

## Research Article

# The Persistence of Traditional Gender Roles in the Information Technology Sector: A Study of Female Engineers in India

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### **Abstract**

*As women in India enter the rapidly expanding Information Technology (IT) workforce, it could be predicted that their active participation in this sector will change their socio-economic status within the employing organization and the communities in which they reside. It is often expected that women's participation in the professional realm will contribute to a breakdown of traditional gender roles. And indeed, the data illustrate that women are working in the IT sector in India in increasing numbers. However, data collected in 1992 and again in 2002 by the Indian Institute of Technology suggest that not only does women's participation fail to occur at the same speed as IT expansion, but that their participation is based on a continuation of traditional gender roles, which places women on the periphery of an employing organization. Questioning the paradigm of technological determinism, this paper examines how technology and its development can adapt to the existing social structure. The persistence of such gender divides perpetuate the notion of gender segregation and do not enhance women's socio-economic and political status, nor provide equal participation in the information economy.*

### **Introduction**

The Western paradigm of development and modernization suggests that as rational processes and bureaucratic functions overtake traditional forms of social organization, gender inequities will disappear, along with other forms of social closure based on differentiation, such as religion and ethnicity. Similarly, the concept of the information technology revolution implies equal access to all. Of course, this is recognized as far from reality, and the digital divide has become part of the popular lexicon to describe the division between those with access to information technology (IT) and those without. Yet this distinction further seems to imply that, once one is across this divide, social exclusion and barriers to equal participation are no longer significant. While the digital divide increases the disparity between the rich and poor, with notable patterns occurring along gender, ethnic, and socio-economic divisions, there is the popular contention that technology, once accessed, is an agent for advancing the status of women. This advancement implies a change in gender relations.

Peter Drucker (2001), for example, has called technology the "great equalizer" as it can be used on an equal basis by both men and women. Kelkar and Nathan (2002) expand upon this by stating that IT serves as a

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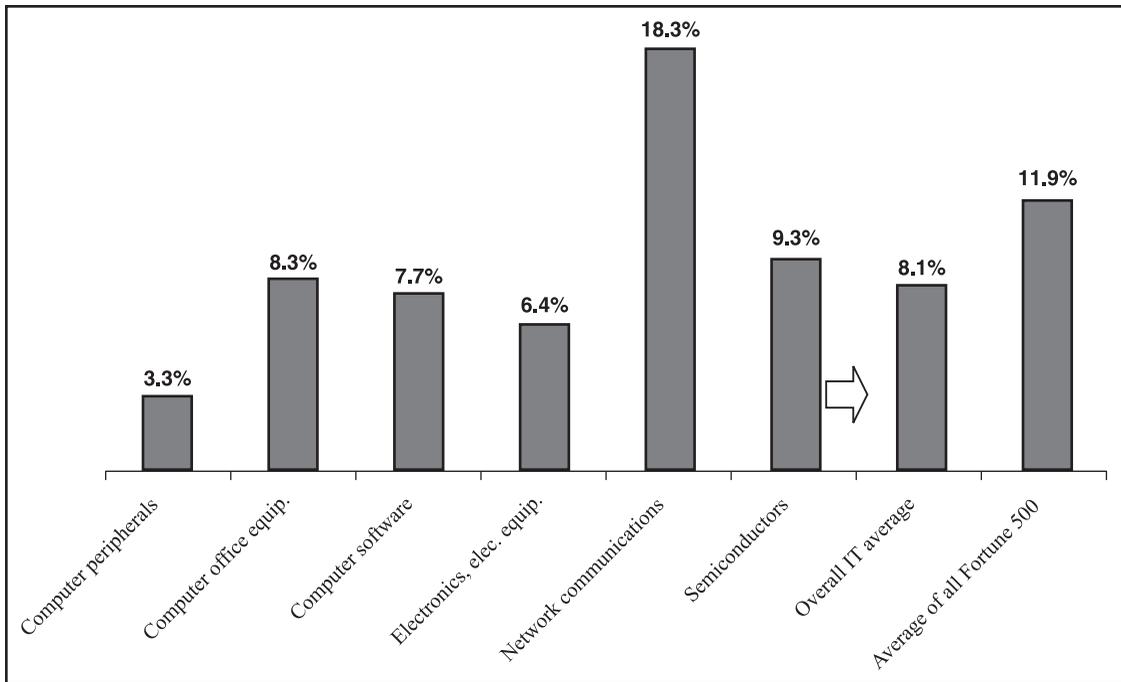


