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Silicon Ceilings: Information Technology Equity, the Digital Divide and the Gender Gap among Information Technology Professionals

Andrea M. Matwyshyn

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¶1   Information technology increasingly permeates all aspects of life. In the last ten years, home computers have become, in some sectors of society, nearly as commonplace as telephones, and Internet access has become an apparent necessity for inclusion in mainstream society.[1] As a consequence of this social transformation, new policy dilemmas have arisen and certain entrenched policy dilemmas have gained heightened importance. One such policy issue that has taken on both a new dimension and a higher level of gravity is the threatened marginalization of women in the information technology economy.

¶2   Although women use the Internet in greater numbers than men,[2] the number of women who are information technology professionals—producers of information technology rather than simply consumers—lags far behind that of men.[3] Women still comprise less than a quarter of information technology professionals,[4] only eight percent of information technology engineers,[5] and no more than five percent of information technology management.[6] The percentage of women earning degrees in computer

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[1] U.S. DEP'T OF COMMERCE, NATIONAL TELECOMMUNICATION AND INFORMATION ADMINISTRATION, FALLING THROUGH THE NET: TOWARD DIGITAL INCLUDSION (Oct. 2000), *available at* http://www.ntia.doc.gov/ntiahome/fttn00/contents00.html (last visited Jan. 26, 2004).

[2] Women accounted for 50.6 percent of U.S. Internet users in December 2000 according to the Pew Internet and American Life Foundation. Janet Kornblum, *Web Users Look Like America, Only Richer*, USA TODAY, Feb. 8, 2002, *at* http://www.usatoday.com/tech/news/2001-02-19-ebrief.htm (last visited Jan. 26, 2004).

[3] U.S. DEP'T OF COMMERCE, *supra* note 1; Kendra Mayfield, *Why Girls Don't Compute*, WIRED NEWS, Apr. 20, 2000, *at* http://www.wired.com/news/culture/0,1284,35654,00.html (last visited Jan. 26, 2004). As used in this journal paper, the term "information technology industry" includes the production of goods and services that support information technology enabled business practices throughout the economy. Thus, the term "information technology professional" as used in this article refers not only to those individuals who write code but also those individuals in management or business operations employed within the information technology industry.

[4] Cisco Learning Inst., *Gender Initiative*, *at* http://gender.ciscolearning.org (last visited Jan. 1, 2004).

[5] Penn State School of Information Sciences and Technology, *Penn State Study Could Hold Key to More Women in IT Field* (Aug. 7, 2002), *at* http://ist.psu.edu/news/News2.cfm?HeadlineID=672 (last visited Jan. 26, 2004).

[6] Cisco Learning Inst., *supra* note 4.

science has declined steadily since 1984 and the attrition rate among women computer science students is higher than among men.[7] In particular, minority women make up not more than two percent of information technology professionals in the United States.[8] Furthermore, research has indicated that these percentages will decline.[9]

¶3   The gender disparity in interest to learn about information technology is already firmly entrenched at the undergraduate level. According to the Department of Commerce, only 1.1 percent of undergraduate women select information technology disciplines as compared to 3.3 percent of male undergraduates in 1998,[10] and the percentage of women earning bachelor's degrees in information technology fields has dropped steadily since 1984.[11] In the words of the U.S. Office of Technology Policy:

> Women—who comprise 51 percent of the population and earn more than half of all bachelor-level degrees awarded—earn about one-quarter of the bachelor-level computer and information sciences degrees awarded by U.S. academic institutions. More disturbing is the trend line: the share of all computer science degrees awarded to women in the United States has fallen steadily from a peak of 35.8 percent in 1984, to only 27.5 percent in 1994—the lowest level since 1979.[12]

Since 1994, this trend has continued. In 2000, the percentage of undergraduate women earning bachelor-level computer and information science degrees awarded by U.S. academic institutions dropped further to only twenty-one percent.[13] These statistics on

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[7] THE CONGRESSIONAL COMMISSION ON THE ADVANCEMENT OF WOMEN AND MINORITIES IN SCIENCE, ENGINEERING AND TECHNOLOGY DEVELOPMENT, LAND OF PLENTY: DIVERSITY AS AMERICA'S COMPETITIVE EDGE IN SCIENCE, ENGINEERING AND TECHNOLOGY at 31, 40 (National Science Foundation, 2000), *at* http://www.nsf.gov/od/cawmset/report/cawmset_report.pdf [hereinafter CONG. COMM'N].

[8] *Id.* at 46; Terence Chea, *Panel Urges Bigger Pool For Tech Jobs*, WASH. POST, July 14, 2000, *available at* http://www.popstop.org/pages/h1b/wp_071400.html (last visited Jan. 1, 2004). Whites represent approximately eighty-two percent of the information technology workforce but only seventy-six percent of the general workforce. Latinos comprised approximately three percent of the information technology workforce, as compared to approximately ten percent of the general workforce. Latino women comprised less than one percent of the information technology workforce in 1997. CONG. COMM'N, *supra* note 7, at 44-46.

[9] AMERICAN ASS'N OF UNIVERSITY WOMEN ("AAUW") EDUCATIONAL FOUNDATION COMMISSION ON TECHNOLOGY, GENDER, AND TEACHER EDUCATION, TECH-SAVVY: EDUCATING GIRLS IN THE NEW COMPUTER AGE (AAUW Educational Foundation 2000), *available at* http://www.aauw.org/research/girls_education/techsavvy.cfm (last visited Jan. 1, 2004).

[10] COMPUTING RESEARCH ASS'N, THE SUPPLY OF INFORMATION TECHNOLOGY WORKERS IN THE UNITED STATES (1999), *at* http://www.cra.org/reports/wits/cra.wits.html (last visited Jan. 1, 2004)

[11] *Id.*

[12] U.S. DEP'T OF COMMERCE, OFFICE OF TECHNOLOGY POLICY, AMERICA'S NEW DEFICIT: THE SHORTAGE OF INFORMATION TECHNOLOGY WORKERS 24 (1998), *available at* http://www.technology.gov/reports/itsw/itsw.pdf (last visited Jan. 1, 2004).

[13] Dragana Brzakovic, Increasing Opportunities for Women in U.S. Science and Engineering: Contemporary Issues and Trends, Address at EARMA: Successful Initiatives in Modern Human Resource Management to Promote Equal Opportunity in Science and Science Management (National Science Foundation Jun. 15, 2002), *at* http://www.nsf.gov/od/oia/presentations/brzakovic/SE_Women_june02.ppt (last visited Jan. 22, 2004).

the college level imply that by the time women select majors in college, they may have already decided against information technology professions.[14]

¶4   The existence of this gender gap, which might be termed the "gendered digital production divide," has been acknowledged repeatedly in Congress[15] and internationally[16]

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[14] It is true that some information technology professions are not necessarily foreclosed as a consequence of the decision by an individual not to obtain a computer science related degree. Training can be acquired for some types of information technology fields through programs not related to universities. Also, some information technology professionals lack college degrees.

[15] *See* H.R. Rep. No. 107-809, *11-12 (2003) (discussing the need for more National Science Foundation (NSF) funds for women and minority owned businesses), *available at* 2003 WL 394127; S. Rep. No. 107-317, *5 (2002) (discussing NSF Funding Doubling Act and need to encourage women in the sciences), *available at* 2002 WL 31342884; S. Rep. No. 107-291, *2 (2002) (discussing women and the NSF Funding Doubling Act), *available at* 2002 WL 31116820; H.R. Rep. No. 106-1040, *19 (2001) (discussing Women's Educational Equity Act), *available at* 2001 WL 29435; H.R. Rep. No. 106-821(I), *10 (2000) (discussing "Go Girl Grants" under The National Science Education Act), *available at* 2000 WL 1279138; P.L. 105-255 (HR 3007) § 2 Findings (1998) (discussing the Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development Act); H.R. Rep. No. 105-177, *34 (1997) (discussing single pregnant women as target for vocational technical education programs), *available at* 1997 WL 398817; H.R. Rep. No. 103-888, 157 (1995) (discussing women's careers in science and technology), *available at* 2000 WL 1279138; H.R. Rep. No. 103-475, *1 (1994) (defining Education Support for Underrepresented Groups to include supporting women in sciences as NSF goal), available at 1994 WL 133035; S. Rep. No. 102-65, *1 (1991) (discussing nontraditional employment for women), *available at* 1991 WL 102758; S. Rep. No. 101-412, *1 (1990) (discussing improving excellence in mathematics and science for women and minorities), *available at* 1990 WL 201663; H.R. Rep. No. 101-571, *1 (1990) (discussing need for Task Force for Women, Minorities and the Handicapped in Science and Technology), *available at* 1990 WL 258835; SUBCOMMITTEE ON LABOR OF THE COMMITTEE ON LABOR AND HUMAN RESOURCES, WOMEN IN THE NONTRADITIONAL WORKFORCE. HEARING BEFORE THE UNITED STATES SENATE, ONE HUNDREDTH CONGRESS, FIRST SESSION ON EXAMINING THE PROBLEMS FACING WOMEN WHO SEEK JOBS IN FIELDS TRADITIONALLY DOMINATED BY MEN, PARTICULARLY IN CONSTRUCTION AND HIGH TECHNOLOGY AREAS (1987); H.R. Conf. Rep. No. 96-1474 (1980) (Section 21 of NSF Funding Act grants special focus for programs for women and minorities); S. Rep. No. 96-713, at *5 (1980) (discussing need for women in science) *available at* 1980 WL 12931; 144 Cong. Rec. S11303-02 (1998) (passing the creation of the Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development), *available at* 1998 WL 673036; 144 Cong. Rec. H7664-01 (1998) (establishing the Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development and stating that women face artificial barriers in the information technology field and that technology has been a historically male profession), *available at* 1998 WL 609468; 144 Cong. Rec. S10423-02 (1998) (proposing the establishment of the Commission on the Advancement of Women in Science, Engineering, Technology Development and acknowledging discrimination against women in technology), *available at* 1998 WL 634148; 143 Cong. Rec. E2317-02 (1997) (introducing the Women in Science, Engineering, and Technology Development Act), *available at* 1997 WL 696777; 142 Cong. Rec. E1180-03 (1996) (introducing the Commission on the Advancement of Women in Science and Engineering Workforce Act), *available at* 1996 WL 360817; 139 Cong. Rec. E690-01 (1993) (stating that girls are less likely to pursue technology careers than boys), *available at* 1993 WL 76511; 139 Cong. Rec. E98-01 (1993) (introducing the Women in Science and Engineering Act and stating that women are grossly underrepresented and face barriers in recruitment, retention and advancement), *available at* 1993 WL 1841; 138 Cong. Rec. E3029-01 (1992) (acknowledging the existence of sexism in science), *available at* 1992 WL 253494; 138 Cong. Rec. E3032-02 (1992) (recognizing discrimination against women in science), *available at* 1992 WL 253499; 138 Cong. Rec. S16439-03 (1992) (proposing the Advancement of Women in Science and Engineering Work Forces Act), *available at* 1992 WL 274943; 138 Cong. Rec. H9749-01 (1992) (passing the establishment of the Commission on the Advancement of Women in the Science and Engineering Work Forces Act and acknowledging past and continuing discrimination against women in the sciences), *available at* 1992 WL 250121; 137 Cong. Rec. H8471-04 (1991) (acknowledging that women face barriers in science related fields), *available at* 1991 WL 219976; 137 Cong. Rec. E3246-01 (1991) (introducing the Women in Science, Engineering, Apprenticeships, and Nontraditional Occupations Act and acknowledging barriers faced by women in science); 137 Cong. Rec. E1496-01 (1991) (introducing the Women and Minorities in Science and Mathematics Act of 1991 and acknowledging discrimination against girls and calling for reform of the

for over twenty years[17] to no avail. Despite repeated acknowledgement, only limited legislative[18] and private sector[19] efforts to eliminate this gender gap in information technology production have been implemented. Meanwhile, the social importance of information technology was fundamentally altered between late 1998 and 2001. No substantive legislative attention has been paid to the gendered production divide in this post Internet boom era, and arguably the last two decades of efforts have been misdirected and ineffective in the aggregate.[20] The limited legislative efforts to date to increase numbers of women among information technology professionals may have failed partially because they have been primarily focused on adults.[21] Gender disparities in information technology career interest are traceable throughout the educational system.[22] In 1999, girls comprised only nine percent of high school students taking information technology related advanced placement (AP) exams.[23] Therefore, girls' self-selection away from computers occurs before the college level. Consequently, a more promising point for intervention is during girls' early high school and junior high school years.

¶5   Thus, this article calls for the revitalization of the legislative, social policy and academic discourse regarding the causes and appropriate remedies for the gender gap among information technology professionals, with two critical differences. First, this article theoretically reframes the issue of women's under-representation among information technology professionals by presenting it as primarily a technology equity policy issue to be discussed in the context of the digital divide discourse. Second, this article argues for a legislative intervention effort primarily focused on education in the junior-high and high school levels by catalyzing corporate participation in the information technology workforce education process through mentorship programs.[24]

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educational system), *available at* 1991 WL 67193; 135 Cong. Rec. H1716-02 (1989) (authorizing the Applied Technology Amendments and incorporating a "tech-prep" program that encourages coordination between high schools and community-based colleges and reviewing applied technology education programs for bias against women for girls ages 14-25), *available at* 1989 WL 175358.

[16] *See* Andrew Swinton, *Government Calls for More Women in IT*, ZDNET UK, Oct. 18, 2001, *at* http://news.zdnet.co.uk/business/employment/0,39020648,2097585,00.htm (last visited Jan. 1, 2004).

[17] *See* S. Rep. 96-713 (discussing P.L. 96-516, National Science Foundation Authorization and Science and Technology Equal Opportunities Act), *available at* 1980 WL 12931; H.R. Conf. Rep. 96-1474 (discussing P.L. 96-516, National Science Foundation Authorization and Science and Technology Equal Opportunities Act), *available at* 1980 WL 12932.

[18] CONG. COMM'N, *supra* note 7.

[19] *Id.*

[20] Undoubtedly, however, intervention efforts to date have encouraged individual women to pursue careers in information technology.

[21] *See* Carl D. Perkins Vocational and Applied Technology Education Act of 1998, 20 U.S.C. §2301 (2003). Although the Perkins Act was amended to include technology education as a particular area of concentration for funding, it is not evident that large scale concentrated efforts have resulted from this amendment, certainly not on the level of intervention efforts in the context of the digital access divide at the high school level.

[22] *See* AAUW, *supra* note 9; Press Release, Loyola University, Teens Launch Future Entrepreneur Careers at AT&T/Coleman Foundation Girls Summer Web Camp (Jul. 15, 2002), *available at* http://www.cimt.luc.edu/womenandtechnology/docs/news_release.pdf (last visited Jan. 1, 2004).

[23] *See* AAUW, *supra* note 9.

[24] The legal literature has, as yet, only tentatively ventured into information technology policy debate. The legal literature has not addressed the policy issues at the intersection of information technology production and gender.

¶6   Specifically, this article presents a social policy analysis of issues surrounding the under-representation of women among information technology professionals, which might be termed the "gendered digital production divide." The article argues that:

(1) The absence of women in the information technology industry constitutes a production divide that is socially undesirable for reasons of social governance, social cohesion, and economic self-realization;
(2) The roots of this production divide are multifaceted, straddling various layers of society's human ecology;
(3) Attention to this production divide is overdue, and developmentally-sound social policies that incorporate insights from multiple disciplines should be crafted in order to most efficiently increase women's presence in the information technology industry; and
(4) Such social policy interventions are most efficiently focused on secondary and pre-secondary educational settings.

Constitutionally permissible educational experimentation, particularly experimentation that incorporates the private sector, should be encouraged.

