ISECON 2001 Best Paper Award Winner

Gender and Information Technology: Implications of Definitions

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ABSTRACT

This paper examines implications of definitions of information technology to women's participation in the industry and in academe. It is exploratory only, based on a review of selected government and industry reports and data related to IT education and the profession. However, it argues that there is evidence to suggest that discourse related to information technology has the effect of excluding women and multi-disciplinary perspectives. On the one hand, there is considerable evidence that the IT industry and skills it demands are multi-disciplinary and that many people working in the industry, particularly women, come from a variety of disciplines. On the other hand, despite the evidence of the multi-dimensional nature of IT, the impact of convergence, the importance of matching IT solutions to user needs and so on, a very narrow definition of IT dominates the discourse. This definition equates IT and IT professionals with computer science and engineering, disciplines which are predominately male. The result, then of this narrow definition is to marginalize women and their contributions. This is a pattern that has been observed with the development of other disciplines such as medicine. Not only does the narrowing of the definition of Information Technology tend to exclude and devalue the contribution of women but it also results in marginalization of other disciplines that would bring more "neutral" or "critical" perspectives to bear on technology. Thus the exclusion of multiple disciplines and women may contribute to poor technology decision-making at the societal and organizational level.

Keywords: Gender, Information Technology, Institutional Theory, Human Resources

1. THE IT SKILLS SHORTAGE AND THE PARTICIPATION OF WOMEN

Much attention is paid to the evolution of the 'information economy' and the importance of ensuring an adequate supply of computer scientists and engineers to fuel its growth. In many countries attention has been focused on projected skills shortages - recent estimates suggest that Canada alone will face a shortage of 20,000 software workers during the first few years of this century (HRDC, 1998). A range of industry programs has been devised in response to this shortage in Canada and the United States. Emphasis has been placed on expanding computer science, engineering and programming oriented educational programs. Some have noted that one solution to current labour shortages would be to increase the participation of women in IT (U.S. Department of Commerce, 1997). Consequently, concerns have focused on the decline in female enrolment in computer science and engineering courses at Canadian universities over the past five years (Whittaker, 2000). Studies undertaken in a number of countries have focused on the absence of women's participation in disciplines such as engineering and computer science and have examined a wide range of contributing factors (University of Limerick, 1998; Trauth et. al. 2000, Turkle, 1995; CAEB, 1991; Frize and Deschenes, 1999; Fountain, 1999, Cukier, 1993). Typically these have focused on the absence of women in disciplines such as engineering and computer science, the barriers to female participation and ways to increase the participation of women in these disciplines. A few have framed the gender gap in a different way suggesting that the fact that women are not choosing these disciplines reflects on the disciplines not on women (Wajcman, 1991; O'Donoghue, 1995). Nevertheless, most of the work to date, even by feminists, has accepted the prevailing idea that 'information technology' is virtually synonymous with engineering and computer science.