Figure 1. 1999 catalyst census of women corporate officers and top earners.

basis for redefining traditional gender roles, while Fountain (2000) asserts that socially, in the United States, there is no better time than now for women in terms of IT opportunities. Fountain (2000) explains that a defining factor of the IT Revolution is economic competitiveness, whereas physical power, associated primarily with masculinity, was more important during the Industrial Revolution. Varma (2002b) has stated that "IT work remains one of the best prospects for women in terms of salary, career path, rewarding office-based environment, and intellectually stimulating work" (p. 274–75). In the area of gender relations and technological change, Castells (2000) asserts that social changes are just as dramatic as economic and technological transformation, and in fact the term *revolution* implies that there will be significant social changes. Haraway (1991), however, when referring to technology and social relations, contends that while technology can be a catalyst for restructuring social relations between genders, at the same time "we are not dealing with a technological determinism, but with a historical system depending upon structured relations among people" (p. 165).

And, in fact, there are indications that even in

developed countries structured inequities based on gender persist on both sides of the digital divide. For example, although women make up 51% of the population and 46% of the U.S. labor force, a 2000 study conducted by the National Science Foundation showed that only 28% of computer and mathematical scientists are women (Varma 2002b). In addition, research by Catalyst (1999) indicates that throughout the Fortune 500 ranks, 88.1% of corporate officer positions are held by men. At the same time, women's participation at the corporate officer level within the IT sector is 8.1% (Figure 1), and women hold only 3.3% of such positions in the computer peripherals sector.

How is it that the IT sector, which some view as a revolutionary force and the "great equalizer," has the lowest overall participation of women (8.1%) in its upper echelons when compared with other industries, such as diversified financial institutions (27.1%) and publishing/printing (24.1%), that have been entrenched in North American society for decades (Catalyst 1999)? If such an imbalance is occurring in the United States, where arguably women enjoy more social and economic freedoms, what is happening in a developing country such as India

where gender roles are more firmly entrenched and the socio-economic status of women continues to be far less than that of men?

Women, of course, are working in the IT sector in India, both in the highly publicized IT-enabled call centers, as well as in the higher-skilled areas of IT production. Kelkar and Nathan (2002) have noted the positive economic effects of the growing service industry on both genders in India, stating that "the spread of IT-enabled services has been immensely beneficial to both women and men, especially those who have limited skills or lack of resources to invest in higher education. The minimum wage in India is just over Rs [rupees] 1000 per month, while in the IT Industry, monthly wages range from Rs 5000 to Rs 15,000" (p. 433). Yet, while both men and women derive benefits from participation in the IT sector, there is evidence that suggests such benefits exist on a gender-based continuum. One gets a glimpse of how gender roles are being perpetuated in a recent article in *India Today* (Chengappa and Goyal 2002). The cover story, "Housekeepers to the World," focused on call centers in India. In terms of visual presentation, the front cover, along with photo-ops of customer service workers, were primarily young women. In contrast, photo-ops involving a high-level position, such as chairman or president, were all older men. Within the contents of this article, it was men who were presented as leaders of the industry and experts in terms of discussing future growth and challenges in developing the industry. In contrast, the women interviewed were not in positions that were any higher than that of an entry-level worker. The one exception to this was a female vice president. However, she worked for a company that trains women on how to be effective customer service representatives. She was not in a direct position of power in terms of owning a call center or serving as an agent for influencing policy surrounding the development of this industry. The article gave one the sense that women are to be seen, but not serve as active participants in the decision-making sphere. In addition, Kelkar et al. (2002) have argued that women's access to call center employment does not contribute to changes in their social status within the household due to the secondary status given to call center employment within the IT sector.