¶7   Part I sets forth the proposition that the scope of the academic digital divide discourse should be redefined to include not only concerns of Internet access but also broader concerns of information technology equity. Specifically, the academic and policy polemic surrounding the digital divide should contemplate issues of economic power in a two-fold manner: the framing of the debate should include both an examination of issues related to digital access divides and an examination of issues related to digital production divides. Part I further argues that although literature has burgeoned with regard to access divides, production divides have not been addressed as zealously although they have long existed in pre-Internet incarnations. As we conclude the first decade of Internet regulation and policy, we are closer to successfully eliminating access divides in the United States.[25] However, production divides have been neglected and present a serious threat to information technology equity and governance in the next decade. The economy of the United States has become increasingly dominated by information and product flows mediated by information technology. E-commerce increased almost 30 percent between fourth quarter 2001 and fourth quarter 2002 and will, undoubtedly, continue to grow.[26] Similarly, the penetration of Internet access has progressed dramatically, with new consumers getting online and existing Internet consumers becoming more comfortable with commerce in virtual space.[27] Inevitably, economic forces will increasingly arise from and be contingent upon information technology. The absence of women and minorities in representative numbers from the production end of these economic forces may result in a future where women's and

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[25] U.S. DEP'T OF COMMERCE, *supra* note 1.
[26] Press Release, U.S. Census Bureau, Retail E-Commerce Sales in Fourth Quarter 2002 Were $14.3 Billion, up 28.2 Percent from Fourth Quarter 2001 (Feb. 2003), *available at* http://www.census.gov/mrts/www/data/pdf/20024.pdf (last visited Jan. 1, 2004).
[27] U.S. DEP'T OF COMMERCE, *supra* note 1.

minorities' progress toward economic parity with men is slowed or counteracted.[28] Also, perhaps even more importantly, women and minorities will lack a voice in the construction of the technologies that mediate and govern their lives. Ultimately, because governance structures are inherently bound up with and influenced by technology, the end result may be the effective marginalization of women and minorities within society, hindering their full participation in their own governance.[29] This type of information technology inequity is socially undesirable, and, consequently, current legislative, policy and academic discourse surrounding information technology equity and the "digital divide" should more aggressively address the under-representation of women and minorities in digital production.

¶8   Part II introduces one production divide, the ever-increasing gender gap among information technology professionals, and it performs what might be termed a "socio-ecological" policy analysis[30] of this divide through an examination on the "macrosystem,"[31] "mesosytem,"[32] and "microsystem"[33] levels of society. The macrosystem, or societal level, addresses the individual's development within her society. Specifically, forces of social governance through law, informal mechanisms, and forces within civil society (such as cultural and industry bias) influence the inclusion of women in the information technology industry. On the mesosystem or interpersonal level, the entry of women into information technology is influenced by low enrollment of girls in information technology courses, lack of encouragement and role models, and suboptimal information technology curriculum. The microsystem level, which focuses on the individual herself, presents obstacles for women's entry into information technology careers because many women hold negative attitudes toward information technology or lack computer confidence.

¶9   Part III discusses legislative and policy initiatives undertaken to address the information technology gendered production divide. Inadequate legislative attention has been allocated to the gendered production divide, and efforts to eliminate the divide have not targeted girls at the junior high and high school levels, developmentally an efficient window for such encouragement. Finally, Part III argues that intervention is required and that, although interventions on all levels of social ecology are needed, efforts that focus on the educational system are more likely to produce results. Perhaps the key obstacle that prevents greater numbers of girls from entering the information technology field is girls' tendency to hold negative attitudes toward careers in information technology. Facilitating the elimination of this obstacle is a necessary component of any successful legislative and policy effort to address the gendered production divide. As such, innovative experimental educational programs in cooperation with the private sector

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[28] *See* AFL-CIO*, It's Time for Working Women to Earn Equal Pay, at* http://www.aflcio.org/yourjobeconomy/women/equalpay (last visited Jan. 1, 2004).

[29] *See* Part I.A.1 *infra.*

[30] An ecological policy analysis consists of a systematic examination of a policy issue on multiple levels of analysis—the macrosystem level of institutions of governance, the mesosystem level of interpersonal and subcultural interactions, and the microsystemic level of individual development. This construct is based on Bronfenbrenner's work in the context of human development. *See* URIE BRONFENBRENNER, THE ECOLOGY OF HUMAN DEVELOPMENT: EXPERIMENTS BY NATURE AND DESIGN (Harvard University Press 1979).

[31] *Id.* at 258.

[32] *Id*. at 209.

[33] *Id*. at 11.

should be encouraged to the greatest extent permitted by the Constitution. In particular, programs facilitating mentorship opportunities offer a promising method of both humanizing information technology for girls, thus improving their attitude toward careers in information technology, and catalyzing a re-conceptualization of corporate citizenship, thus instilling a greater sense of corporate responsibility for the education of future work forces and for eliminating digital production divides. Efforts to date to encourage girls' entry into information technology fields have failed in the aggregate. With continued neglect, the gender gap among information technology professionals will undoubtedly increase.

I. DEFINING THE "DIGITAL DIVIDE"

¶10   The escalating importance of the Internet and other forms of information technology in daily life is incontrovertible. This encroaching omnipresence of information technology has fundamentally transformed the nature of the social debate over information technology policy. Information technology equity and the digital divide have been described by some authors as the civil rights issue of the new millennium.[34] Although courts to date have not recognized a protectable individual level interest in information technology equity,[35] civil society and legislative bodies have begun to focus attention on the role of information technology in society and the developmental consequences of individuals' use of information technology.[36]

¶11   The term "digital divide" has been used by academics and policymakers to describe the gap that exists within and across countries between information technology "haves" and "have nots"—those individuals and groups with access to information technology, specifically the Internet, and those individuals without such access.[37] However, as discourse regarding the digital divide has progressed, the usage and expanse of the term have burgeoned. This spiraling use of the term has pushed some Internet researchers to call for greater definitional specificity. These researchers assert that the digital divide contains numerous overlapping elements and in truth is not a single issue;[38] the digital divide is actually a series of issues that create inequities for different reasons.[39]

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[34] *See generally,* Patricia F. First & Yolanda Y. Hart, *Access to Cyberspace: The New Issue in Educational Justice*, 31 J.L. & EDUC. 385 (2002); Donald R. Tetreault, *Technology Equity: Are We Asking the Right Questions?* 66 SCHOOL BUSINESS AFFAIRS 28 (2000) (arguing that existing civil rights laws should be applied to obtain universal access to cyberspace).

[35] *See* Access Now, Inc. v. Southwest Airlines, Co., 227 F. Supp. 2d 1312 (S.D. Fla. 2002).

[36] *See* 15 U.S.C. §§ 6501-6506 (2003).

[37] Rowena Cullen, Addressing the Digital Divide, (Aug. 16-25, 2001) (unpublished manuscript, on file with the Victoria University of Wellington), *available at* http://www.confer.co.nz/lianza2002/PDFS/cullen.pdf (last visited Jan. 26, 2004).

[38] Allen S. Hammond, *The Digital Divide in the New Millennium*, 20 CARDOZO ARTS & ENT. L.J. 135 (2002); Int'l Literacy Inst. & Centre for Educ. Research and Innovation [hereinafter Int'l Literacy Inst.], The Lifelong Learning and New Technologies Gap: Reaching the Disadvantaged (Dec. 8-10, 1999) (unpublished manuscript), *available at* http://www.literacyonline.org/products/ili/pdf/IP0001.pdf (last visited Feb. 4, 2004).

[39] *See generally*, Andrew G. Celli, Jr. & Kenneth M. Dreifach, *Postcards from the Edge: Surveying the Digital Divide*, 20 CARDOZO ARTS & ENT. L.J. 53 (2002) (arguing that three separate digital divides exist: technology access, capital access, and treatment differences among different consumers in pricing and purchase terms); Education Week, *Technology Counts 2001: The New Divides* (2001), *available at* http://www.edweek.org/sreports/tc01 (last visited Jan. 1, 2004); William E. Kennard, *Equality in the Information Age*, 51 FED. COMM. L.J. 553 (1999) (arguing that access divides to tools of learning and

¶12   Ultimately, the issues encompassed in the idea of a digital divide—regardless of how broadly or narrowly the term "digital divide" itself is defined—can all be classified as part of a broader set of policy questions relating to information technology equity. Generally speaking, information technology equity issues can be divided into two rubrics:

> (1) Issues of equal access for all potential *consumers* of information technology; and
>
> (2) Issues of equal access for all potential *producers* of information technology, enabling them to participate in the research, development, and production of information technology.

An inequality in the first might be termed a "digital access divide," and an inequality in the second might be termed a "digital production divide."

A. Digital Access Divides

¶13   A digital access divide refers to a lack of Internet access. Such a divide might be viewed as, fundamentally, a gap in ability to obtain information: certain individuals have access to digitally purveyed information, while certain other individuals do not.

1. The Contours of the Access Divides

¶14   Numerous studies have investigated which individuals in the United States generally have access to the Internet, digital "haves," and which individuals and groups tend to be "have-nots." This body of research has examined demographic differences in digital access, including differences in income, race, education, household type,[40] age, urbanization,[41] disability,[42] geography, attitudes toward computers, language fluency and length of exposure to information technology.[43]

¶15   Social science research on access divides highlights an underlying complexity that hinders remedial action targeting elimination of access divides: various causal factors cannot be easily parsed out from one another.[44] For example, although the number of low income and minority households with Internet access is increasing, some evidence indicates that access appears to be tied to income.[45] Therefore, it can be argued that without mitigating the underlying poverty of certain segments of society, universal access may not be possible. Many stakeholders are involved, and some of the most relevant

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broadcast diversity exist because of costs associated with Internet access and low minority ownership of broadcasting entities).

[40] U.S. DEP'T OF COMMERCE, *supra* note 1 (finding that at the lowest income levels, urban residents are more than twice as likely to have Internet access than are rural residents earning the same income).

[41] *Id*.

[42] Stephen H. Kaye, *Disability and the Digital Divide*, DISABILITY ABSTRACTS NO. 22 (2000) (finding that Americans with disabilities are less than half as likely as their counterparts to own a computer and about one-quarter as likely to use the Internet), *available at* http://dsc.ucsf.edu/pdf/abstract22.pdf (last visited Jan. 1, 2004)

[43] Education Week, *supra* note 39.

[44] Int'l Literacy Inst., *supra* note 38.

[45] Janice Hinson & Cathy Daniel, Connecting Across Many Divides: Digital, Racial, and Socio-Economic, Address Before the National Educational Computing Conference (Jul. 25-27, 2001), *available at* http://home.earthlink.net/~anebl/hinson.pdf (last visited Jan. 1, 2004).

variables are infrequently influenced by policy initiatives.[46] Similarly, consensus on measurement and documentation of the digital divide is lacking,[47] and firm criteria have not yet been established for determining in what circumstances this access divide will be deemed closed.[48] Notwithstanding these caveats, progress toward universal access is being achieved.[49] Between 1994 and 1998, the number of Americans owning computers increased by over fifty percent, and the number of households using e-mail quadrupled.[50] Between December 1998 and July 2000, the percentage of households with Internet access increased by fifty-eight percent.[51] Over half of all households had computers by July 2000,[52] and individuals using the Internet rose by a third.[53]

¶16   Technologically disadvantaged minority groups are closing gaps between themselves and the digital "haves."[54] Research indicates that between 1994 and 2000, African-Americans and Latinos demonstrated gains in Internet access, and the disparity in Internet usage between minority women and men almost disappeared.[55] However, Latino and African-American households were still less likely to own computers than Caucasian and Asian-American households.[56] Latinos were also significantly disadvantaged in terms of knowledge of technology,[57] and African-Americans were the most likely to be totally detached from the information age.[58] Nevertheless, African-Americans without access were more likely than Caucasians or Asian-Americans without access to state that they wanted to acquire access to a computer.[59]

¶17   Increasing levels of household income and education increased the likelihood of access to a computer, regardless of race.[60] When students were considered, race made a difference. African-American students who lacked a computer at home tended to have difficulty finding an alternative means of Internet access, while white students had less difficulty.[61] Results showed, however, that if access was ensured, use tended to follow.[62]

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[46] Int'l Literacy Inst., *supra* note 38.

[47] Hammond, *supra* note 38.

[48] *Id.*

[49] U.S. DEP'T OF COMMERCE., *supra* note 1.

[50] U.S. DEP'T OF COMMERCE, NAT'L TELECOMM. & INFO. ADMIN., FALLING THROUGH THE NET II: NEW DATA ON THE DIGITAL DIVIDE (Jul. 1998), *available at* http://www.ntia.doc.gov/ntiahome/net2/falling.html (last visited Jan. 26, 2004).

[51] *Id*.

[52] *Id.*

[53] *Id.*

[54] *Id.*

[55] *Id.*

[56] REGIONAL TECH. ALLIANCE, MAPPING A FUTURE FOR DIGITAL CONNECTIONS, 7-8 (Cliff Numark ed., Feb. 2001), *available at* http://jobs.sandiegoatwork.com/rta_report_0201.pdf (last visited Jan. 1, 2004).

[57] *Id*. at 7.

[58] *Id.*

[59] Donna L. Hoffman & Thomas P. Novak, *Bridging the Racial Divide on the Internet*, 280 SCIENCE 380-381(Apr. 17, 1998), *available at* http://www.sciencemag.org/cgi/content/full/280/5362/390 (last visited Jan. 26, 2004) (password required to access document).

[60] *Id*.

[61] *Id.*

[62] *Id*. At the college level, African-American students at historically black colleges and universities reported ninety-eight percent access to the Internet, Web and campus networks. However, concerns existed with regard to the access divide in the areas of student access to networking and computing resources; usage of higher bandwidth technologies for accessing the Internet, Web, or other networks; faculty use of Web-based resources in the classroom and in professional development and exchange; awareness of the

Nationally, individuals with college degrees were more likely than individuals with only an elementary school education to own a personal computer.[63] Single parent households, the elderly, and rural households[64] were also less likely to be online and own computers.[65] Similarly, the gap between U.S. rural households and urban households in percentage of Internet penetration has narrowed.[66]

¶18   One access divide that is not diminishing, however, is an access divide between developed and less-developed countries internationally.[67] Advocates of globalization argue that eliminating these geographically-based inequalities in Internet access will benefit both developed and less-developed countries.[68] Although the Internet has had a profound political, social, and economic effect on less developed countries,[69] information technology has also further exacerbated the uneven distribution of wealth, physical development, and literacy between less-developed and developed countries.[70] However, regardless of whether technological globalization is viewed as progress, global universal Internet access is clearly a distant goal; even the United States has not yet reached universal access levels. In fact, true universal access, though perhaps ideal, may not be a realistic aim. For example, the level of penetration of the telephone in the U.S. is not truly universal, remaining relatively constant at the level of 93.8 % nationwide.[71]

¶19   Some authors have argued that aside from access divides related to infrastructure connection, another type of access divide relates to accessibility of Internet content.

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importance of network security; and use and maintenance of technology strategic plans to include innovation and update changing technology. These problems were particularly visible at smaller, private, rural institutions. *See* NAT'L ASS'N FOR EQUAL OPPORTUNITY IN HIGHER EDUCATION, HISTORICALLY AFRICAN-AMERICAN COLLEGES AND UNIVERSITIES: AN ASSESSMENT OF NETWORKING AND CONNECTIVITY (2000), *Available at* http://search.ntia.doc.gov/nafeo.pdf (last visited Feb. 4, 2004).

[63] REGIONAL TECH. ALLIANCE, *supra* note 56, at 14.

[64] *See* Rosie Simpson, *The Internet & Regional Australia: How Rural Communities Can Address the Impact of the Internet* (Jun. 2001) (arguing that the decline in traditional agriculture's terms of trade and fewer employment opportunities has seen many rural communities looking for new means to survive, and that the Internet may also pose a threat, further opening up communities to global forces outside their control), *at* http://www.rirdc.gov.au/reports/HCC/01-087.pdf (last visited Jan. 26, 2004).

[65] REGIONAL TECHN. ALLIANCE, *supra* note 56; Stephen G. Katsinas & Pat Moeck, *The Digital Divide and Rural Community Colleges: Problems and Prospects*, 26 CMTY. COLL. J. RESEARCH & PRACTICE 207-224 (Mar. 2002).

[66] U.S. DEP'T OF COMMERCE, *supra* note 1, at 4.

[67] *See* Ramli Abdul Samad, *The Double Edged Sword: A Brief Comparison of Information Technology and Internet Development in Malaysia and Some Neighbouring Countries*, 27 IFLA J. 314 (2001).

[68] Peter K. Yu, *Bridging the Digital Divide: Equality in the Information Age*, 20 CARDOZO ARTS & ENT. L.J. 1, 16-29 (2002); *see also* Nate Brennaman, *G8's Dotforce Initiative: Bridging the Digital Divide or Widening It?,* 11 MINN. J. GLOBAL TRADE 311 (2002) (arguing that that the G8 Dotforce program to introduce information and communication technologies into developing countries is likely to widen the digital divide rather than reduce it because of ambiguities in the program and implementation difficulties).