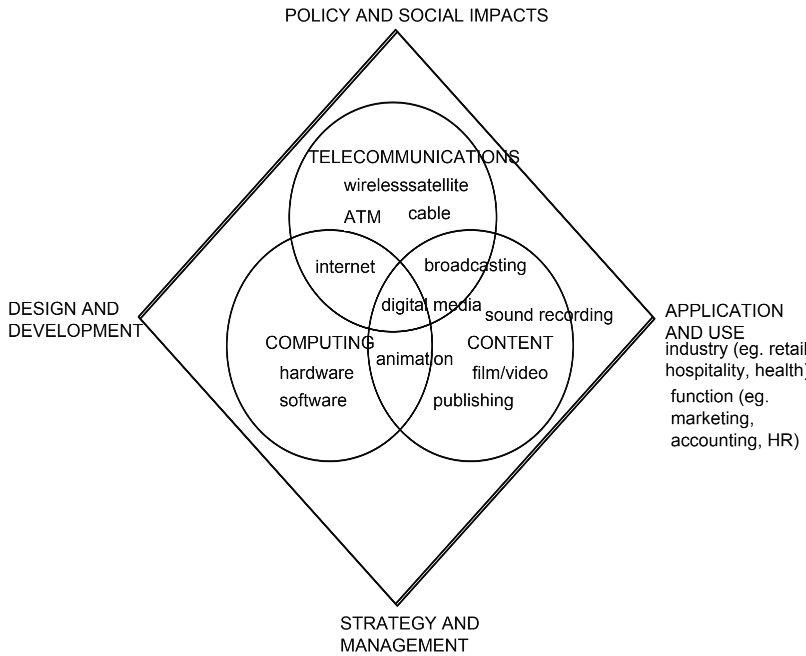

Figure 1. Integrated Model of IT (Cukier, 1998)

Technology discourse shapes the ways in which technology is understood and enacted in organizations Postman (1992, 11). The language of technology both reflects and shapes culture contributing to and sustaining gender disparities in relations to participation and continued study of technology-related fields (Hanson 1997, 1). The tendency to narrow technology, which includes practice, to "the technical bits," has the effect of excluding critical perspectives as well as women (Frey, 1989; Franklin, 1990).

2. WHAT IS INFORMATION TECHNOLOGY? WHO ARE IT PROFESSIONALS?

The growth of 'convergence', the 'information highway' and 'ebusiness' has emphasized the growing overlap between telecommunication, computer hardware/ software and 'content' in the new 'digital economy' (e.g. Tapscott, 1996) and the demand for new skills and knowledge. A wide number of reports and analysis of the 'skills gap' emphasize the growing importance of "hybrid" workers who understand technology, but also know how to apply and manage it. Many professionals who are not engineers or computer scientists work in information technology sector jobs. The convergence of telecommunication, computer hardware, software and "content" is evident in the emerging technology infrastructure (i.e. the Internet), the applications (e.g. Web design) and the industry itself (e.g. New multimedia corporations) (see Figure 1).

In addition, a number of government reports have stressed the critical need for new skill sets (e.g. Advisory Council on Science and Technology's Report of the Expert Panel on Skills, 1999; The Canadian E-business Roundtable Report, 2000; and the Software Human Resources Council (SHRC) Report, 1998). Each report emphasizes the importance of soft skills including content design and development, communications and interpersonal skills, and project management.

Even mainstream computer science researchers have started to question the scope of their discipline. As Denning (2001) notes, while the roots of the discipline were in math and electrical engineering, now the field has grown into a much broader discipline and has shifted from technology focussed to human/user centered. He also notes the limitations of the discipline including the lack of communication skills. Denning also calls for information technology to be defined as a profession rather than a discipline since IT professionals are now a much larger and more diverse group than just computer scientists and engineers. He proposes a redefinition of the industry to include what he terms 'IT specific disciplines, IT intensive disciplines, and IT supportive occupations'.

Table 1. IT Profession (Denning 2001, 16)

IT-Specific Disciplines	IT-Intensive Disciplines	IT-Supportive Occupations
Artificial intelligence	Aerospace engineering	Computer technician
Computer science	Bioinformatics	Help desk technician
Computer engineering	Cognitive science	Network technician
Computational science	Digital library science	Professional IT trainer
Database engineering	E-commerce	Security specialist
Computer graphics	Financial services	System administrator
Human-computer interaction	Genetic engineering	Web services designer
Network engineering	Information science	Web identity designer
Operating systems	Information systems	Database administrator
Performance engineering	Public policy and privacy	
Robotics	Instructional design	
Scientific computing	Knowledge engineering	
Software architecture	Management information systems	
Software engineering	Multimedia design	
System security	Telecommunications	
	Transportation	

3. GENDER AND DISCIPLINE: THE BIG PICTURE

Although we might quibble about scope and where the boundaries begin and end, it is clear that a broadening of the definition of IT to reflect the current reality of the IT profession, would instantly result in greater female participation simply by increasing the number of women who are 'counted.' By including disciplines with higher levels of female participation rather than just computer science and electrical engineering, women are more fully represented. Our preliminary review of female participation in university programs, faculty, research institutes and the profession reflects this finding.