In terms of the higher-skilled technical employment, Mansell and Wehn (1998) caution that, while

women are entering the ICT field, including software development, "terms of contracts, wages, training, health, and safety are often very poor" (p. 249). A study done in the mid 1990s (Webster in Mansell and Wehn: 251) reports that in every country of the world women are marginalized from the more instrumental and lucrative careers involved with the research and development of IT, and relegated to lower skill and income tiers of IT production.

India has put forth a comprehensive effort to develop as a modern, technologically advanced nation, and the IT sector is considered a key contributor to India's progress. India's IT policy indicates its centrality in the country's overall development planning, including issues of the digital divide and gender inequities. The Ministry of Communications and Information Technology has stated that "investment in ICT has the largest multiplier effect rippling through the economy" (MCIT 2003: 3). The ministry projects software exports to increase from 2.4% of the fixed-GDP to 7% by 2008. Regarding gender equality, India was one of the first countries to give women the right to vote and its Constitution is considered one of the most progressive in the world (Constitution of India 1995). The National Policy for the Empowerment of Women seeks "equal access to participation and decision making of women in social, political and economic life of the nation" (National Policy 2001: 1). One senses, however, that the attainment of professional employment is assumed to satisfy these conditions and that bridging the digital divide with opportunities for women will inherently solve gender inequities. Yet, there is scant attention given to gender issues in relation to technology policy at either the national or state level. For example, the current IT policy for the state of Kerala and the 2000 IT policy for the state of Assam make no mention of gender issues. On a national level, the 2003 annual report by the Ministry of Communications and IT devotes only three paragraphs, in a 108-page document, to gender issues, mentioning only that the software sector offers flexible employment conducive to women who must juggle family and career, and announcing a new scholarship program for female students in computer science. Thereafter, the report concludes by stating, "This sector has, thus, successfully addressed gender issues" (p. 49).

In fact, how successfully have the software and

other technology sectors in India addressed gender issues? Does the growth of an IT sector, with the participation of women, inevitably contribute to changed gender relations and enhanced gender equality, as many have suggested? What is happening to gender roles and gender relations in India in the midst of an IT revolution? This paper considers these questions, challenging the assumptions that access to technology and employment within the sector necessarily mean significant changes in gender roles and power relations between the genders. Instead, this paper proposes that technological development can be acquired by and adapted to the existing social structure. After a brief review of literature which addresses issues of women, development, and technology, current gender relations in India are examined within the technologically connected side of the digital divide in India by studying a segment of the IT sector. This segment is the field of engineering, representing the driving force of many aspects of IT and ICT development, spanning software design and hardware development to telecommunications technology. Background is provided on the socio-economic status of women in India; however, it is important to note that observations made can only be discussed in broad terms, as India is a highly heterogeneous society where no generalization could apply to all the social, religious, and economic groups that make up the nation. For instance, there are 91 identifiable cultural regions that each contain a distinct language, territorial identity, and cultural norms (Singh 2002).

### **Gender, Development, and Technology**

Unlike sex, which is defined by biological differences between men and women, gender refers to the socially learned behaviors and expectations that are attributed to masculinity and femininity (Anderson 1988; Peterson and Runyan 1999). Barribeau et al. (2000) define gender relations as "societies [sic] socially constructed relations between men and women" (p. 205). In general, traits that define masculinity are assertiveness, leadership, physical strength, and dominance. In contrast, feminine traits are defined as emotional, supportive, nurturing, and submissive. Despite modernization and technological development, such traditional roles can remain firmly entrenched at all levels of society. Peterson

and Runyon (1999) find that "gender is a particularly powerful lens through which all of us see and organize reality" (p. 5). Peterson (interview, March 6, 2003) stated that placing individuals within the context of gendered categories fails to take into account all aspects of one's capabilities and characteristics. This dichotomy perpetuates a form of gender hierarchy in which the adoption of supposed masculine traits is deemed as positive and the adoption of feminine traits is viewed negatively. Furthermore, masculinity and femininity are inter-relational. An individual with more masculine characteristics is understood to be positive based on having fewer feminine characteristics, for example, being aggressive rather than nurturing. This is illustrated when women are applauded for participating in masculine activities such as sports and politics. In contrast, men who move into feminine activities, such as nursing or domestic work, are viewed as taking a "step back." According to Peterson and Runyon (1999), adopting one set of traits (masculine) comes at the expense of other traits (feminine).