[69] Samad, *supra* note 67.

[70] *Id.*

[71] U.S. DEP'T OF COMMERCE, *supra* note 1. Despite the high levels of penetration of the telephone, a racial divide is evident: whites still have a far higher telephone penetration rate (95.9 %) than African-Americans (86.0 %) and Latinos (86.5 %). *But see* Jennifer S. Light, *Rethinking the Digital Divide*, 71 HARVARD EDUC. REVIEW 4 (2001) (comparing the digital divide debate to debates over access to cable in the 1960s and 1970s, arguing that access to technology is constructed as a social problem, and concluding that the current debate is different because it accepts the premise of technological determinism and assumes that closing the gap will mitigate broader social inequities), *available at* http://www.edreview.org/harvard01/2001/wi01/w01light.htm (last visited Jan. 1, 2004) (password required to access document).

These authors assert that accessibility of content is limited due to the scarcity of information regarding users' local communities, literacy limitations, language barriers and the lack of cultural diversity in Internet content. They estimate that at least twenty percent of U.S. residents face one or more content-related barriers that leave them underserved.[72] Notwithstanding the foregoing, in general, the research demonstrates a consensus that progress toward remedying access divides within the U.S. is being achieved.

2. Successful Intervention in Access Divides

¶20   The contraction of existing access divides in the U.S. has resulted in part from public and private sector interventions designed to eliminate infrastructure barriers to access.[73] For example, federally funded programs have lowered costs of Internet access for underserved communities. Such programs include the Education Rate (E-Rate) program, which permits schools and libraries[74] to establish Internet connections at discounted rates, the National Telecommunications and Information Administration's Telecommunications and Information Infrastructure Assistance Program,[75] several programs sponsored by the Federal Communications Commission and the Commerce Department,[76] and programs facilitated by funding made available through the Library Services and Technology Act.[77]

¶21   Schools are, rightfully, a primary locus of efforts to bridge the access divide. Authors have argued that the federal programs such as E-Rate have helped many schools incorporate technology into their classrooms.[78] Elementary schools are rapidly closing the gap that used to separate them from high schools. Small schools are nearly as likely to

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[72] THE CHILDREN'S PARTNERSHIP, ONLINE CONTENT FOR LOW-INCOME AND UNDERSERVED AMERICANS: THE DIGITAL DIVIDE'S NEW FRONTIER (2000). Factors preventing low income and minority people and communities from participating fully in the information age include lack of relevant content, lack of adequate literacy, lack of training, and lack of alleviation of fear. *See* Julia R. Gordon, *Legal Services and the Digital Divide*, 12 ALB. L.J. SCI. & TECH. 809 (2002).

[73] THE PRESIDENT'S INFORMATION TECHNOLOGY ADVISORY COMMITTEE, RESOLVING THE DIGITAL DIVIDE: INFORMATION, ACCESS, AND OPPORTUNITY (Feb. 2003), *available at* http://www.hpcc.gov/pubs/pitac/digital_divide/pres-2feb00-ddfinrep.pdf (last visited Jan. 1, 2004).

[74] The role of libraries in reducing the access divide at the national and global levels is generally considered to be very important. *See* Cullen, *supra* note 37.

[75] U.S. DEP'T OF COMMERCE, *supra* note 1; Charles R. McClure, et al., *Public Library Internet Services and the Digital Divide: The Role and Impacts from Selected External Funding Sources* (Florida State University 2002)*, at* http://www.ii.fsu.edu/getProjectDetail.cfm?pageID=9&ProjectID=7 (last visited Jan. 1, 2004).

[76] James M. Lonergan, *Internet Access and Content for Urban Schools and Communities*, 157 ERIC DIGEST (2000), *available at* http://www.edrs.com (ERIC doc. no. ED446180) (last visited Feb. 3, 2004).

[77] McClure, *supra* note 75 (citing the cost of computers for education as a major problem for approximately twenty percent of community college students); Kent A. Phillippe & Michael J. Valiga, *Faces of the Future: A Portrait of America's Community College Students,* American Association of Community Colleges (2000), *available at* http://www.edrs.com (ERIC doc. no. ED439760) (last visited Feb. 3, 2004).

[78] Under the current Bush Administration, schools are facing funding cuts and E-Rate implementation challenges, and such progress may be threatened. *See* Sister Dale McDonald, *Capital Info: E-Rate for Everyone*, 32 MOMENTUM 2 (2000). Originally, schools with lower concentrations of poor students and suburban schools were more likely to have Internet access, but by 1996, all schools were equally likely to have Internet access. Urban schools remain more likely to have more students per computer with Internet access. *See* Lonergan, *supra* note 76.

use certain technologies as are large schools.[79] However, some researchers indicate that schools still have room to improve not only in infrastructure access but also in content access. In particular, schools should focus on improving their technology curricula[80] and training teachers to play a more active role in shaping students' attitudes toward information technology.[81] Echoing these suggestions, in 1999, Congress established the Web-based Education Commission[82] which explored ways the Internet could change education delivery. The Commission identified several key barriers that are preventing the realization of the Internet's full potential for enhancing learning. The Commission called for making powerful new Internet resources, especially broadband access, available and affordable for all learners.[83] The Commission also suggested providing continuous and relevant training and support for educators and administrators; building a new research framework of how people learn in the Internet age; developing quality online educational content that meets the highest standards of educational excellence; revising outdated regulations that impede innovation and replacing them with approaches that embrace anytime, anywhere, any-pace learning; protecting online learners and ensuring their privacy; and sustaining adequate funding through traditional and new sources.[84]

¶22   Finally, innovative private sector programs have been influential on a local level. Some authors have argued that the information technology industry should provide meaningful contributions to explicitly subsidize programs to help close the divide.[85] One such program is WorldGate Internet School to Home (WISH), which gives students, parents and teachers Internet access through a television set and a cable set-top converter, eliminating the need for computer ownership.[86] Intervention efforts have also included building community technology centers and creating partnerships among libraries, schools, and the private sector.[87]

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[79] ANNE WAJCIK, MARKET DATA RETRIEVAL, TECHNOLOGY IN EDUCATION 2000: A COMPREHENSIVE REPORT ON THE STATE OF TECHNOLOGY IN THE K-12 MARKET (2000), *available at* http://www.edrs.com (ERIC doc. no. ED448698) (last visited Feb. 4, 2004).

[80] Education Week, *supra* note 39.

[81] Int'l Literacy Inst., *supra* note 38.

[82] Web-Based Education Commission (WCEC) to the President, The Power of the Internet for Learning: Moving from Promise to Practice: Final Report (2000), *at* http://www.ed.gov/offices/AC/WBEC/FinalReport/index.html (last visited Jan. 1, 2004).

[83] *Id*.

[84] *Id.*; *see also* Tania di Giantomasso, *E-Commerce and Education*, CIRCUIT AT RMIT: GRADUATE PAPERS SERIES ON ELECTRONIC COMMERCE (RMIT University 2000) (arguing that broad assumptions about the impact of the Internet have created a "cult of hype" where the latest technological advancement sweeps up educators in the promise of an educational utopia, and that the lack of an effective global telecommunications systems is creating a "digital divide," widening economic gaps among nations and resulting in a situation where areas that would benefit most from online education, such as remote areas in Australia and countries with limited economic resources for education, which are the areas hardest to reach with new technologies), *at* http://www.circit.rmit.edu.au/publics/GRAD3.PDF (last visited Jan. 1, 2004).

[85] Hammond, *supra* note 38.

[86] Janice Hinson & Cathy Daniel, Connecting Across Many Divides: Digital, Racial, and Socio-Economic, paper presented at the National Education Computing Conference (June 2001).

[87] PRESIDENT'S INFORMATION TECHNOLOGY ADVISORY COMMITTEE, *supra* note 73. Authors have also argued that certain prerequisites may exist to bridging the access divide, including awareness, access, affordability, availability, and adaptability. *See* Yu, *supra* note 68. They also include managing information overload and mitigating the damage of commercial Internet capture. *See* Carlin Meyer, *Women and the Internet*, 8 TEX. J. WOMEN & L. 305 (1999).

¶23   As illustrated by WISH, a condition of eliminating digital divides involves connecting families, schools, and communities to technology in strong, supportive, and mutually beneficial ways.[88] In addition to the direct benefits of programs fostering technological inclusion, indirect effects may also result: individuals not directly involved in digital inclusion programs may be more likely to choose to connect themselves if their neighbors are connected. For example, households tend to be more likely to buy a computer when a high percentage of individuals around them own a computer. Such "spillover effects" of subsidies for Internet access and computer purchases may provide additional rationale for efforts to close the digital divide through access interventions. The cumulative impact of such interventions appears to be significantly greater than their immediate impact.[89]

¶24   Suggestions for continued efforts to bridge the access divide include rethinking and improving educational and market approaches, providing additional funding, and performing more research, data collection and evaluation of existing programs.[90] Most importantly, a cooperative effort across the public and private sectors is required for long term success. If provided with proper incentives, the private sector offers a useful source of assistance for schools and communities in continuing to bridge access divides. Public sector efforts alone to solve problems of digital exclusion will not be socially optimal in terms of efficiency.

B. Digital Production Divides

¶25   Digital production divides refer to gaps in access to, and participation in, the information technology creation process. Unlike access divides, which relate to information access, production divides matter for reasons of social governance, social cohesion, economic security, and human development. Information technology professionals and the information technology they produce influence the future of the information technology industry, the global economy, and the daily lives of the consumers of information technology.[91] By participating in the research, development, and creation of information technology, individuals progress from being merely consumers of information technology to becoming the technological legislators who wield cultural tools capable of influencing both society's development and their own.[92]

¶26   The problem of under-representation of women among information technology professionals should be reframed as primarily an information technology equity issue in addition to being a gender equity issue. By placing this gender gap within the digital

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[88] Videotape: Web of Support: Families, Schools, and Communities: Bridging the Digital Divide (U.S. Department of Education 2000), *available from* North Central Regional Educational Lab., Oak Brook, IL.

[89] *See generally,* Austan Goolsbee & Peter J. Klenow, *Evidence on Learning and Network Externalities in the Diffusion of Home Computers*, 45 J.L. & ECON. 317 (2002).

[90] PRESIDENT'S INFORMATION TECH. ADVISORY COMMITTEE, *supra* note 73.

[91] A poll conducted by AOL Time Warner found that the average U.S. teenager spends approximately 12.27 hours per week online. *See* Tobi Elkin, *Harried Mothers Use Internet More*, ADAGE.COM, May 7, 2003, *at* http://www.adage.com/news.cms?newsId=34672 (last accessed Sept. 28, 2003) (password required to access document).

[92] The term "cultural tool" is loosely defined as a tool which permits an individual to accomplish more than she/he otherwise could and was coined by developmental psychologist Lev Vygotsky. For a discussion of cultural tools, see LEV VYGOTSKY, THOUGHT AND LANGUAGE (Massachusetts Institute of Technology 1962).

divide discourse, a different group of policymakers, agencies and academics will become engaged in its remediation—the same groups who have succeeded in remediating the digital access divide. Similarly, this reframing emphasizes that society as a whole benefits from greater inclusion of women and minorities among producers of information technology.

¶27   Movement toward elimination of access divides will not simultaneously alleviate production divides. The reason for this disjuncture rests with the development progress of technology itself: technology is progressing toward an increasingly less participatory design. In other words, in order to effectively use various applications, for example, an individual needs fewer computer programming skills than s/he did ten years ago. On one hand, this progressive simplification of graphical user interfaces is a positive step to pull more of society into the fold of information technology. However, this simplification increases the gap between the access and production divides and reflects an approach which believes that "any sufficiently advanced technology is indistinguishable from magic" for users.[93] Consequently, progressively smaller percentages of users may become producers. Thus, a concerted effort at addressing production divides is needed for reasons of social governance, social cohesion and individual level economic self-realization.

1.   Governance

¶28   Information technology is an instrument of social control which shifts power from institutions to individuals[94] and is an integral component to exercises of coercion in the 21st century.[95] Some legal scholars argue that technology unavoidably impacts social structures and constitutionalism; all social governance occurs within a particular socio-historical technological context with which it is inextricably intertwined.[96] Further, other legal scholars argue that computer code constitutes a form of social regulation equivalent to legislation.[97] When these two arguments are contemplated in tandem, they underscore the role of information technology as a mechanism of social governance and the role of information technology creation as a form of legislative process. If these two assertions are correct, then the exclusion or lack of participation of certain groups in the creation of this technological governance context can be viewed as a type of *de facto* (voluntary or involuntary) technological disenfranchisement. If code is law and governance occurs within a technological context that acts upon governance processes, then the voices of all those whose lives are governed by information technology, ideally, should be represented in the ranks of the digital legislators.

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[93] ARTHUR C. CLARK, PROFILES OF THE FUTURE: AN INQUIRY INTO THE LIMITS OF THE POSSIBLE (Gollancz 1962).

[94] ANDREW L. SHAPIRO, THE CONTROL REVOLUTION: HOW THE INTERNET IS PUTTING INDIVIDUALS IN CHARGE AND CHANGING THE WORLD WE KNOW (Public Affairs 1999).

[95] *See* Reuters, *Bush Reportedly Orders Cyberwarfare Plan,* CNET.COM, Feb. 6, 2003, *at* http://news.com.com/2100-1023-983723.html?tag=fd_top (last visited Jan. 26, 2004).

[96] John O. McGinnis, *The Symbiosis of Constitutionalism and Technology*, 25 HARV. J.L. & PUB. POL'Y 3 (2001).

[97] LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE (Basic Books 2000); *see also* Mark N. Cooper, *Inequality in the Digital Society: Why the Digital Divide Deserves All the Attention It Gets*, 20 CARDOZO ARTS & ENT. L.J. 73 (2002).

¶29   Also, some suggest that a diverse workforce improves the quality of information technology product development.[98] According to the Congressional Commission on the Advancement of Women and Minorities in Science (CCAWMS):

> There is factual evidence that businesses and other organizations see a significant return on their investment when diversity is achieved. . .[I]ncreasing diversity is desirable for the five following reasons: better utilization of talent; increased marketplace understanding; enhanced breadth of understanding in leadership positions; enhanced creativity; and increased quality of team problem-solving.[99]

Despite such benefits, however, we are on the verge of a digital future where a majority of those governed have no voice in a portion of the forces involved in their governance. Our future social governance will be inextricably bound up with technologies that control, but are not controlled by, a digital underclass composed disproportionately of women and minorities.[100]

2. Social Cohesion

¶30   In 2000, 800,000 technology jobs went unfilled because of a dearth of qualified workers, resulting in an opportunity cost, by some estimates, of US$4 billion per year.[101] The inclusion of greater numbers of women in the information technology workforce would have at least, in part, alleviated this problem[102] and eliminated the need for measures such as lifting caps on H-1B visas to increase the supply of information technology workers from other countries.[103] Although numbers from 2000 may reflect inflated employment resulting from the technology "bubble," the shortage of skilled technology workers is expected once again to become a problem as the information technology industry continues to grow.[104] Both industry pundits and the U.S. Department of Commerce[105] assert that, in fact, the "new economy" is not a myth and that a fundamental change driven by information technology has occurred.[106] At least one report from the Department of Commerce from December 2002 corroborates this statement: it states that, despite the heavy recession in the information technology

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[98] *See* Microsoft Corporation, *Valuing Diversity* (Nov. 15, 2000), *at* http://www.microsoft.com/issues.essays/11-15diversity.asp (last visited Jan. 1, 2004); *see also* Cisco Learning Inst., *supra* note 4.

[99] CONG. COMM'N, *supra* note 7.

[100] *See* Mary L. Lyndon, *Technology and the Law: Articulating a Woman's Rights Perspective*, 69 ST. JOHN'S L. REV. 191 (1995) (arguing that women lack the power to choose and develop technologies but are nonetheless frequently the objects of these technologies).

[101] Cisco Learning Inst., *supra* note 4; Microsoft Corp., *supra* note 98.

[102] CONG. COMM'N, *supra* note 7.

[103] Sandra B. Cooke, *Jobs in the New Economy, in* DIGITAL ECON. 2002 (U.S. Department of Commerce 2002), *at* http://www.esa.doc.gov/DigitalEconomy2002.cfm (last visited Jan. 26, 2004).