Generally, disciplines where the focus is on application of technology rather than 'the technical bits' have greater female participation. Research into gender and technology has suggested that whether it is automobiles or computers, women are less interested in the workings of technology and more interested in its application. Technology for technology's sake, or 'toys for boys' phenomenon is gendered and has significant implications to the way in which technology is constructed and used (Coyle, 1996).

In some segments of the workforce and academic study related to IT, women are much better represented than in the disciplines of computer science and engineering. Certainly, many women who are not computer scientists and engineers define themselves as IT professionals. In general, women enter information systems management and multimedia programs in greater percentages than computer science and electrical engineering programs. These programs are perceived to be more people-oriented and more attuned to the uses of information technology, whereas computer science and computer engineering are more focused on the technology itself (CRA, 1998).

Library science, for example, which is arguably one of the most IT intensive (and critical) disciplines, is predominantly female. Despite the high levels of education and expertise (the norm is masters level education) this profession has tended to be marginalized in discussions of IT professionals.

Table 3: Gender by Program—Undergraduate Bachelor Degrees Conferred Undergraduate (USA) 1997/8 (IPEDS, 2000)

	Male	Female	Total
Electrical Engineering	11,410 **88%**	1,585 **12%**	12,995
Applied Computer Science	12,874 **76%**	4,118 **24%**	16,992
Business Management and Administration (Commerce)	44,510 **51%**	42,426 **49%**	86,936
Mass Communication and Communication Technologies	19,361 **39%**	29,754 **60%**	49,385
Library/information Science	17 **23%**	56 **77%**	73

This trend is also seen in terms of the gender split within the faculty of these same disciplines although men dominate faculty positions in all disciplines except library/information science.

Table 4: Gender by Program—Undergraduate Bachelor Degrees Conferred Undergraduate (Canada) 1998 (AUCC, 1999)

	Male	Female	Total
Electrical Engineering	7,662 **85%**	1,352 **15%**	9,104
Applied Computer Science	13,848 **79%**	3,677 **21%**	17,525
Business Management and Administration (Commerce)	29,660 **51%**	28,063 **49%**	57,723
Mass Communication and Communication Technologies	2,518 **38%**	4,111 **62%**	6,629
Library Science	27	73	100

	27%	**73%**	

Other	7%

studied computer science or engineering before entering the technology field. A great many had liberal and even performing arts backgrounds. Similarly, a recent survey of members of the "Wired Woman" association revealed that while the majority defined themselves as IT professionals (64%) only a fraction (11%) were computer scientists and none were engineers. Most respondents had non-traditional backgrounds. Most of their computer/IT skills were self-taught or attained though short courses.

Table 5. Gender by Faculty (All ranks)—Canadian Universities (AUCC, 1999)

Gender by Faculty	1999		
	Male	**Female**	**TOTAL**
Electrical Engineering	557 **95%**	31 **5%**	588
Applied Computer Science	728 **86%**	115 **14%**	843
Business Admin. and Mgmt.(Commerce)	1,675 **77%**	491 **23%**	2,166
Mass Communications	145 **68%**	67 **32%**	212
Library/Information Science	27 **40%**	40 **60%**	67

Gender imbalance is aggravated in research centers where IT is narrowly defined as computer science and electrical engineering in contrast to those which are multidisciplinary and focus on the application of technology, for example in education. In Canada, there is a network of centres of excellence funded by the federal government. The Canadian Institute for Telecommunications Research (CITR) Network of Centres of Excellence (NCE) defines interdisciplinary very narrowly – all its researchers are computer scientists and engineers. Only 6% of its board members are women (CITR, 2001). In contrast, the TeleLearning Network of Centres of Excellence (TL-NCE) which focuses on the application of technology to learning and incorporates a wide range of disciplines has a governing board that is 50% female (TL-NCE, 2001).