From Boserup (1970), whose work was seminal in highlighting the lack of women's roles in development, to current research in the field of women in development, it is recognized that modernization does not automatically improve the status of women, and that, furthermore, development of society as a whole is hindered by this. Mehra (1997) argues that development policies have failed to integrate women into the economic development process, and that there have been higher investments in women's reproductive rather than productive roles, such as funding for population programs versus income-generating programs. Theoretical and policy approaches have often focused on the situation of rural women. For example, the UNDP 2003–2007 Country Programme for India (UNDP 2003b) emphasizes poverty eradication along with promoting human development and gender equality. Article 13b describes "piloting and testing gender-responsive models of support for traditional artisan communities, such as handloom weavers and rural craftpersons, for employment and poverty eradication, and to make them competitive in a climate of globalization and liberalization" (p. 5). However, while there is a policy-driven effort in the rural population to address issues surrounding women and economic development, what is happening in the urban domain where the presence of education and

technology, combined with IT development, sets the stage for economic and social development? Does the access to education and technology afforded to urban women make up for the absence of policies focused on integrating women into the upper echelons of the IT sector? Or do urban women participating in the IT sector continue to be placed in positions that are defined as feminine and secondary, which in turn, mimic rural gender roles on a grander and more influential scale?

In the past 10 years, development literature has emerged that focuses on issues such as capabilities, empowerment, and opportunities. This approach lends itself to the study of gender relations within the privileged side of the digital and economic divide, since the emphasis is not on economic growth and material wealth alone. Amartya Sen (1999) has argued that development is linked to the freedoms one enjoys and that the lack of women's empowerment affects all members of a society, stating that "the most immediate argument for focusing on women's *agency* may be precisely the role that such agency can play in removing inequities that depress the *well-being* of women" (p. 91). Martha Nussbaum (2000) focuses on women's capabilities, using India as a case study, with the primary question, "What is a woman actually able to do and to be?" versus how satisfied a woman is or how much in the way of resources a woman is able to command. At the same time, Mehra (1997) points out, "It is relatively easier to expand women's capabilities than their opportunities" (p. 139). For example, while women are capable of being educated, the social structure in place may not necessarily provide them with the opportunities to apply their education to its full potential in the paid labor force.

This approach to development, emphasizing opportunities rather than economic outcomes, has influenced the United Nations Development Programme (UNDP), including its treatment of women. In addition to the GDI (gender-related development index), the UNDP (2003a, 2004) has, since 1995, generated a gender empowerment measure (GEM), which includes indicators of "participation and decision-making, political participation and decision-making, and power over economic resources." This is an attempt to capture issues of gender inequality that are not as apparent as outright oppression, violence, and unequal access to basic needs. Charms and Wierenga (2003) have

critiqued this measurement, noting that even here women's empowerment has been "underconceptualized" (p. 420), that it actually involves complex patterns of male and female relations at every level and sector of society, and that a "holistic" approach to the construction of the GEM needs to be adapted. One point they make is that the empowerment of women "is not a linear process" (p. 425), and in fact, advances made in the status and well-being of women *can mask the persistence of unequal power* relations between the genders. The authors provide an example from Barbados, which illustrates male resentment and backlash at the increase in female participation and success in school and the workplace, which is interpreted as having a negative effect on male opportunities (p. 433). Thus, studies of gender relations in the development process need to look beyond isolated measurements of female advancement, to the dynamics of male-female relations in all sectors and levels of society. It is this notion of empowerment that is useful in the study of gender relations within the advanced technology sectors, as this would reveal data missed by solely measuring numbers of women in the field.

## Public versus Private Spheres and Gender Roles

The *public versus private sphere* model, from one of the first waves of feminist theory, is employed here to analyze the participation of women in India's IT, and specifically, the engineering sector. This model stems from the study of gendered categories within a society, whereby there are prescribed roles for men and women. While biological differences have long been assumed, feminist anthropologists argue that gender hierarchies are not culturally universal. Therefore, one needs to look at gender roles and relations from a different perspective. As early as 1975, Mitchell's work called attention to the division of a public, or male, sphere and a private, or female, sphere, which can be detected in both social and economic structures (Anderson 1988). Based on academic research from the fields of anthropology, sociology, and political science, Table 1 provides an outline of the traits that define each sphere.