[104] Lee Price & George McKittrick, *The New Economy Endures Despite Reduced IT Investment, in* DIGITAL ECON. 2002 (U.S. Department of Commerce 2002), *at* http://www.esa.doc.gov/DigitalEconomy2002.cfm (last visited Jan. 26, 2004).

[105] *Id.*

[106] James Surowiecki, *The New Economy Was a Myth, Right? Wrong.*, 10 WIRED 89 (Jul. 2002), *at* http://www.wired.com/wired/archive/10.07/wired_index.html (last visited Jan. 26, 2004).

industry, information technology producing industries still contributed disproportionately to the U.S. economy and continued to grow at double digit rates.[107] The information technology industry is credited with twenty-nine percent of the U.S. economy's real growth, and twenty-six percent of such growth in 2000.[108] Despite the information technology job cuts in 2001, technology related jobs nevertheless accounted for approximately eight percent of all jobs nationwide and as much as thirty-two percent of all jobs in some areas of the country.[109] Information technology investment in 2002 exceeded levels prior to 2000, and businesses increased employment in information technology services in order to capitalize on investments in information technology made in 2001.[110] U.S. businesses are expanding the importance and role of information technology in their operations,[111] and seven of the ten fastest growing occupations are projected to be in the information technology industry.[112] Meanwhile, Silicon Valley has begun to recover from the technology bust of 2000-2001.[113]

¶31   Studies indicate, however, that increasing numbers of workers are not able to acquire access to the technological resources needed to ensure productivity in a progressively digitized world economy.[114] Therefore, even if digital access divides are fully eliminated, without adequate computer education and access to computers, these workers will be economically less relevant to the economy.[115] Simultaneously, although an increasingly greater percentage of the workforce in the U.S. is comprised of women and minorities,[116] women and minorities are severely underrepresented among information technology professionals.[117] Women, particularly minority women, have been and continue to be systematically left out of the information technology creation process, and this gendered production divide is escalating in magnitude.[118] Women comprise less than a quarter of information technology professionals and, in particular,

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[107] David Henry & Donald Dalton, *Information Technology Industries in the New Economy, in* DIGITAL ECON. 2002 (U.S. Department of Commerce 2002), *at* http://www.esa.doc.gov/DigitalEconomy2002.cfm (last visited Jan. 26, 2004).

[108] *Id.*

[109] *Id.*

[110] During 2001, as employment dropped by 1.4 % in the total private sector, employment gained 0.5 % in telecom services and 1.4 % in computer software and services. *See* Price & McKittrick, *supra* note 104, at 1.

[111] *Id.*

[112] Cooke, *supra* note 103.

[113] Jim Hopkins, *Hints of Recovery in Silicon Valley*, USA TODAY, Dec. 10, 2002, *available at* http://www.usatoday.com/tech/news/2002-12-10-valley_x.htm (last visited Jan. 27, 2004).

[114] The impact of information and communications technologies on jobs is not yet known and no outcome is inevitable. Technology-driven changes in organizational structures, employment relations, worker autonomy, and work organization will not automatically result in higher job quality. Jill Rubery & Damian Grimshaw, *ICT's and Employment: The Problem of Job Quality*, 140 INT'L LAB. REV. 2 (2001).

[115] International Labour Organization, Department of Communication, *Bridging the Digital Divide: Harnessing ICT for Economic Development, Job Creation and Poverty Eradication*, 38 WORLD OF WORK 4 (2001), *available at* http://www.ilo.org/public/english/bureau/inf/magazine/38/index.htm (last visited Jan. 27, 2004).

[116] CONG. COMM'N, *supra* note 7.

[117] AAUW, *supra* note 9.

[118] CONG. COMM'N, *supra* note 7; *see also*, Rena Faye Norby, *Evaluating Progress in Gender Equity in Careers for Women in Science and Technology: The Impact of Role Making on Women's Career Choices*, 1 ELEC. J. SCI. EDUC. 3 (1997), *available at* http://unr.edu/homepage/jcannon/ejse/norby.html (last visited Jan. 27, 2004).

minority women make up not more than three percent of information technology professionals in the United States.[119] Only eight percent of information technology engineers are women.[120] No more than five percent of information technology management is composed of women.[121] Finally, the percentage of women earning degrees in computer science has declined steadily since 1984,[122] and the attrition rate among women computer science students is higher than among men.[123] In other words, no hope of improvement in representation of women in the information technology industry is in sight.

¶32   Simultaneously, the number of households headed by women is steadily increasing.[124] With women increasingly in the role of primary breadwinner, their economic viability in the marketplace becomes increasingly important; more people, particularly children, are starting to rely on women's income.[125] New technologies create opportunities for new markets and enlarge the need for value-added knowledge work; but, these new technologies may also cause substantial displacement of workers in routine-based jobs such as clerical work,[126] some of which may be held disproportionately by women.[127] As a greater percentage of jobs in the U.S. economy become skilled information technology positions—positions disproportionately held by men—the suboptimal participation of women in the future of the digital economy comes closer to becoming a reality.

3. Economic Self-realization

¶33   Familiarity with computers is considered by many to be an essential element of economic success in the future economy.[128] During the early years of the Internet, an expectation existed among some members of the "digerati"[129] that a cornucopia of online informational resources would increase equity throughout the socio-economic spectrum.

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[119] Terence Chea, *Panel Urges Bigger Pool For Tech Jobs*, WASH. POST, Jul. 14, 2000, *available at* http://www.popstop.org/pages/h1b/wp_071400.html (last visited Jan. 27, 2004).

[120] Penn State School of Information Sciences and Technology, *Penn State Study Could Hold Key to More Women in IT Field* (Aug. 7, 2002), *at* http://ist.psu.edu/news/News2.cfm?HeadlineID=672 (last visited Jan. 1, 2004).

[121] Cisco Learning Inst., *supra* note 4.

[122] CONG. COMM'N, *supra* note 7.

[123] *Id*. at 29.

[124] Women and the children that they solely support account for seventy-five percent of people in poverty. Female-headed households are five times more likely to be poor, and the number of these households has doubled since 1995. *See* Feminist Majority Foundation, *Empowering Women in Philanthropy, at* http://www.feminist.org/research/p_poverty.html (last visited Jan. 1, 2004).

[125] *Id.*

[126] Information technology can directly substitute for clerical jobs. *See* Price & McKittrick, *supra* note 104; Luc Soete, *Knowledge Work and Employment: The Challenges to Europe,* 140 INT'L LAB. REV. 2 (2001).

[127] At least one third of all women workers work in clerical positions. *See* BELINDA PROBERT & BRUCE WILSON, PINK COLLAR BLUES (Melbourne University Publishing 1993).

[128] EDUCATIONAL SERVICES & ECONOMIC DEVELOPMENT DIVISION INSTRUCTIONAL RESOURCES AND TECHNOLOGY UNIT, CHANCELLOR'S OFFICE, CALIFORNIA COMMUNITY COLLEGES, CALIFORNIA COMMUNITY COLLEGES TECHNOLOGY II STRATEGIC PLAN, 2000-2005 (2000).

[129] The term digerati has come to be used in common parlance to pertain to the intellectual elite of technology advocates. *See* Edge, *Who Are the Digerati?, at* http://www.edge.org/digerati (last visited Jan. 26, 2004).

However, research suggests that the opposite may be true. If corrective steps are not taken, technology may worsen rather than solve equity disparities by causing informational stratification to be layered onto preexisting economic stratification within societies.[130] Although remedying access divides increases information equity, it will not necessarily assist society or individuals in remedying economic inequality. Remedying production divides, however, is more likely to ameliorate some economic inequality than is remedying access divides.

¶34   From the standpoint of human development, individuals who enter the information technology industry acquire the means to economically empower themselves and economically self-realize: information technology professionals have been historically well-compensated in relation to educational commitments, and information technology careers tend to provide a relatively efficient means of upward social mobility compared to other careers.[131] Average wages per worker in information technology industries are twice the national average: on average, information technology workers earn US$73,800 while all workers engaged in non-farm private industries earn US$35,000.[132] Certifications can be obtained in relatively short periods of time, often in a few months or less,[133] and individuals with such certificates frequently command salaries in excess of US$50,000.[134] In particular, entry-level technical jobs typically offer salaries twenty to thirty percent higher than the entry-level jobs typically filled by women such as clerical positions. Entry-level technology jobs usually also include benefits,[135] and many information technology positions require only two years or less of post-high school training.[136] Therefore, information technology positions offer comparatively high earning power for low levels of formal education.

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[130] *See* Jack Linchuan Qui, *Coming to Terms with Informational Stratification in the People's Republic of China*, 20 CARDOZO ARTS & ENT. L.J. 157 (2002); Mila Stoicheva, *The Digital Divide and Its Implications for the Language Arts* (2000), *available at* http://www.edrs.com (ERIC doc. no. ED442138) (last visited Feb. 4, 2004).

[131] Taysir Nashif, Technological Education for Women as a Tool of Upward Social Mobility, with Reference to the Middle East, Cross-Roads of the New Millennium, Paper presented at the Proceedings of the Technological Education and National Development (TEND) Conference, Abu Dhabi, United Arab Emirates (Apr. 8-10, 2000), *at* http://crm.hct.ac.ae/events/archive/tend/TayNP.html (last visited Jan. 27, 2004).

[132] Cooke, *supra* note 103.

[133] Some certifications can be obtained simply by passing an examination without formal classroom training. Materials are available at low cost or free online. *See, e.g.,* Microsoft Corporation, *Certification and Training, at* http://www.microsoft.com/traincert (last visited Jan. 27, 2004).

[134] Cisco Learning Inst., *supra* note 4. However, information technology can be used as a tool both of economic empowerment and economic oppression. Although individuals who create information technology are well compensated in their work, others who work with information technology but do not produce it do not necessarily reap similar benefits. *See, e.g.,* Shruti Rana, *Fulfilling Technology's Promise: Enforcing the Rights of Women Caught in the Global High-Tech Underclass*, 15 BERKELEY WOMEN'S L.J. 272 (2000) (analyzing the experiences of women assembly workers in Malaysia and the U.S. to demonstrate how companies seek out women for such positions, how the exploitation of this workforce has become embedded in state politics, and arguing that a gender-based, immobile industrial underclass can emerge in both developing and developed countries). Similarly, some authors have argued that information technology brings with it the possibility of privacy intrusions, such as abortion sites and new forms of exploitation that uniquely impact women. *See* Anita L. Allen, *Gender and Privacy in Cyberspace*, 52 STAN. L. REV. 1175 (2000); Donna M. Hughes, *The Use of New Communications and Information Technologies for Sexual Exploitation of Women and Children*, 13 HASTINGS WOMEN'S L.J. 127 (2002).

[135] Women Employed, *Increasing the Number of Women in Higher Paying Technology Related Jobs* (2001), *at* http://www.womenemployed.org/publications/brief3.pdf (last visited Jan. 1, 2004).

[136] *Id*.

¶35   This assertion also holds true for individuals with more than two years of post-high school training. In 2000, the median earnings of computer engineering managers, positions requiring only a bachelors degree and experience, was US$84,070.[137] By way of comparison, in 2000, the median earnings of attorneys, positions requiring a bachelors degree and three years of post-graduate study, was US$69,680 for men and US$50,648 for women.[138] Individuals who train to become information technology professionals can reasonably expect future economic rewards disproportionately large in relation to their time and educational commitment. Women and minorities who foreclose this lucrative option for themselves, or are not given entry to the field of information technology, lose a promising option for financial security in the long term and, correspondingly, they lose the non-pecuniary benefits of self-realization that would accompany this financial security.[139] In the words of one information technology professional, "[I]t's definitely worth it. The freedom that you have, knowing that no matter what happens I can support my family, I can take care of myself, I can make my own way in the world is absolutely worth it."[140]

II. THE GENDERED PRODUCTION DIVIDE

¶36   Currently, women comprise approximately forty-seven percent of the U.S. workforce but hold only approximately twenty percent of the information technology jobs.[141] As articulated by the CCAWMS, this gender imbalance has not declined significantly in the last ten years and, in fact, is now increasing.[142]

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[137] Cooke, *supra* note 103.

[138] American Bar Association, *A Snapshot of Women in the Law in the Year 2000* (2000), *at* http://www.abanet.org/women/snapshots.pdf (last visited Jan. 27, 2004).

[139] For a discussion of self-realization in an economic context, *see* Martin H. Redish, *Self-Realization, Democracy, and Freedom of Expression: A Reply to Professor Baker*, 130 U. PA. L. REV. 678 (1982).

[140] Cisco Learning Inst., *supra* note 4 (quoting Michelle Cormier, Systems Engineer III, Cisco Systems Institute).

[141] Mayfield, *supra* note 3. The situation throughout the rest of the world is equally bleak. Western Europe has approximately the same number of Internet users as the U.S., with approximately half of Internet users being women. Moreover, women comprise nineteen percent of the technical and professional workforce throughout Western Europe. In Eastern Europe, however, despite a very conservative male-dominated culture, women traditionally have comprised a large percentage of the technical workers in these countries; in 1998, this amounted to thirteen percent of all women (as compared to ten percent of men). In Latin America and the Caribbean, women reportedly make up only a small number of workers in the software industry, and even fewer women are employed in information technology hardware jobs. In Africa (other than South Africa) and the Middle East, little data is available on Internet use and employment for specific countries, but women's participation in information technology is presumed to be low, partially due to the male-dominated socio-cultural and religious norms. In South Africa, however, women constitute fifty-one percent of total Internet users but are also underrepresented in the information technology industry. Issues of race as well as gender compound this under-representation because whites clearly dominate the industry. In India, while women Internet users outnumber men, the pervasive belief persists that women are not as qualified as men in information technology. Cisco Learning Inst., *supra* note 4; *see* Lynette Saldanha, Information Technology and the Training and Career Development of Women: The Case of India, Discussion Paper No. 30, International Labour Office, Geneva (1988).

[142] CONG. COMM'N, *supra* note 7; Mayfield, *supra* note 3.

A. The Ecology of the Divide

¶37   The first step in eradicating the gendered production divide among information technology professionals entails identification of the factors that perpetuate and exacerbate the gap. A multidisciplinary, holistic approach holds the most promise because the causes of the gendered production divide are complex and cut across multiple levels of analysis. Therefore, this section adopts what might be termed an "ecological" approach to the problem[143] and embarks upon a holistic analysis of the information technology gendered production divide on three levels: (1) the macrosystem/societal level, (2) the mesosystem/institutional level, and (3) the microsystem/individual level. The results of this ecological analysis underscore the importance of the need for broad-based change: in order for the gendered production divide to be eradicated change must occur with respect to each level of the problem.

1. Macrosystem Level

¶38   A macrosystem level analysis of the information technology gendered production divide involves an examination at the level of the subculture or culture as a whole, along with belief systems and ideologies underlying cultural rules and norms.[144] In other words, the analysis focuses on the mechanisms of social governance and the world-view prevalent in civil society.

a. Social Governance

¶39   Generally speaking, social governance occurs through both formal and informal mechanisms. The primary formal mechanism of social governance is, of course, law, both through statutes passed by Congress[145] and through the evolution of legal doctrine in the courts. Informal mechanisms of social governance involve extralegal systemic mechanisms of control that circumscribe or facilitate conduct.

i. Formal Social Governance through Law

¶40   To date, although the gap in women's entry into math and science fields has received legislative attention, women's entry into information technology fields has not received similar levels of attention. This neglect may occur in part because individuals tend to perceive computer science as linked closely to mathematics and science.[146] However, even as a future stream of women mathematicians and science professionals seems likely because girls are entering math and science classes at higher rates than boys,

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[143] BRONFENBRENNER, *supra* note 30. This ecological approach informs my study design by providing a coherent, comprehensive framework for analysis. To date, most research addresses issues relating to the digital divide focusing on only one level of analysis, frequently neglecting practical complicating factors which occur outside the scope of such research. Each social policy dilemma exists on and interacts with multiple levels of analysis simultaneously. By applying an ecological perspective and performing an analysis comprehensively, a more accurate and balanced picture of the problem, and possible solutions will, ideally, be the result.

[144] *Id*. at 25.

[145] This would include the corresponding regulations promulgated by appropriate agencies pursuant to a Congressional mandate.