Further research is needed into the background of IT professionals. Certainly, engineering and computer science graduates are overwhelmingly male. There are strong indications, however, that many women are working in the IT field (broadly defined) from a much broader range of disciplines. For example, Napier et. al, (2000) profiled 57 women who are "movers and shakers" in what is still a heavily male-dominated world of high technology. Few of the women profiled

Table 6. Wired Woman Membership Sample Survey (2001)

Discipline	Wired Women Members
Engineering	0
Computer Science	9%
Library Science	2%
Multimedia	27%
Communications	15%
IT Management	24%
Business/Sales Management	15%

4. DISCIPLINE AND GENDER: A CASE STUDY

The influence of gender on program choice is reflected in a survey of first year information technology-related programs at one Canadian University in 2000. The results revealed women accounted for 15% of students in computer science, 16% in electrical engineering, 35% in information technology management, 44% in new media and 56% in business management. Gender splits in faculty were similar (Cukier and Devine, 2001) (Tables 3 and 4).

One concrete case, that raises many questions, surrounds the revision of IT curriculum in the Faculty of Business and the creation of a new school, the School of Information Technology Management (Cukier, Devine, Pille, 1999). While other factors may have contributed, the revision of the curriculum involved the restructuring and merging of two programs - Administration and Information (AIM) on the one hand and Business Information Systems on the other.

The final curriculum was not substantially different than AIM. Certainly the positioning in the marketplace was different, but at the curriculum level it involved 3 basic changes. Most of the 41 courses required for graduation remained the same with a couple of exceptions:

- the addition of a compulsory programming course
- the addition of a compulsory finance course

In addition, a higher-level math was added to the entry requirements.

In 1999, the first year of the new program and the last year of the AIM program, the math entry requirement was 'preferred' but not required. In that year, as in previous years, women remained the majority (58%) of the incoming AIM students but fell to 39% of the incoming ITM students. In the following year, when math became a requirement, female enrolment in the ITM program fell to 35% of the incoming ITM students.

Table 7. Gender by Program – e.g. Ryerson University

	1999		
	Male	Female	Total
Electrical Engineering	235 88%	32 12%	267
Applied Computer Science	195 83%	40 17%	235
Information Technology Management	186 61%	118 39%	304
Administration and Information Management	47 42%	65 58%	112
Business Management	241 50%	244 50%	485
New Media	22 47%	25 53%	47

	2000		
	Male	Female	Total
Electrical Engineering	217 84%	42 16%	259
Applied Computer Science	272 85%	49 15%	321
Information Technology Management	287 65%	153 35%	440
Administration and Information Management			
Business Management	205 44%	261 56%	466
New Media	29 56%	23 44%	52

At one level, the women accounted for a slightly smaller percentage of the tenure track faculty in the new school of ITM in 2001/2. Interestingly, while 6 of 7 female faculty members had PhDs completed or in progress compared to 5 of 10 male faculty members, only one had an undergraduate degree in computer science or engineering compared to 8 of their 10 male colleagues. Of the women, 3 of 7 have MBAs compared to 4 of 10 men. However, only 3 of the 7 women had higher-level high school math compared to the majority of their male colleagues.

Currently a pilot project is being developed in the school to more fully examine the impact of the new requirements and possible interventions including alternative admission routes, bridging programs, female friendly pedagogical techniques and supports (Cukier and Shortt, 2001).