Traditionally, women's work has been associated with the domestic world of home, children, and reproduction. Such labor is relegated to the *private*

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Table 1. Associated Differences of the Public and Private Sphere

Public Sphere	Private Sphere
Masculine	Feminine
Production of goods and services	Reproduction—childbearing
Paid labor	Unpaid labor
Leaders	Followers
Primary	Secondary
Visible	Invisible

Note: Derived from Anderson (1988); Peterson and Runyan (1999).

*sphere* and often is not visible or recognized at many social and economic levels of a society. For example, what would the GNP of a country look like if the unpaid labor of women's work in the household were given some form of economic value? But further, does the cultural and societal association of women with unpaid labor (i.e., domestic duties) impact their roles in the paid workforce? Do *private sphere* traits, in which women's labor is considered secondary, relegate them, consciously or unconsciously, to a form of gender segregation that places them on a career track limited to the role of follower rather than leader? In terms of specific job roles, the assumption that women are followers could contribute to their placement in positions below their abilities because it is assumed that most women would place their reproductive and household roles before that of a leadership role in workplace. In contrast, men's work is associated with the *public sphere* of paid labor, economic power, and political influence. Anderson (1988) contends that the *private sphere* is viewed as inferior because it is identified with women, while the *public sphere* is positive as it is identified with men, and their corresponding levels of social, economic and political power. As women in India move into the paid labor force, how do they navigate between these spheres? Also, is a *public versus private sphere* distinction occurring *within* the paid labor force itself? Is it possible that traits that define the *public versus private sphere*, even as women move from the *private sphere* of the home to the masculine *public sphere*, are being replicated in the workplace?

### Women in Indian Society

India ranks 103 out of 161 on the UNDP's 2004 gender-related development index (GDI). The GDI measures average achievement in the three basic di-

mensions captured in the human development index—a long and healthy life, knowledge, and a decent standard of living—adjusted to account for inequalities between men and women. Ironically, India was ranked worse than nondemocratic nations such as Saudi Arabia (GDI of 72) and Kuwait (GDI of 42). At the same time, Ghose et al. (2001) criticize the GDI score for India because it fails to consider regional variations, ignores the rural-urban divide, and does not take into account the magnitude of female poverty in comparison to male poverty. The research set forth by Ghose et al. implies that the status of women in relation to men is even worse than the GDI measurement indicates.

Despite India's many advances since independence from Great Britain in 1947, the subjugation of women, combined with the preference for men, occurs at almost every level of Indian society. While literacy rates have improved, there has only been marginal improvement (18%) in terms of narrowing the male/female illiteracy gap over the past 30 years (World Bank 2002). The average Indian woman earns 60% of what men in the same job earn and women occupy only 3% of the management positions in the business sector (*Dow Jones International News* 2002). Kumar and Menon-Sen's 2001 study, commissioned by the United Nations, found that 65.3% of Indian women have been subjected to some form of domestic violence. The preference for sons in India has contributed to a sex ratio unusually in favor of the male population, illustrated by Sen's (1999) concept of "missing women." According to a 1901 census, in colonial India, the ratio of females per 1,000 males was 972 (Varma 2002a). By 2001, almost 50 years after the end of colonial rule, the ratio of females per 1,000 males had dropped to an alarmingly low 933 (Varma 2002a). Factors contributing to such an imbalance are female infanticide

and neglect of female children in terms of health care and nutrition (Dreze and Sen 1995).

From an economic standpoint, women are perceived as a drain on the wealth of a family due to factors such as dowry payments for marriage and the expectation that upon marriage a woman will transfer her loyalty to her husband's family (Varma 2002a; Singh 2002). Parents expect little in the way of financial and emotional support from their daughters (Singh 2002). The role of a female child and woman in Indian society is primarily within the confines of the home. Her status is directly linked to her role as wife and mother. Regardless of whether a woman works outside the home, she is held accountable for domestic labor and the raising of children. In contrast, men are perceived to be lifetime financial contributors for the family, as they are not required to transfer their allegiance to the bride's family upon marriage. The birth of a son brings not only dowry payment in the future, but also brings, by taking a wife, additional labor within the family for matters such as caring for aging parents and maintenance of the household.