[146] Alan Durndell et. al., *Gender and Computing: Persisting Differences*, 37 EDUC. RES. 219 (1995).

girls are still choosing not to enter computer science courses.[147] Girls enroll in greater numbers in all courses except computer science courses.[148] According to at least one study, college preparatory computer science classes had 43 percent fewer girls enrolled than boys.[149] Meanwhile, AP computer science courses enrolled 72 percent fewer girls than boys.[150] Some authors attribute the narrowing of the math and science gap to education legislation on the national level, specifically Title IX[151] and the Women's Educational Equity Act,[152] passed in the 1970's, each of which specifically targeted the math and science gender gap. These authors now call for similar national efforts, focused more concretely on the area of information technology education.[153] Despite legislative efforts through the Women's Educational Equity Act,[154] the Carl D. Perkins Vocational and Applied Technology Education Act Amendments of 1998,[155] and the creation of the now defunct CCAWMS,[156] significant increases in representation of women among information technology professionals have not occurred in the last twenty years.[157] More concerted legislative effort in the area of the production divide is warranted.

ii. Informal Social Governance

¶41   Like law, informal mechanisms of governance can act as powerful constraints on individuals. One such mechanism of informal regulation may be computer code itself. If the architecture of computer code truly constitutes an extrapolation of the social values held by the coders who wrote it and reflects the social values pervading our society, as has been argued by some legal scholars, then the code itself may constitute a form of self-reinforcing social regulation: it, or the memes contained in it, may work to attract some groups within society into its production processes and work to exclude others. [158]

¶42   Software reflects the biases of its creators,[159] and tends to be biased in favor of what are perceived by many to be boys' interests.[160] For example, some research has found

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[147] *See* Press Release, Public Policy Institute of California, High School Girls Now Outnumber Boys in Most Math and Science Classes (Feb. 28, 2001), *available at* http://www.ppic.org/main/pressrelease.asp?i=309 (last visited Jan.27, 2004).

[148] *Id.*

[149] *Id*.

[150] *Id*.

[151] 20 U.S.C. § 1681 (2003).

[152] 20 U.S.C. § 7231 (2003). Although it is true that the Women's Educational Equity Act contemplated technology education as one of the areas in which women are under-represented, the focus of the legislation was not primarily on technology. Additionally, it can be argued that the meaning and importance attached to technology education has been fundamentally altered by the arrival of the Internet.

[153] Kendra Mayfield, *Girls into Science, Not Computers,* WIRED NEWS, Mar. 9, 2001, *at* http://www.wired.com/news/culture/0,1284,42210,00.html (last visited Jan. 1, 2004).

[154] During the past 17 years, the Women's Educational Equity Act program has funded programs to open math, science, and technology courses and careers to women and girls. WEEA Publishing Center, *Gender Equity and the Year 2000*. WEEA DIGEST (Education Development Center 1991), *at* http://www.edc.org/WomensEquity/resource/alldigest/index.htm (last visited Jan 1, 2004).

[155] 20 U.S.C. § 2301 (2003).

[156] CONG. COMM'N, *supra* note 7.

[157] *Id*.

[158] LESSIG, *supra* note 97.

[159] *See* Bruce Sterling, *A Contrarian View of Open Source* (Jul. 26, 2002), *at* http://slash.interactivist.net/analysis/02/08/06/1210227.shtml (last visited Jan. 1, 2004).

that girls tend not to prefer software and computer games that revolve around violence and, instead, they respond more positively to software products that require collaboration and communication.[161] Additionally, computer games tend to under-represent women characters and frequently portray them negatively. A study performed by the children's advocacy group Children Now reviewed twenty-seven games available for the Sega Dreamcast[TM], Sony PlayStation[TM] and Nintendo64[TM] console systems. Children Now found that 92 percent of the games had male characters but only 54 percent of the games had female characters. Over half of the games with female characters presented them as violent and one third presented unrealistic female body images.[162] It can be argued, therefore, that the code itself attempts to dissuade girls from entering information technology fields. Some authors go so far as to state that they expect the entire architecture of technology, which they believe reflects a bias due to the predominance of male coders, to change as women become more involved in computer science.[163]

b. Civil Society

¶43   Civil society and the belief systems and ideologies of the groups it embodies act as a powerful force to facilitate or constrain individuals' participation in society. Generally speaking, two types of bias within civil society[164] both perpetuate and reflect the marginalization of women in and from information technology culture: one, the subconscious cultural bias which asserts that girls do not and should not interact with computers; and two, the bias within the information technology community which favors male coders.

i.   Cultural Bias

¶44   Several studies have found that our society contains a cultural bias that technology is a "male" domain.[165] For example, one study found that pictorial advertisements in

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[160] Alfred S. Forsyth, Jr. & David F. Lancy, *Girls and Microcomputers: A Hopeful Finding Regarding Software.*, 6 COMPUTERS IN THE SCH. 3 (1989); Marlaine E. Lockheed, *Women, Girls, and Computers: A First Look at the Evidence*, 13 SEX ROLES 3 (1985).

[161] John D. Elliott, Computer Literacy for Student Teachers and Elementary Children through Programming, Presentation at the International Conference on Technology and Education (Mar. 20-22, 1990), *at* http://www.icte.org/edtech12.HTM (last visited Jan. 1, 2004) (available by request).

[162] Kendra Mayfield, *A Pretty Face is not Enough,* WIRED NEWS, Dec. 18, 2000, *at* http://www.wired.com/news/culture/0,1284,40478,00.html (last visited Jan. 1, 2004); *see also* Helen Morris & Amy Veen, *Virtual Sexpots: No End in Sight,* WIRED NEWS, Jul. 14, 2000, *at* http://www.wired.com/news/culture/0,1284,37416,00.html (last visited Jan. 1, 2004).

[163] Katie Dean, *Zooming in on a Site for Life,* WIRED NEWS, Apr. 9, 2001, (quoting Lenore Blum, professor at Carnegie Mellon School of Computer Science), *at* http://www.wired.com/news/culture/0,1284,42759,00.html (last visited Jan. 1, 2004); Leanna J. Standish, Women, Work and the Scientific Enterprise, Presentation at the Annual Conference of the Association for Women in Psychology (March 5-8, 1981), 14 SCIENCE FOR THE PEOPLE 12 (Sept./Oct. 1982).

[164] "Civil society" refers to U.S. civil society in this context due to cultural variations. For example, results of the analysis indicate that over thirty years, Russian women were equal with men in terms of education and achieved all but the highest offices equally with men. Gerhard F. Schilling & Kathleen M. Hunt, *Women in Science and Technology: U.S./USSR Comparisons,* 5239 RAND PAPER SERIES (1974), *available at* http://www.edrs.com (ERIC doc. no. ED125886).

[165] *See* Elizabeth Lage, *Boys, Girls, and Microcomputing*, 6 EUR. J. PSYCHOL. EDUC. 1 (1991); Linda Thurston, Girls, Computers, and Amber Waves of Grain: Computer Equity Programming for Rural Teachers, Presentation at the 11th Annual Conference of the National Women's Studies Association (Jun.

magazines depict male computer users twice as frequently as female computer users.[166] Similarly, another study found that computer professionals are stereotypically expected to be male, and women computer professionals are considered aberrations from the norm.[167] Studies also indicate that individuals are less favorably disposed toward women in information technology careers than men in those careers,[168] and women are more likely to experience social rejection in information technology graduate schools and sexual pressures on the job.[169]

ii.   Industry Bias

¶45   Women in the information technology industry continue to voice concern over negative industry attitudes toward women information technology professionals. If institutions reflect cultural attitudes, the gender imbalance in the Internet Architecture Board speaks volumes: currently only two women sit on the board comprised of twelve members,[170] and no women were among its members until 1989.[171] Although many women feel that discrimination in the information technology industry is unintentional and occurs as a result of younger men's social ineptitude in working with women who are often older than them,[172] other women information technology professionals speak of a clear presumption that pervades the industry: a woman does not have information technology skills equivalent to those of a man in the industry until she proves otherwise.[173] In the words of Carol Kovac, director of IBM Life Sciences, "[t]echnical environments are ones where you fight for your ideas, and if you automatically have ideas dismissed because of some kind of cultural subtlety, you have to fight harder. And if you fight harder, then you're a bitch."[174] Stated simply, "You're always trying to prove yourself, because females are not always well-received in the tech field."[175]

14-18, 1989), *available at* http://www.edrs.com (ERIC doc. No. ED319660); EDUCATIONAL COMPUTER CONSORTIUM OF OHIO (ECCO), YES, I CAN: ACTION PROJECTS TO RESOLVE EQUITY ISSUES IN EDUCATIONAL COMPUTING (1991). For a comparison to the traditionally male domain of the military, *see* Guy I. Seidman & Eyal A. Nun, *Women, The Military and the Court: Israel at 2001*, 11 S. CAL. REV. L. & WOMEN'S STUD. 1 (2001).

[166] Mary Catherine Ware & Mary Frances Stuck, *Sex Role Messages Vis-À-Vis Microcomputer Use: A Look at the Pictures*, 13 SEX ROLES 3-4 (1985).

[167] Katie Dean, *Girl Geeks Just Want to be Heard,* WIRED NEWS, Nov. 7, 2000, *at* http://www.wired.com/news/technology/0,1282,39958,00.html (last visited Feb. 4, 2004).

[168] Thomas Owen Erb, *Attitudes of Early Adolescents Toward Science, Women in Science, and Science Careers*, *in* MIDDLE SCHOOL RESEARCH, SELECTED STUDIES, 108, 116 (Thomas Owen Erb ed., 1981).

[169] Linda Rae Markert, *Women Researchers in Science and Technology: Why So Few?*, 41 MAN, SOC'Y, TECH. 1 (1981).

[170] Internet Architecture Board, *IAB Members and Bios*, *at* http://www.iab.org/about/members-plus.html (last visited Jan. 1, 2004).

[171] A. Michael Froomkin, *Habermaas@Discourse.Net: Toward a Critical Theory of Cyberspace*, 116 HARV. L. REV. 749, 807 (2003).

[172] Lakshmi Chaudry, *Sili Valley: Unfriendly to Women?,* WIRED NEWS, Jul. 5, 2000, *at* http://www.wired.com/news/culture/0,1284,37047,00.html (last visited Feb. 3, 2004).

[173] Dean, *supra* note 167.

[174] Kristen Philipkoski, *How Women Make Science Work*, WIRED NEWS, Dec. 27, 2000, *at* http://www.wired.com/news/technology/0,1282,40757,00.html (last visited Jan. 1, 2004).

[175] Cisco Learning Inst., *supra* note 4 (quoting Cordella Grimes, District Wireless Network Administrator, Indianapolis Public Schools, and Cisco Network Academy Program Instructor).

¶46   Similarly, some women information technology entrepreneurs assert that venture capital backing is more difficult to obtain for women-owned start-ups. As a result, women entrepreneurs have begun to form organizations such as Springboard 2000, a venture capital fair aimed at assisting women-owned and operated start-ups in securing such coveted funding;[176] Women's Technology Cluster, the first incubator created exclusively for women-run technology businesses; and Ground Floor Ventures, the first for-profit women's incubator.[177]

2. Mesosystem Level

¶47   Mesosystem level analysis of the information technology gendered production divide focuses attention on interpersonal dynamics and the dynamics between the individual and secondary settings, such as school or work.[178] A potent cause of gender imbalance in information technology lies on the mesosystem level in the interactions between students and the actors in the educational system. In order for women to be equally represented in the next generation of information technology professionals, girls' enrollment in advanced computer science classes in high school and beyond is essential.[179]

a. Low Enrollment of Girls in Information Technology Courses

¶48   Female enrollment in computer programming courses lags behind male enrollment.[180] In 1999, girls comprised only seventeen percent of AP computer science test takers and, of those who did take the test, significantly proportionately fewer girls than boys scored well enough to obtain AP credit.[181] Although girls' attitudes lead them to self-select away from computer science, teachers and schools also select girls out of computer science.[182] Still, improvement is possible. For example, educators in the last few decades have become sensitized to girls' under-enrollment in mathematics and science. Today, girls are catching up to boys in mathematics and science enrollment. According to the Public Policy Institute of California, girls are even enrolling in most mathematics and science courses at higher rates than boys at the middle school and high school level.[183] Thus, if educators become sensitized to increasing girls' enrollment in computer science, progress toward eradicating the information technology gendered production divide is feasible on the mesosystem level. The role of the educational system is particularly important because women's persistence in technology careers appears to

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[176] Kendra Mayfield, *Women Entrepreneurs Hit D.C.*, WIRED NEWS, Jul. 11, 2000, *at* http://www.wired.com/news/business/0,1367,37433,00.html (last visited Feb. 3, 2004).
[177] Lakshmi Chaudry, *Hatching with a Heart,* WIRED NEWS, Apr. 20, 2000, *at* http://www.wired.com/news/business/0,1367,35741,00.htm1 (last visited Feb. 3, 2004).
[178] BRONFENBRENNER, *supra* note 30, at 25.
[179] Kendra Mayfield, *Creating More Women Coders*, WIRED NEWS, May 19, 2000, *at* http://www.wired.com/news/culture/0,1284,36372,00.html (last visited Feb. 2, 2004).
[180] Durndell et. al., *supra* note 146; AAUW, SEPARATED BY SEX: A CRITICAL LOOK AT SINGLE SEX EDUCATION FOR GIRLS (AAUW Educational Foundation 1998).
[181] AAUW, TECH-SAVVY, EDUCATING GIRLS IN THE NEW COMPUTER AGE 42 (AAUW Educational Foundation 2000).
[182] *Id.*
[183] Mayfield, *supra* note 153.

be correlated with the number of elective high school science courses they have taken.[184] Also, research suggests that in order to help foster positive attitudes in girls toward computers, exposure to and instruction in information technology should occur as early in girls' education as possible. Several studies have assessed early adolescence to be an important time to make a difference in computer attitude and use.[185] At least one study has found that sex differences in attitudes toward computers are strongly established by the eighth grade.[186] Thus, if this research can be generalized, programs to foster girls' interest in computer careers later than the junior high and high school level are less likely to be effective.

b.   Lack of Encouragement and Role Models for Girls

¶49   Research indicates that boys have more educational opportunities for mastery of computer skills and for working with role models and that boys receive more encouragement in computer use and study.[187] Meanwhile, girls suffer from a lack of women teachers as role models[188] as fewer women than men are computer educators.[189] Some studies indicate that teachers may also be unconsciously transmitting a message that girls do not need to participate in information technology or that the teachers themselves may be less technologically proficient.[190] For example, at least one study has found that on the high school level, male computer-using teachers tended to have significantly more developed curricula than female computer-using teachers.[191] Also, despite awareness of the dearth of female technology education teachers, at least one study has found that few administrators, both male and female, would hire a woman over an equally qualified man.[192] At least one study has also indicated that fathers, male peers, and male siblings play a strong part in motivating girls to engage in information

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[184] Helen S. Farmer et al., *Women's Career Choices: Focus on Science, Math, and Technology Careers,* 42 J. COUNSELING PSYCHOL. 155 (1995).

[185] Melissa Koch, *No Girls Allowed*!, 3 TECHNOS 3 (Fall 1994), *at* http://www.technos.net/tq_04/tq_03/3koch.htm (last visited Jan. 27, 2004); Joyce Kasman Valenza, *Girls + Technology = Turnoff?*, 3 TECH. CONNECTION 10 (1997).

[186] K. Sheingold, Issues Related to the Implementation of Computer Technology in Schools: A Cross-Sectional Study, paper presented at the NIE Conference on Issues Related to the Implementation of Computer Technology in Schools, Washington, D.C. (1981).

[187] Irene T. Miura, Understanding Gender Differences in Middle School Computer Interest and Use, Presentation at the 67th Annual Meeting of the American Educational Research Association (Apr. 16-20, 1986), *available at* http://www.edrs.com (ERIC doc. no. ED273248) (last visited Feb. 4, 2004).

[188] Markert, *supra* note 169; Sylvia Stalker, Computers in the Classroom: A Feminist Issue, Presentation at the National Women's Studies Association Conference (Jun. 26-30, 1983), *available at* http://www.edrs.com (ERIC doc. no. ED240015) (last visited Feb. 4, 2004).