5. THE GLASS HOUSE: INVISIBLE BARRIERS TO ENTRY?

In light of these findings, more research into the relationship between the entry-level requirements for employment and performance would be fruitful. In addition, there may be value in revisiting assumptions regarding the predictors of success for academic programs as well as employment. Considerable research has been done into systemic and institutional forms of discrimination, which are often unintentional, 'taken-for-granted' artifacts of institutionalized values, beliefs and behaviour such as the existence of requirements, which are not essential to performance and have the unintended consequence of excluding certain groups. For example, it is important to consider alternative routes to computing. "Respect multiple points of entry. Different children will encounter different entry points into computing – some through art, for example, some through design, some through mathematics. These multiple entry points need to be respected and encouraged, while we remain sensitive to activities and perspectives that are appealing to girls and young women" (AAUW, 2000).

In addition, there may be merit in further examining the almost sacrosanct assumption that math is an essential requirement or predictor of performance in IT programs and careers. This concept of course has been reinforced by the assumption that IT is synonymous with computer science and engineering. Considerable research has been conducted into differences in male and female attitudes to mathematics in terms of proficiency, preference, (AAUW, 1991) confidence, (Toronto Board of Education, 1996), as well as female friendly pedagogical approaches (AAUW, 1991). "All students' enthusiasm for mathematics declines as they get older, but the loss of interest among girls is significantly greater. The percentage of girls who like mathematics drops 20 points to 61 percent by high school. The number of boys drops 12 points to 72 percent. And the gap between girls and boys who like mathematics increases 3 points to 11 points" (AAUW, 1991). The issue of mathematics proficiency as the principal indicator of success in information technology academic programs is one area for further exploration.

6. THE EFFECTS OF NARROW DEFINITIONS OF IT

There is strong evidence that a broad range of skills are needed in the IT industry and that IT professionals include a wide range of disciplines. However, much of the discourse regarding 'information technology' still equates IT with computer science and electrical engineering, all of which tend to be male dominated. This has the effect of reinforcing and perpetrating the exclusion of women. We can draw evidence of this

from industry hiring practices, government allocation of funds and in the way IT careers are promoted. Further research is needed but anecdotal evidence suggests the following:
There is evidence of a tension in the discourse between studies that emphasize the need for broad and integrated perspectives for the industry and successful application of the technology on the one hand and the persistent definitions that reinforce narrow and traditional definitions of information technology on the other. For example, the Advisory Council on Science and Technology's Report on the Expert Panel on Skills recognizes the need for a multidisciplinary approach to IT, but still defines IT as computer science and engineering (1999).

Further examination of the ways in which the discourse is reproduced is required, but there is some evidence to suggest that the definitions determine who is included and excluded in the discussions of policy processes, which in turn, reinforce traditional definitions and institutionalized practices. Traditional technology companies, engineers, and computer scientists are dominant in associations and government boards designed to select specialists to develop policies related to 'information technology'. They are also, as a result, predominantly male. For example, the Canadian Advanced Technology Association's board is 96% male (CATA, 2001) and the Information Technology Association of Canada's Board of Directors is 87% male (ITAC, 2001).

Traditional computer science and engineering educational programs are the programs targeted for additional government support. Although disciplines such as library/information science, communications and multimedia are highly relevant to the development and implementation of information systems (and are more gender balanced) they are seldom included in discussions. For example, in Canada, the recent Access to Opportunities Program (ATOP) which funneled $150 million over 3 years into Ontario universities to address the skills shortage in IT focused primarily on computer science and electrical engineering and other programming related programs. There was no consideration of other disciplines or attention to the gender dimensions (Ontario Ministry of Education and Training, 1998). Similarly, funding for research centres is heavily oriented towards traditional technology disciplines. While the guidelines for these programs emphasize the importance of human resources development, their definition of interdisciplinary is often computer science and engineering and no consideration is given to gender (SSHRC/NSERC, Centre of Excellence Evaluation Guidelines, 1996).

