liisa A. von Hellens, Jenine Beekhuyzen and Eileen M. Trauth, Women Talking About IT Work: Duality or Dualism? *SIGMIS Conference '03*, April 10-12, 2003.

[5] Adding Value…Growing Careers: The Employment Outlook in Today's Increasingly Competitive IT Job Market. *The Information Technology Association of America, Annual Workforce Development Survey*, September 2004.

[6] Adding Value…Growing Careers: The Employment Outlook in Today's Increasingly Competitive IT Job Market. *The Information Technology Association of America, Annual Workforce Development Survey*, September 2004.

[7] Sue H. Nielsen, Liisa A. von Hellens, Jenine Beekhuyzen and Eilen M. Trauth, Women Talking About IT Work: Duality or Dualism? *SIGMIS Conference '03*, April 10-12, 2003.

[8] John T. Jost and Aaron C. Kay, Exposure to Benevolent Sexism and Complementary Gender Stereotypes: Consequences for Specific and Diffuse Forms of System Justification. February 2003. Stanford Graduate School of Business, Research Paper Series, Research Paper No. 1789.

[9] Interview conducted by Nancy Ramsey, December 20, 2004.

[10] Interview 11/22/04 by Nancy Ramsey with Art Kliner, author, professor and consultant.

[11] Interview 10/7/04 by Nancy Ramsey with "Gloria Zachary."

[12] Interview 10/11/04 by Nancy Ramsey with "Isabelle Loren."

[13] http://www.sacbee.com/static/archive/news/projects/women/wcmain.html

[14] http://www.sacbee.com/static/archive/news/projects/women/scmain. Html

[15] Interview 10/18/04 by Nancy Ramsey with "Linda Osborne."

[16] Andrea H. Tapia and Lynette Kvasny, Recruitment is never enough, *SIGMIS '04*, April 22-24, 2004.

[17] Tapia and Kvasny, Recruitment is never enough, *SIGMIS '04*, April 22-24, 2004.

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