[189] Ingeborg Janssen Reinen & Tjeerd Plomp, *Some Gender Issues in Educational Computer Use: Some Results of an International Comparative Survey*, 20 COMPUTERS & EDUC. 353 (1993), *available at* http://www.sciencedirect.com (last visited Jan. 27, 2004).

[190] *See generally*, Katherine Hanson, *Gender, 'Discourse' and Technology,* Working Paper 5, Center for Equity and Diversity (1997), *available from* Educational Development Center, Inc., 55 Chapel St., Newton, MA 02458; Reinen & Plomp, *supra* note 189; Koch, *supra* note 185.

[191] Henry Jay Becker, *Men and Women as Computer-Using Teachers*, 13 SEX ROLES 137 (1985), *available at* http://www.edrs.com (ERIC doc. no. EJ324781).

[192] Melvin J. Pedras et al., *The Attitudes of Public School Administrators Toward the Hiring of Women Technology Educators*, 31 J. INDUS. TCHR. EDUC. 3 (1994).

technology experimentation and providing active assistance through scaffolding.[193] Interpersonal interactions tend to be positively motivational, but merely giving girls access to written materials on technology careers in lieu of mentoring does not appear to have a positive motivational effect on them.[194]

c. Suboptimal Computer Curriculum

¶50   Similarly, the organization of the learning setting[195] and curricular homogeneity may perpetuate negative computer attitudes in girls. Studies indicate that many girls' attitudes toward computers tend to vary based on the type of task. In particular, many girls tend to exhibit more positive attitudes in the context of reading and writing tasks on the computer.[196] By developing a computer science curriculum that takes into account the different learning styles of different students, a school may be more likely to stimulate girls to enroll in computer science classes in greater numbers.

¶51   In "Tech Savvy: Educating Girls in the Computer Age," the American Association of University Women ("AAUW") made several recommendations to educators regarding fostering positive attitudes in girls toward computer science and including greater numbers of girls in computer science curricula. Specifically, the AAUW suggests that educators:

(1) Compute across the curriculum;
(2) Provide multiple points of entry for girls into the technology curriculum;
(3) Increase the visibility of women in computing;
(4) Prepare tech-savvy teachers who are sensitized to gender issues;
(5) Begin a discussion on equality for educational stakeholders;
(6) Educate students about technology and the future of work; and
(7) Support efforts that give girls a boost into the pipeline.

As a consequence of the aforementioned mesosystemic concerns, some parents and educators have begun to view single sex education as a promising vehicle for facilitating and increasing girls' interest in careers in information technology.[197]

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[193] "Scaffolding" means helping students to teach themselves while providing guidance and direction when necessary. Lola B. Smith, *The Socialization of Females with Regard to a Technology Related Career: Recommendations For Change,* 3 MERIDIAN 2 (2000), *available at* http://www.ncsu.edu/meridian/sum2000/career (last visited Jan. 27, 2004); *see also* Jamie McKenzie, *Scaffolding for Success*, *in* BEYOND TECHNOLOGY: QUESTIONING RESEARCH AND THE INFORMATION LITERATE SCHOOL COMMUNITY (FNO Press 1999), *available at* http://fno.org/dec99/scaffold.html (last visited Jan. 27, 2004).

[194] American College Testing Program, *Promoting the Exploration of Personally Relevant Career Options in Science and Technology: Final Report* (1976), *available at* http://www.edrs.com (ERIC doc. no. ED173599).

[195] Jan Hawkins, *Computers and Girls: Rethinking the Issues*, 13 SEX ROLES 165 (1985).

[196] Susan Tyler Eastman & Kathy Krendl, *Computers and Gender: Differential Effects of Electronic Search on Students' Achievement and Attitudes*, 20 J. RES. & DEV. IN EDUC. 3 (1987).

[197] AAUW, *supra* note 9.

3. Microsystem Level

¶52   On the microsystem level, the analysis of the information technology gendered production divide focuses on an individual within her context.[198] Important considerations include not only the objectively quantifiable reality of a context, but also the subjective perceptions of the individual in the context.[199] Perhaps the most influential cause of the information technology gendered production divide rests with women and girls themselves and their attitudes toward careers in information technology. Many women self-select out of as many as seventy-five percent of all careers before they reach college age because of lack of confidence, lack of preparation, and discrimination.[200]

a. Attitude toward Computers

¶53   Girls' self-selection away from information technology courses has been attributed to a number of factors. One such factor is that many girls hold a negative attitude toward computers.[201] A preponderance of studies has found that women and girls are more likely to hold negative attitudes toward computers than men and boys:[202] in a meta-analysis of 106 studies published between 1984 and 1997 on sex differences in attitudes toward computers, male subjects had more positive attitudes[203] toward computers than did female subjects.[204] Although girls tend to believe that computers will be important to their futures,[205] boys tend to have a more positive attitude toward computers than do girls,[206] particularly minority girls.[207]

¶54   Analyzing minority girls' attitudes toward computers requires sensitivity to both issues of gender and issues of race in connection with the gendered production divide. Minority girls' attitudes may reflect the general lack of identification with the digital

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[198] A microsystem level of analysis focuses on patterns of activities, interpersonal relationships, and roles of an individual within a particular setting with given physical and material qualities. BRONFENBRENNER, *supra* note 30, at 22.

[199] *Id.*

[200] Agency for Instructional Teaching, *Women in Science, Resource Guide* (Indiana University Bloomington 1988).

[201] A subject's attitude toward computers generally denotes that subject's liking, confidence, sex and ability stereotypes, reaction to and beliefs about usefulness of computers. *See* Yuen-kuang Liao, *Gender Differences on Attitudes toward Computers: A Meta-Analysis*, 30 J. RES. ON COMPUTING IN EDUC. 341 (conducting a meta-analysis of 106 empirical studies on girls' attitudes toward technology and finding that a majority of studies find that male subjects hold more positive attitudes toward computers).

[202] Andrew R. Wallace & Kenneth E. Sinclair, Affective Responses and Cognitive Models of the Computing Environment, Paper presented at the Annual Meeting of the American Educational Research Association, April 18-22, (1995), *available at* http://www.edrs.com (ERIC doc. no. ED389279); Janice E. Woodrow, *The Development of Computer-Related Attitudes of Secondary Students*, 11 J. OF EDUC. COMPUTING RES. 307 (1994).

[203] A positive attitude was defined as a favorable reaction to computers and was operationalized through measures of computer liking, computer confidence, and belief about usefulness.

[204] Liao, *supra* note 201.

[205] Lockheed, *supra* note 160.

[206] Miura, *supra* note 187.

[207] John R. Slate et al., *The "Digital Divide": Hispanic College Students' Views of Educational Uses of the Internet*, 27 ASSESSMENT & EVAL. IN HIGHER EDUC. 75 (2002), *available at* http://taylorandfrancis.metapress.com/openurl.asp?genre=article&issn=0260-2938&volume=27&issue=1&page=75 (last visited Jan. 27, 2004).

future prevalent among most minorities.[208] Some studies have indicated that minorities do not see a future for themselves in the field of information technology because information technology is "something white people do."[209] When students are asked to draw an information technology professional, the resulting picture is usually a drawing of a white man. In this way, the effects of attitudes toward gender and race coalesce.[210] This confluence may lead minority girls to internalize the stereotypes regarding computing ability and gender to an even greater degree than non-minority girls. Minority girls may view themselves to be twice-removed from the world of information technology—once because of their gender and a second time because of their race.

b. Computer Confidence

¶55   Girls tend to be far less confident than boys about their computer skills according to a survey conducted by the University of California at Los Angeles (UCLA). UCLA conducts an annual survey of entering college students' computer use and confidence, polling over 400,000 students at 717 colleges and universities nationwide. Although previous studies had reported that girls tend to use computers at home less frequently than do boys,[211] the women and men in the 2001 entering class reported almost equal computer use—77.8 percent of women used computers frequently compared to 79.5 percent of men. However, female freshmen were less than half as likely as male freshmen to rate their computer skills as above average or within the top ten percent of people their age—23.2 percent of men, compared to 9.3 percent of women. In the largest gender gap in the survey's history, only 1.8 percent of women stated plans to enter computer programming, compared to 9.3 percent of men.[212]

¶56   Girls also tend to identify computer technology more strongly with males.[213] Therefore, girls tend to view information technology as an area in which they are less competent and tend to view careers in information technology to be less desirable. According to the AAUW, part of the reason for this self-selection away from computer science may result from girls' perceiving computer science careers to be less challenging, less creative, more materialistic and more anti-social than other careers.[214] These stereotyped perceptions of computer careers may be the result of lack of exposure, mentoring and knowledge of the industry.

¶57   At least one clear conclusion can be drawn from the preceding elaboration of the information technology gendered production divide: any successful steps toward

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[208] DAVID B. BOLT & RAY A.K. CRAWFORD, DIGITAL DIVIDE: COMPUTERS AND OUR CHILDREN'S FUTURE, 101 (TV Books 2000) *as cited in* P.F. First & Y.Y. Hart, *Access to Cyberspace: The New Issue in Educational Justice*, 31 J.L. & EDUC. 385 (2002). For a discussion of educational needs of minority girls, see Diana T. Slaughter Defoe et al., *Toward the Future Schooling of Girls: Global Status, Issues and Prospects*, 45 HUM. DEV. 43 (2002).

[209] *Id*.

[210] *Id*.

[211] Lorraine Culley, *Girls, Boys and Computers*, 14 EDUC. STUD. 3 (1988); Lori J. Nelson & Joel Cooper, Sex Role Identity, Attributional Style, and Attitude toward Computers, Paper presented at Annual Meeting of the Eastern Psychological Association, Boston, MA (Mar. 30-Apr. 2, 1989), *available at* http://www.edrs.com (ERIC doc. no. ED 314658).

[212] Kendra Mayfield, *Computing the Geek Gender Gap*, WIRED NEWS, Jan. 25, 2001, *at* http://www.wired.com/news/culture/0,1284,41399,99.html (last visited Jan. 1, 2004).

[213] Culley, *supra* note 211; Eastman & Krendl, *supra* note 196, at 45*;* Thurston, *supra* note 165.

[214] AAUW, *supra* note 9.

eliminating the production divide must contemplate and address each of the three levels of the problem: macrosystem, mesosystem, and microsystem. In particular, because attitudes toward computers appear to become solidified in children around the age of thirteen, educational interventions on the junior high and high school level may hold the most promise, particularly if they are implemented in a holistic manner which embeds the child in a broader community context.[215]

III. CHIPPING AWAY THE SILICON CEILING

¶58   According to the CCAWMS, a deteriorating national infrastructure may threaten U.S. leadership in information technology.[216] In order to avoid such deterioration, the U.S. must encourage, recruit, and retain a wide range of new information technology professionals, especially women and minorities.[217] The United States must view diversity among information technology professionals as a "competitive edge."[218] This perspective also appears to be shared by at least a portion of the major technology companies in the United States.[219] Nevertheless, the information technology gendered production divide has garnered only limited attention from the academic and popular press and legislators.[220]

A. Current Efforts

¶59   Without active intervention across society and across developmental contexts, it is likely that the gendered production divide will continue to increase. Some intervention efforts have begun on each level of social ecology—macrosystem, mesosystem, and microsystem.

1. Macrosystem: Legislative Interventions

¶60   During the last twenty-five years, the issue of the gender divide in digital production has been on the Congressional radar screen in one form or another. However, it has not always garnered adequate levels of attention, and meaningful improvements in the numbers of women information technology professionals have not occurred. Despite the untiring efforts of former Representative Constance Morella[221] and hearings on the

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[215] Sheingold, *supra* note 186.

[216] CONG. COMM'N, *supra* note 7.

[217] *Id*.; Mae C. Jemison, S.E.E.Ing the Future: Science, Engineering and Education. Commentary from the Scientific Grassroots, White Paper on the Issues and Need for Public Funding of Basic Science and Engineering Research (Jemison Institute for Advancing Technology in Developing Countries 2001) *at* http://www.maejemison.com/SEEING_the_Future/Seeing_the_Future_Revision.pdf (last visited Feb. 4, 2004).

[218] CONG. COMM'N, *supra* note 7.

[219] *See* Microsoft Corp., *supra* note 98; Cisco Learning Inst., *supra* note 4*;* Institute for Women and Technology, *Partners and Supporters*, *at* http://www.iwt.org/partnersandsupporters/partnerssupporters_wts1.html (last visited Jan 1, 2004).

[220] Culley, *supra* note 211*;* Marian Fish et al., *The Effect of Equity Strategies on Girls' Computer Usage in School*, 2 COMPUTERS IN HUMAN BEHAVIOR 127 (1986).

[221] Representative Constance A. Morella of Maryland was defeated in November 2002. *See* CNN.com, *Incumbent Morella Defeated in Maryland*, (Nov. 5, 2002), *at* http://www.cnn.com/2002/ALLPOLITICS/11/05/elec02.md.08.hotrace (last visited Jan 1, 2004).

subject of women's exclusion from information technology,[222] it took almost a decade for Congress to deem the gender gap among information technology professionals a problem warranting even the creation of a commission on the subject. Since the CCAWMS delivered its report in 2000, its recommendations, which involve, among other things, the creation and implementation of information technology education standards at the state level,[223] have not garnered high levels of attention in the popular or academic press. Production divides are not adequately addressed on the national or state level at present. Congressional action in response to the findings of the now defunct CCAWMS is warranted and overdue.[224]

2.   Mesosystem: Educational Environments

¶61   Some interventions to remedy the production divide are already underway in educational contexts.[225] However, further research and experimentation is needed in connection with technology education to optimize technology instruction environments for all students. Such targeted efforts can occur both through state and local governments and the private sector.

a.   School Based Efforts

i.   Single-Sex Technology Education

¶62   One popular proposal that inevitably arises in the context of remedying any gender-based educational inequity is single-sex schools and classrooms.[226] This suggestion

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[222] *See*, Subcommittee on Labor of the Committee on Labor and Human Resources, *Women in the Nontraditional Workforce, Hearing before the United States Senate,* 100th Congress, First Session on Examining the Problems Facing Women Who Seek Jobs in Fields Traditionally Dominated by Men, Particularly in Construction and High Technology Areas (Nov. 17, 1987), *available at* http://www.edrs.com (ERIC doc. no. ED295012).

[223] The specific recommendations of the CCAWMS were as follows:

1)   Aggressive, focused intervention efforts targeting women, underrepresented minority and disabled students at the high school level in connection with their transitions to higher education;

2)   Federal and state government expansion of financial investment in support of underrepresented groups in technology; including through fellowships, internships and scholarships;

3)   Both public and private employers be held accountable for the advancement of underrepresented groups within their organizations;

4)   Identification or establishment of a body representing public, private and nonprofit actors attempting to create an inclusive attractive image of information technology for underrepresented groups; and

5)   Identification or establishment of a collaborative entity for planning, development and coordination of plans to incorporate higher numbers of underrepresented groups.

CONG. COMM'N., *supra* note 7, at 3-6.

[224] One method of Congressional assistance might come through assisting states in their ability to provide a technologically adequate education through targeted programs at the junior high and high school level. Another might come in the form of a diversity tax break to enterprises that employ and train women information technology professionals or assistance in funding technology internships for high school girls.

[225] Ayla Jean Yackley, *Bridging the Inner City Gap*, WIRED NEWS, Jan. 12, 2002, *at* http://www.wired.com/news/culture/0,1284,33104,00.html (last visited Jan. 1, 2004).

[226] All-women settings are considered by dominance theory gender theorists, for example, to create an empowering milieu in which women are free from the gender discrimination they face in society. For a

arouses both vociferous support[227] and protest.[228] Single sex-schools are touted by proponents as providing a mentoring network and a "safe" environment for engaging in "unconventional" behaviors and interests and, consequently, they enable girls to break from socially constructed gender stereotypes.[229]

¶63   Similarly, proponents assert that single-sex technology education is one possible mechanism to ensure equal time and access for girls to computers.[230] For example, in one survey of 154 female technology education professionals, suggestions for improving enrollment and retention of females in technology education in secondary schools included establishing single-sex classes and same-sex mentoring programs.[231] Many parents, educators, and policy makers also zealously believe that single-sex education, particularly public single-sex education, may yield strong educational benefits for some students.[232] Anecdotal evidence regarding the effectiveness of single-sex education for particular students is plentiful.[233] As a result, single-sex technology education environments are being employed by some educators as a method of fostering girls' positive attitudes toward computer science.[234] Private organizations have begun to create single-sex technology training programs, and certain public school districts have begun experimenting with various types of single-sex pilot programs at the middle school and high school level. California, New York and Illinois are among the states that have ventured into single-sex public school experiments.