Hi-tech companies, dominated by computer scientists and engineers, perpetrate the practice of hiring in their own image and not matching skill set to job requirements. Despite clear evidence that graduates of many technology-related disciplines have the necessary skills and do succeed in the sector, there is clear bias towards hiring from traditional (and also male dominated) disciplines. While evidence suggests that math is an indicator but not the only predictor of success in IT careers, and indeed some have maintained that facility with languages is a better predictor of programming skills than math intensive programs, which women less often choose, are favoured. The assumption is that soft skills (communication, project management, user needs assessment, etc.) are easily learned on the job. Other approaches, for example, selecting for soft skills and providing support or retraining for learning the other skills are seldom considered.

Industry programs aimed at encouraging women to enter IT focus almost exclusively on computer science and engineering despite evidence that individuals with other backgrounds have demonstrated success (IBM Diversity, IBM Canada, 1998).

Many women working in systems analysis and design, systems development, sales and marketing jobs in the hi-tech sector are neither computer scientists nor engineers. Some report experiencing discriminatory work practices as a result not just of being women but also by not being engineers or computer scientists (Wired Woman Survey, 2001).

7. IMPLICATIONS

This paper suggests that defining Information Technology as synonymous with computer science and engineering, has the effect of marginalizing women who already work, study and research in the IT field and has potential implications for government policy, the industry, educational institutions, research and practice. While the paper is exploratory in nature – implications of this perspective on gender and IT are potentially quite broad and global in scope.

First, broadening the definition of IT has implications for addressing the issue of the 'skills gap' identified as a significant challenge to the information technology industry nationally and globally. The growth in the Information Technology sector has been so profound that worldwide demand for people who can design, develop and manage information technology far exceeds the current supply. More empirical research is needed to examine qualifications of those working in the IT profession and studying in IT related disciplines. We need to examine more fully implications of definition as it impacts gender. As well, revisiting fundamental assumptions regarding skills needed for success, sources of those skills and innovative approaches to education, recruitment and training, will not only address the needs of the industry but also equity in academe and the profession. More work on exploring fundamental skills needed for the high demand IT jobs, sources of those skills, training and development, and hiring practices would be fruitful.

Second, effects of the dominant and narrow definition of information technology which excludes multidisciplinary perspectives and women from decision making may actually result in poor technology decision making at the societal and organizational level (Cukier and Bauer, 2000). Not only does this marginalize women who often have played bridging roles between technology and applications, but it also tends to exclude the disciplines most likely to examine technology impacts and unintended consequences. In the context of information technology, it is understood that the failure to take 'practice' or 'user needs' adequately into account is at the root of many systems failures (Lucas, 1999) and may be linked to some current problems associated with the 'productivity paradox'. There is also ample evidence of the prevalence of a 'supply fix' mentality or technology for technology's sake orientation underlying deployment of information technology rather than any effective critique. This is manifest within organizations and in technology marketing and government policy formulation (Menzies, 1989). Further gendered analysis of the definition of information technology and the implications for policy and practice will add to this discussion.

We may also speculate about the effects of this 'tunnel vision' at the organizational level. Traditional systems development life cycle analysis rests heavily on activities such as user needs assessment that requires a broad range of skill and cost/benefit analysis which is predicated on the assumption of 'objective' assessment of technology. In addition, virtually every study of human resources requirements in the information technology sector places emphasis on broad skills. However, despite lip service paid to the importance of incorporating users into systems development, there is much evidence that their views are devalued. 'Users' are viewed as just another input to the system and their involvement often treated as a necessary evil rather than a source of valued insight (Joshi, 1991) and that the technological imperative dominates decision making related to technology (Cukier and Bauer, 2000). Within organizations, computer scientists and engineers often control decisions regarding the deployment of technology. Others are often made to feel unable (unqualified) to provide a critique, to question, or to resist because their perspective is undervalued. It has also been suggested for example, that a more female-influenced industry might also better respond to consumers' needs. Technology would be easier to understand and 'friendlier' products could also reduce business costs as less money might be spent on tech support (the workers who answer customers' questions about puzzling products and services) (Geewax, 2000). More research on the impact of crossing discipline and gender balance on the systems development process would also be a fruitful area to explore.

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