¶64   As the gender gap among mathematics and science professionals closes, the gendered information technology production divide will likely become the focus of future pilot programs in single-sex education. The Illinois program, in particular, is a harbinger of the future of single-sex pilot programs: Young Women's Leadership Charter School in Chicago, a public single-sex charter school focusing on technology education, opened in September 2000.[235] The school is housed in connection with the Illinois Institute of Technology and was the brainchild of Businesspeople and Professionals for the Public

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discussion of various schools of legal gender theory, *see* MARY BECKER, CYNTHIA GRANT BOWMAN, & MORRISON TORREY, FEMINIST JURISPRUDENCE: TAKING WOMEN SERIOUSLY (West Group 2001).

[227] For a discussion of the positives of single sex education, *see* Bruce V. Spiva, Note, *Inner-City Single-Sex Schools: Educational Reform or Invidious Discrimination*, 105 HARVARD L. REV. 1741 (1992); Kristin S. Caplice, Comment, *The Case for Public Single-Sex Education*, 18 HARV. J.L. & PUB. POL'Y 227 (1994); Beth Willinger, *Single Gender Education and the Constitution*, 40 LOY. L. REV. 253 (1994).

[228] For a discussion of the negatives of single sex education, *see* Michael Meyers, *The Non-Viability of Single-Race Single-Sex Schools*, 21 N.Y.U. REV. L. & SOC. CHANGE 663 (1994); Bernice R. Sandler, *Publicly-Supported Single-Sex Schools and Policy Issues*, 14 N.Y.L. SCH. J. HUM. RTS. (1997).

[229] *See* Yackley, *supra* note 225. For a review of the social science literature regarding single sex education, *see* Fred A. Mael, *Single-Sex and Coeducational Schooling: Relationships to Socioemotional and Academic Development*, 68 REV. OF EDUC. RES. 101 (1998).

[230] Culley, *supra* note 211*;* Fish, *supra* note 220.

[231] Jim Flowers, *Improving Female Enrollment in Tech. Ed.*, 58 THE TECHNOLOGY TEACHER 2, 21-25 (1998).

[232] *See* Koch*, supra* note 185.

[233] *See* Andrea M. Matwyshyn, Socially Deprived or Socially Constructed?: Orientalization of Female Students from Same Sex Schools (1998) (unpublished manuscript, on file with author) (reviewing literature on single sex education and conducting interviews with 30 high school graduates); AAUW, *supra* note 180 (discussing anecdotal evidence of success of single sex schools).

[234] Katie Hafner, *Girls Soak up Technology in Schools of Their Own*, N.Y. TIMES, Sept. 23, 1999, *available at* http://www.nytimes.com/library/tech/99/09/circuits/articles/23girl.html (last visited Feb. 4, 2004); Yackley, *supra* note 225.

[235] Young Women's Leadership Charter School, *at* http://www.ywlcs.org (last visited Jan. 27, 2004).

Interest, a nonprofit organization active in legal and social reform for underserved populations.[236] Like Young Women's Leadership School in East Harlem, Young Women's Leadership Charter School in Chicago particularly targets minority girls. Created as a charter school, the school is exempt from many of the state regulatory educational requirements but is subject to periodic charter review.[237] The Illinois American Civil Liberties Union has voiced its opinion that Young Women's Leadership Charter School would not survive a legal challenge on the basis of Title IX and on Fourteenth Amendment Equal Protection grounds, but has not yet filed suit.[238] Thus, the primary objection to single-sex public technology education for girls arises out of not pedagogical but legal grounds.

ii. Teaching and Curriculum Changes

¶65   Other types of educational programs and strategies aimed at increasing girls' interest and participation in careers in information technology include efforts focusing on instructor education and curriculum structuring.[239] Educational authors have advocated training instructors to be more observant of group process and dynamics that may impact female students in the male-dominated classrooms. These authors also urge instructors to work to provide forums for female students to connect with each other in real time or on-line. They further suggest that schools attempt to increase the number of female instructors and student assistants as a way to introduce female role models. With regard to curriculum, collaborative group learning and contextual hands-on methods increase the likelihood of female students' success according to some studies. Ensuring equal time for girls' use of the computer equipment, incorporating basic computer use into the first weeks of classes, getting parents involved, holding a career orientation for girls/women, making personal invitations to female students to enroll in classes, and providing additional open lab time for students who need it, also increase the likelihood of success.[240] Another suggestion for increasing girls' interest in information technology coursework involves building partnerships among high schools, community colleges, private information technology entities and community-based organizations to create certification, internship and improved curricular opportunities.[241] For example, a number of high schools in the Chicago public school system have begun to collaborate with

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[236] Yackley, *supra* note 225.

[237] *Id*.

[238] Telephone Interview with Edwin Yohnka, Ilinois ACLU (Jan. 9, 2002). One possible rationale for the school's survival of a 14th amendment challenge would be based in affirmative action—remedying women for past harms of discrimination in the information technology industry. For a discussion of recent affirmative action case law in the education context, see Victor G. Rosenblum, *Surveying the Current Legal Landscape for Affirmative Action in Admissions*, 27 J.C. & U.L. 700 (2001).

[239] *See* Victoria Di Benedetto, El Paso Community College, El Paso Community College Women in Technology End of the Year Report, 1998-1999 (1999), *available at* http://www.edrs.com (ERIC doc. no. ED435429) (last visited Feb. 4, 2004); Cisco Learning Inst., *supra* note 4.

[240] According to one student of such a program in which class work is done in small groups, and involves hands-on practice, "[L]abs on the router really helped out a lot because when it came to commands on the test, I actually knew them—not from the book but from learning them hands-on." Cisco Learning Inst., *supra* note 4.

[241] *Id*.

information technology companies such as Cisco Systems to offer curriculum in preparation for certification examinations.[242]

b. Private Sector Efforts

¶66   Non-school-based private sector efforts are also underway. One such effort to encourage girls to become interested in information technology careers was a series of girls-only computer camps operated by American Computer Experience, which ceased operations on August 10, 2001.[243] American Computer Experience began the girls-only camps with a grant from the Garnett Foundation because female enrollment in coeducational camps hovered around only ten to fifteen percent.[244] This low female enrollment in the aforementioned computer camps reflects low enrollment nationwide.[245] Additionally, organizations such as GirlGeeks[246] and Women in Technology International ("WITI") attempt to raise the profile of women in technology and encourage mentoring of women by women in the industry. WITI, for example, has begun a technology incubator at Smith College to support young women in technology through mentoring and outreach efforts. It has also encouraged members to bring their daughters to the annual WITI Silicon Valley Technology Summit in order to encourage more girls to consider careers in information technology.[247] However, these private sector efforts will prove inadequate without the sensitization of teachers and the improvement of technology education. To address gender issues in technology education, the Cisco Systems Gender Initiative, which seeks ways to increase women's access to information technology career opportunities, has created a network of partners and academies worldwide as well as a website devoted to the gender gap among information technology professionals. This website, among other things, articulates "best practices" for teaching and including women in the information technology industry.[248]

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[242] *Id*.

[243] Katie Dean, *Kids Computer Camp Crashes, Quits*, WIRED NEWS, August 14, 2001, *at* http://www.wired.com/news/school/0,1383,46042,00.html (last visited Jan. 1, 2004).

[244] Katie Dean, *Techie Girls Head Off to Camp*, WIRED NEWS, May 30, 2000, *at* http://www.wired.com/news/culture/0,1284,36556,00.html (last visited Jan. 1, 2004).

[245] Robert D. Hess & Irene T. Miura, *Gender Differences in Enrollment in Computer Camps and Classes*, 13 SEX ROLES 3 (1985).

[246] Dean, *supra* note 167, at 1.

[247] Katie Dean & Kendra Mayfield, *You Go Grrl! Execs Play up Tech*, WIRED NEWS (June 19, 2000), *at* http://www.wired.com/news/culture/0,1284,37028,00.html (last visited Jan. 1, 2004).

[248] Cisco Learning Inst., *supra* note 4. Examples of other private sector efforts include the following: American Association for University Women (AAUW), *at* http://www.aauw.org (professional organization seeking to further advancement of women worldwide); Carnegie Mellon Project on Gender and Computer Science, *at* http://www.cs.cmu.edu/afs/cs/project gendergap/www/index.html (research effort with a special focus on gender imbalance in computer science classes); Carnegie Mellon University's Computer Science Department, *at* http://www.cs.cmu. edu/~women (website devoted to the advancement of girls and women in computing); Center for Women and Information Technology, *at* http://www.umbc.edu/cwit/index.html (addresses rectifying women's under-representation in information technology); Cybersisters, *at* http://www.cyber- sisters.org (mentoring program in technology for middle-school girls); Gender Relations in Educational Applications of Technology (GREAT), *at* http://www-cse.stanford.edu/classes/cs201/Projects/gender-gap-in-education/index.htm (addressing the effect of computers on the gender gap in education); Institute for Women in Technology, *at* http://www. iwt.org/home.html; Institute for Women in Trades, Technology & Science (IWITTS), *at* http://www.iwitts.com (discussing how to recruit women and girls to technology careers); Women in IT Workforce Workshop, *at* http://www.cise.nsf.gov /itwomen.html (archives of an NSF sponsored conference

3. Microsystem: Improving Computer Attitudes and Skills

¶67   Further interdisciplinary research related to the developmental and demographic variables that hinder girls' and women's interest in and entry into the information technology industry is essential. Only through an interdisciplinary analysis can the complexities of the gender gap be understood. Perhaps one of the most important areas of research on the individual level relates to the source of many women's negative attitudes toward computers.[249] These negative attitudes and internalized gender role socialization[250] may provide the most potent source of barriers to entry into the information technology industry. In the words of one information technology professional:

> [R]ealize that right now [information technology] is a male dominated area, but don't let that intimidate you, because the men that I've worked with have been wonderful [despite preconceived notions on both sides of the gender equation]. . . You may think they're going to look down on you, or give you a hard time because you're female. Or you may think you don't have the knowledge that they have because they had a head start - but don't let those notions hold you back. You're never going to know what you can achieve unless you give it a try.[251]

Finally, perhaps, girls must acquire—and we, as a society, must work to encourage girls to develop—the strength and aggressiveness to demand their turn at the keyboard and server. In the words of one information technology professional:

> Going through my hardware courses we were building computers and running cable, stuff like that. And the men would step in and want to take over. So I had to really assert myself, and say, 'you need to back off and let me do it.' [Once these boundaries were established,] it was fine. They backed off and then I just moved forward.[252]

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on women in information technology); Backyard Project, *at* http://www.backyard.org/index.html (fostering young women's awareness of careers in the computer industry); Girlstart-Smart from the start!, *at* http://www.girlstart.org/index.html (program educating and empowering girls in information technology); Webgrrls, *at* http://www.webgrrls.com/explorer.htm (mentoring forum for women interested in new media or technology); Association for Women in Computing *available at* http://www.awc-hq.org (professional membership organization promoting the advancement of women in computing); Women in Technology International, *at* http://witi.com (membership organization dedicated to advancing women in technology).

[249] Liao, *supra* note 201.

[250] For a discussion of internalized gender role socialization and the need to contemplate its role in policy creation, *see* Kimberly A. Yuracko, *Toward Feminist Perfectionism: A Radical Critique of Rawlsian Liberalism*, 6 UCLA WOMEN'S L.J. 1 (1995).

[251] Cisco Learning Inst., *supra* note 4 (statement of Gail Padia, Cisco Academy Instructor and Cisco Curriculum Review Team Member)

[252] *Id.* (statement of Colleen Smith, Cisco PC Technician). One Cisco-certified high school student reiterated this sentiment: "Don't give up just because there's not a lot of women in the field. . .We always hear this, but it's true: if a woman puts her mind to something, she can do it just as well as anyone." *Id.* (statement of Jessica Griffin, High School Student).

B. Focusing on Girls in Context: Educational Experimentation and Mentorship

¶68   In order to successfully address the underrepresentation of women in information technology careers, change within the ecology of society must occur on all three levels of analysis: macrosystem, mesosystem, and microsystem. On the macrosystem level, law and policy must reflect the social priority of eliminating the gendered production divide. Similarly, the information technology industry must commit itself to developing its future workforce in a gender egalitarian manner and expunging the negative images of women presented to children in many video games.[253] On the mesosystem level, educational institutions must work toward engaging girls in information technology studies through curricular experimentation. On the microsystem level, girls' attitudes toward computers must be improved and their openness to careers in information technology must be encouraged.

¶69   The level of intervention that holds the most promise is the mesosystem level, specifically through educational institutions and educational experimentation. National investment in education improves productivity more than any other means.[254] According to the Congressional Commission on the Advancement of Women and Minorities in Science, an increased investment in technology education will "boost U.S. global competitiveness by increasing productivity."[255]

¶70   Traditionally, however, our conception of "education" has been wrongly limited to a relatively rigid set of intellectual categories. In the context of information technology education, these traditional education vehicles have failed and continue to fail girls. In the words of one researcher:

> Although enrollment differences between girls and boys seem to be disappearing in most areas, the lag in computer science. . .is still cause for concern because [computer science prepares] young people for some of today's highest paying and most in-demand professions. In computer science, we see the gap developing as far back as middle school, so it is essential to address this problem in the early grades.[256]

The preceding quote articulates the importance of counteracting girls' selection away from computer science that begins early in their lives. It also points to the importance of considering individuals in context—a student selecting to participate in a particular course of studies at the correct point in the lifecourse.[257]

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[253] *See* Videogame, James Bond 007: Nightfire for Playstation 2 (Electronic Arts 2002) (computer game containing only female characters presented in a hyper-sexualized manner, such that their clothing and body construction would appear to a reasonable person to be constructed with the primary purpose of appealing to a heterosexual male's prurient interest instead of with the purpose of accurately reflecting reality of average women's attire and body construction).

[254] CONG. COMM'N, *supra* note 7, at 14.

[255] *Id*.

[256] Press Release, Public Policy Institute of California, High School Girls Now Outnumber Boys in Most Math and Science Classes (Feb. 28, 2001), *at* http://www.ppic.org/main/pressrelease.asp?i=309 (last visited Jan. 27, 2004).

[257] *See* VYGOTSKY, *supra* note 92.

¶71   The age of thirteen years, in particular, appears to be a pivotal one for both sexes—a year where boys' scores in computer science increase and girls' scores decrease.[258] Therefore, junior high and high school settings are perhaps a logical point for intervention in the education system. Also, because individuals learn differently in different learning contexts, experimentation and variety in educational approaches is mandated. This experimentation should occur in a two fold manner—both in using a variety of techniques advanced in the learning sciences and through techniques advanced in the corporate world, most notably, mentorship.

1. Curricular Priority and Variety in Approaches to Learning

¶72   In order to better introduce high school students to information technology courses and careers, individual schools and school systems should take steps to prioritize information technology within the school curriculum. The importance of an adequate education in information technology on the high school level can be conveyed in several ways including curricular information technology requirements for graduation and mandatory information technology competence testing. Additionally, experimentation with nontraditional educational settings and methods appears to offer the best hope for remedying the current failure of adequately including girls in representative numbers in information technology courses. Diverse educational options within an educational system can effectively bolster individual girls' self-empowerment, provided that state level guarantees of educational adequacy[259] and federal and state Constitutional guarantees of Equal Protection are met.[260] The dearth of girls in information technology classrooms may in part result from a disjuncture between teaching methodologies and learning styles, which vary across individuals. Providing a diverse menu of educational delivery options increases the chance that individual girls will find a learning context that feels comfortable to them.

¶73   In order to accommodate different learning styles of different individuals, educational environments should strive for variety of approaches in five different categories of stimuli in educational settings, identified by the Dunn model of learning styles: environmental stimuli, emotional stimuli, sociological stimuli, physical stimuli, and psychological stimuli.[261] Environmental stimuli refer to preferences of individuals with regard to the physical structure of the learning environment, including classroom organization and design.[262] Emotional stimuli address the types of motivational

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[258] Erb, *supra* note 169.

[259] *See* Erin E. Buzuvis, Note, *"A" for Effort: Evaluating Recent State Education Reform in Response to Judicial Demands for Equity and Adequacy*, 86 CORNELL L. REV. 644 (2001).

[260] *See* Robert J. Sternberg, *Equal Protection Under the Law: What is Missing in Education*, 2 PSYCHOL. PUB. POL'Y & L. 575 (1996).

[261] *See* RITA STAFFORD DUNN & KENNETH J. DUNN, TEACHING STUDENTS THROUGH THEIR INDIVIDUAL LEARNING STYLES: A PRACTICAL APPROACH (Prentice Hall College Division 1978); RITA STAFFORD DUNN & KENNETH J. DUNN, TEACHING SECONDARY STUDENTS THROUGH THEIR INDIVIDUAL LEARNING STYLES: PRACTICAL APPROACHES FOR GRADES 7-12 (Pearson Education POD 1993).

[262] *See* Terry O'Connor, *Using Learning Styles to Adapt Technology for Higher Education*, *at* http://www.indstate.edu/ctl/styles/learning.html (last visited Jan. 1, 2004); Barbara S. Thomson & John S. Mescazine, *Attending to Learning Styles in Mathematics and Science Classrooms,* ERIC DIGEST (Jun. 1997), *at* http://www.ericse.org/digests/dse97-4.html (last visited Jan. 1, 2004).

influences that encourage persistence in learning.[263] Sociological stimuli involve the different types of learning relations on an interpersonal level, including, for example, team exercises and informal teaching relationships.[264] Physical stimuli are those influences related to the concrete intake of information by the mind.[265] Finally, psychological stimuli consider preferences of the individual in connection with analytic modes and action in learning.[266] By adopting a fundamentally flexible and contextualist approach to learning within school systems and classrooms that recognize individual students' needs, girls' interest in information technology courses and careers can be addressed one student at a time.[267] In particular, approaches involving single-sex learning environments, professional certification programs and internship opportunities should be explored.

2. The Importance of Mentorship

¶74   The potency of professional mentorship as an educational tool has been traditionally been underestimated on the junior high and high school despite its high levels of efficacy in many corporate contexts.[268] Although teachers provide one source of

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[263] *See* O'Connor, *supra* note 262.

[264] *Id*.

[265] *Id*.

[266] *Id*.

[267] Theoretically speaking, this new flexibility will result in a continuing progression away from a linear conception of development and learning that is reflected by theorists such as Piaget and toward a contextualist approach represented by Vygotsky and social learning theorists such as Bandura. For a discussion of the differences among linear and nonlinear conceptions of development, generally, and Piaget, Vygotsky and Bandura, particularly, *see* PATRICIA H. MILLER, THEORIES OF DEVELOPMENTAL PSYCHOLOGY (3rd ed., William H. Freeman & Co. 1993).

[268] For discussions of successful effects of mentorship programs within corporate entities, *see* Carol A. McKeen & Ronald J. Burke, *Mentor Relationships in Organizations: Issues, Strategies and Prospects for Women*, 8 J. OF MGMT. DEV. 33 (1989); Erin Strout, *Investigate—Pay It Forward*, 155 SALES & MARKETING MGMT. 6, (2003); Belle Rose Ragins & John L. Cotton, *Mentor Functions and Outcomes: A Comparison of Men and Women in Formal and Informal Mentoring Relationships*, 84 J. APPLIED PSYCHOL. 529 (1999); Anne Fisher, *Staying Smart—Ask Annie—Women Need at Least One Mentor—And One Pantsuit*, 138 FORTUNE 7 (1998); Katie Colon, *Women Physicians Teach the Next Generation*, 81 MINN. MED. 9 (1998), *available at* http://www.mnmed.org/Protected/98MNMED/colon.html (last visited Jan. 1, 2004); M. Rayner-Canham & G. Rayner-Canham, *Hoppy's Ladies: The Success of Many Pioneer Women Biochemists at the University of Cambridge Owes Much to the Enlightened Attitude of Their Mentor, Frederick Gowland Hopkins*, 35 CHEMISTRY IN BRITAIN 1 (1999); M. Katz, *Mentor on Call: Agency Heads and Company Brass Keep Hoping to Attract Young People, and Especially Young Women into Sales* 93 LIFE ASSOCIATION NEWS 12 (1998); *Sister, Scientist, Mentor*, 11 BLACK ISSUES IN HIGHER EDUC. 21 (1994); GAIL MCMEEKIN, THE 12 SECRETS OF HIGHLY CREATIVE WOMEN: A PORTABLE MENTOR (Red Wheel Weiser 2000); Ron Yud, *Real-life Mentoring Lights Way for Future Leaders*, 37 NATION'S RESTAURANT NEWS 30 (Jul. 28, 2003), a*vailable at* http://www.findarticles.com/cf_dls/m3190/30_37/106142588/p1/article.jhtml (last visited Jan. 1, 2004); Larry Ambrose, *Leadership in Mentoring*, 18 HEALTHCARE EXEC. 4 (2003); Jim Perrone, *Creating a Mentoring Culture*, 18 HEALTHCARE EXEC. 3 (2003); Industry Update: *Oce Mentors Chicago Students*, 43 IN-PLANT PRINTER 3 (2003); *CPA Mentor Program Goes Abroad*, 73 AUSTRALIAN CPA 1 (2003), *available at* http://www.cpaaustralia.com.au/03_publications/02_aust_cpa_magazine/2003/47_feb/3_2_47_18_mentor.asp (last visited Jan. 1, 2004); Robyn D. Clarke, *Leading by Direction, Not Dictation*, 33 BLACK ENTERPRISE 9 (2003), *available at* http://www.findarticles.com/cf_dls/m1365/9_33/99516134/p1/article.jhtml (last visited Jan. 1, 2004); Larry Ambrose, *Long-Distance Mentoring*, 18 HEALTHCARE EXEC. 2 (2003); Damon Birchfield, *Coaches and Mentors Online*, 50 NEW ZEALAND MGMT 34 (2003); Betti A. Hamilton & Terri A. Scandura, *E-*

mentorship for students, third party mentors currently working in the information technology industry offer another important source of knowledge and opportunity for student modeling.[269] A large scale mentorship initiative holds great promise in shrinking the gendered digital production divide. It presents a type of educational intervention that would successfully integrate all three levels of the social ecology of the gendered production divide. For example, a macrosystem level mentorship initiative could be structured through tax incentives and public praise for entities who require information technology professionals to engage in school-based mentorship of girls and minorities as part of their employment. Tax incentives and positive public relations exposure are two powerful carrots to incent socially beneficial behavior by entities.[270] A national mentorship initiative aimed at eliminating the gendered digital production divide could offer positive effects on each level of social ecology.

¶75   On the macrosystem level, a mentorship initiative that harnesses the expertise of the information technology private sector initiates a two-fold benefit. First, a mentorship initiative may instigate a societal re-conceptualization of corporate identity toward a view of business entities as members of society that are subject to certain social responsibilities to the forums in which they operate. Education of the future workforce is one such social responsibility. Particularly in light of the express interest of numerous information technology companies in facilitating the entry of more women and minorities into information technology, it is likely that a mentorship program will appeal to the private sector. Also, mentorship initiatives offer a seemingly efficient solution for facilitating entry of students into the workforce upon graduation because they generate connections between the supply and demand of future information technology workforce. Mentors

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Mentoring: Implications for Organizational Learning and Development in a Wired World, 31 ORGANIZATIONAL DYNAMICS 388 (2003); Michael F. Doody, *A Mentor is a Key to Career Success*, 57 HEALTHCARE FINANCIAL MGMT 2 (2003), *available at* http://www.findarticles.com/cf_dls/m3257/2_57/97786244/p1/article.jhtml (last visited Jan. 1, 2004); Anne Field, *No Time to Mentor? Do It Online*, 38 BUS. WEEK 22 (2003), *available at* http://www.businessweek.com/magazine/content/03_09/b3822099_mz025.htm (last visited Jan. 1, 2004); Steven J. Armstrong, et al., *Formal Mentoring Systems: An Examination of the Effects of Mentor/Protégé Cognitive Styles on the Mentoring Process*, 39 J. OF MGMT STUDIES 1111 (2002); Mike Southon & Chris West, *A Friend in High Places*, 55 DIRECTOR 12 (2002); Adrian Savage, *The Real Glass Ceiling* (Works in Progress Coaching 2002), *available at* http://www.wipcoaching.com/downloads/the-real-glass-ceiling.pdf (last visited Jan. 1, 2004); Polly Larson, *Mentor Programs Offer "Somebody to Lean On."* 34 FRANCHISING WORLD 12 (2002); *Mentors: NZIM Study Shows They Help Advance Careers*, 49 NEW ZEALAND MGMT 8 (2002), *available at* www.nzim.co.nz/SITE_Default/SITE_other_services/x-files/2883.pdf (last visited Jan. 1, 2004); M.J. Lankau & Terri A. Scandura, *An Investigation of Personal Learning in Mentoring Relationships: Content, Antecedents, and Conseque*nces, 45 ACADEMY OF MGMT J. 779 (2002); Joel Schettler, *The Measure of A Mentor*, 39 TRAINING 7 (2002); *but see* Maryfran Johnson, *Mentor, Schmentor: Women Will Advance by Taking on Tough Projects and Proving Themselves,* 31 COMPUTERWORLD 25 (1997); Roma Harris, *The Mentoring Trap*, 118 LIBR. J. 37 (1993).

[269] In learning theory, modeling is the acquisition and learning of a new skill by observing and imitating that behavior being performed by another individual. Modeling is an important part of Bandura's Social Learning Theory. *See* ALBERT BANDURA, SOCIAL LEARNING THEORY (Prentice Hall 1977).

[270] Although I have not developed the specifics of such a mentorship program here, such a program would not be without precedent. Basically, mentorship activities can be classified as job training activities. Particularly if targeted at low-income and otherwise underserved groups, providing tax incentives for these activities would be socially productive. Tax incentives for job training activities conducted by entities are already used in other contexts, such as in connection with TIFF Act increment financing transactions. *See* 65 ILCS 5/11-74.4-3(q)(5) (2002). Any successful mentorship structure would set forth standards for eligibility and pricing for benefits received by entities contingent on hours of participation, an auditing and verification procedure, which might include affidavits of participation by both mentor and "mentee".

may form lasting relationships with their protégés, which may develop into offers of employment at the outset and greater shepherding for the protégés following entry into the workforce. In this manner, retention of women and minorities within the information technology industry may similarly improve.[271]

¶76   On the mesosystem level, mentorship programs provide a fundamentally different learning paradigm than that of the traditional classroom. The stimuli of learning styles discussed previously are operationalized differently in a curriculum that includes a mentoring component. The mentored student experiences fundamentally different environmental, emotional, and sociological stimuli than students without mentors by learning from a mentor and being incorporated into the mentor's workplace. For some students, this difference may prove determinative of their interest in information technology careers. Thus, more girls may become engaged with and interested in information technology because their perception of the information technology industry will be driven by their positive interpersonal relationship with their mentor and their mentor's workplace.

¶77   Finally, on the microsystem level, mentorship programs tend to provide a sense of intellectual empowerment for the mentee, giving a different perspective on professional prospects, problems and opportunitites[272] and advice regarding cultural expectations of the workplace.[273] Meanwhile, for the mentor, a mentoring relationship can also prove beneficial.[274] Among other things, it can fulfill the developmental need of adults for being generative,[275] sharing their experiences and creating knowledge that exists independent of themselves.[276] Simultaneously, mentorship puts professionals in touch with individuals who may be good prospective employees upon graduation.

¶78   Therefore, perhaps the correct approach to remedying the gendered digital production divide is realizing that no one approach is truly correct. Perhaps it is only through diversity in educational options while maintaining baseline Constitutional protections of Equal Protection and educational adequacy that a diverse student body is best educated.

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[271] *See infra* discussion Section 2(a).

[272] *See* Karla Haworth, *Mentor Programs Provide Support via E-mail to Women Studying Science*, 44 CHRON. OF HIGHER EDUC. 32 (Apr. 17, 1998) (quoting Karolyn Abram, a sophomore at Dartmouth planning on majoring in computer science, "[I]t's nice to be able to interact with someone older. . .My mentor knows what kinds of majors will get you what sorts of jobs, and that's been a great resource."); Michael J. Weinberg, *Agents as Mentors*, 145 ROUGH NOTES 12 (2002), *available at* http://www.roughnotes.com/rnmagazine/2002/december02/12p46.htm (last visited Jan. 1, 2004).

[273] Haworth, *supra* note 272 (quoting Carol B. Muller, "Because [traditionally male] fields have grown up with a male-oriented culture, there are often unspoken or subtle expectations for behavior and ways to get things done that are less accessible for women. . .A mentor can provide that kind of information.").

[274] Ellen Bolman Pullins & Leslie M. Fine, *How the Performance of Mentoring Activities Affect the Mentor's Job Outcomes*, 22 J. OF PERSONAL SELLING & SALES MGMT. 259 (2002).

[275] "Generativity" refers to "the interest in establishing and guiding the next generation" in the words of Eric H. Erikson, who characterized the fundamental developmental challenge of middle adulthood to be the tension between generativity and stagnation/self-absorption. *See* ERIK HOMBURGER ERIKSON, IDENTITY AND THE LIFE CYCLE, (Reissue ed., W.W. Norton & Co. Apr. 1994).

[276] *See* Haworth, *supra* note 272 (quoting Karla M. Reynolds, an engineering manager at I.B.M. who says, "I'd like to take some of the experience I've gained over the past 20 years and share that with somebody else. . .it's nice to feel the students' enthusiasm and excitement for where they're hearing.").

IV. CONCLUSION

¶79   We as a society are heading toward a future where women in the United States will continue to be technologically disenfranchised and marginalized because of their dearth among the ranks of information technology professionals. Would the entire structure of code change as a consequence of including women in representative numbers among coders and information technology management? Would software and hardware begin to better reflect the influence of a fundamentally gendered perception of reality that only women experience? Although gender theory scholars disagree on the extent that an individual's gender dispositively dictates her/his perceptions of reality, it is not possible to know whether this is the case without constructing an information technology industry that is more representative of women.[277] Inclusion of underrepresented groups in the ranks of information technology professionals would both improve the quality of information technology products and services and the legitimacy of information technology as a mechanism of social governance by reflecting the diversity of the governed.[278] To achieve this end, more attention to production divides—and not only access divides—is required on all levels of government as well as in the private sector. In particular, support of educational intervention at the junior high and high school level is necessitated: interventions at the junior high and high school level are most likely to impact individual attitudes and lead more girls to enter careers in information technology. Thus, states should be encouraged to experiment with educational environments and curriculum to empower girls to choose the nontraditional option of a career in information technology. Such experimentation should, in particular, include nontraditional educational programs such as mentorship initiatives, single sex technology classes within coeducational schools and high school curriculum targeted at qualifying students for professional certification, to the extent such experimentation is constitutionally permissible.

¶80   Information technology is the governance structure of the twenty-first century and embodies the values of its makers, the information technology professionals who create it. Without working to create a more representative body of these "digital legislators," information technology (and the legislative regulation in real space that impacts it) increasingly runs the risk of acting in opposition to, rather than acting in accordance with, the wishes of a majority of those governed. If such a disjuncture between the composition of the populace and the composition of the information technology industry is permitted to fester, a type of crisis of technological legitimacy may result.[279] As we commence the second decade of information technology law and policy, we are faced

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[277] For a discussion of schools of gender theory and the impact of gender on social interactions and perceptions, *See* Becker, *supra* note 226.

[278] Microsoft Corp., *supra* note 98.

[279] Adopting an essentialist posture necessitated by his time, John Stuart Mill observed, "[i]f anything conclusive can be inferred from experience. . .it would be that the things which women are not allowed to do are the very ones for which they are peculiarly qualified; . . . their vocation for government has made its way, and become conspicuous, through the very few opportunities which have been given. . ." JOHN STUART MILL, THE SUBJECTION OF WOMEN 79 (Reprint ed., Dover Publications 1997). In the information technology industry, several revolutionary inventions were produced by women computer scientists. For example, Grace Murray Hopper, one of the first software engineers, invented the compiler. *See* San Diego Supercomputer Center, *Women in Science, at* http://www.sdsc.edu/Publications/ScienceWomen/hopper.html (last visited Jan. 26, 2004).

with a fundamental decision regarding the nature of information technology: will it become the ultimate cultural tool of equality or the ultimate cultural tool of exclusion?