The use in India of sex determination technology (SDT), such as amniocentesis and ultrasonogram, for the deliberate abortion of female fetuses suggests that technology, even when coupled with the attainment of education and a higher socio-economic status, does not automatically result in positive social development. In fact, this usage indicates that, despite socio-economic development in India, the preference for boys remains firmly entrenched. By the 1980s, SDTs were widely used by the educated middle and upper class strata of Indian society to detect and abort female fetuses. Advertisements for services came with slogans such as "Better Rs [rupees] 500 Now Than Rs 500,000 Later" (referring to dowry) and "Come for This Test so You Don't Have an Unwanted Daughter Born to You" (Varma 2002a). While the practice has been outlawed, there are indications that it continues (Rohde 2003). The notion that technology could serve as an agent for rapid social change or allow for "leap-frogging," which assumes positive change, in developing countries is similar to the notion that education improves the status of women. Yet among the higher socio-economic levels of the society, much of the impetus for the education of women comes from the in-

creasing demand for literate brides on the part of young educated men. This suggests that both educating women and enabling them to gain access to modern technology does not necessarily alter the patriarchal structure already in place, but can instead be adapted and utilized to support that structure.

Dreze and Sen's (1995) research on India suggests that the social changes required to promote gender equality cannot be clearly linked to economic growth. For example, the northern states of Haryana and Punjab have experienced rapid economic expansion since independence and their per-capita income is far ahead of other Indian states. Despite this, both states have lower female-male ratios (e.g., 874 girls for every 1,000 boys)<sup>1</sup> than any other state, with the exception of Uttar Pradesh. The northern states are far more patriarchal in contrast to southern states, which are considered more egalitarian. The restrictions on women living in the north is linked to the martial castes, who have led the way historically in the development of practices such as dowry, child marriage, bride burning (if dowry is insufficient), seclusion of women, *sati* (burning of widows), and female infanticide (Dreze and Sen 1995). In contrast, Yadava (1999) asserts that the higher status of women in the south is linked to property ownership rights and educational attainment.

Nationally, however, and despite the fact that Indira Gandhi served as prime minister, women overall are underrepresented in both the governmental and business sector. In 2000, women made up only 20.5% of the professional and technical workforce in India in contrast to China which is at 45.1% (Hafkin and Taggart 2001). As of 2001, fewer than 8% of parliamentary seats, fewer than 6% of cabinet positions, and fewer than 4% of seats in the High Courts and Supreme Court were held by women (Kumar and Menon-Sen 2001).

## Technological Development and Socio-Economic Gaps

This section provides a broad overview of advances in technological development in relation to the advancement of the socio-economic status of women relative to that of men. The indices selected to

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1. Based on the state of Punjab's statistics (Varma 2002a)

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Table 2. Technological Development Indicators (TDI)

Description	1995	2000	% Change
Telephone lines per 1,000 people	13.0	37.0	185%
Mobile phones per 1,000 people	0.08	3.5	4,275%
TV sets per 1,000 people	61.0	78.0	28%
Daily newspapers per 1,000 people	48.01	60.0	25%
Personal computers per 1,000 people	1.3	4.5	246%
Internet users per 1,000 people	0.27	5.4	1,900%

Note: World Bank Development Data Group (2004).

Source: Based on 1997 because data for 1995 was unavailable.

measure technological development are based on research by Rai and Lal (2000), Mansell and Wehn (1998), and Kudaisya (2001). The socio-economic data used are based on women residing in both the rural and urban areas. Therefore, the technological indicators reflect the aggregate development in both of these domains. In addition, indicators such as newspapers and television were included based on their link to the creation and diffusion of knowledge, a key criterion of the emergence of an information society.

Table 2 illustrates a notable improvement in India's access to and implementation of certain technologies, as demonstrated by the marked increase of mobile phones and Internet users. Although the first dial-up service for e-mail access was set up in 1986 and limited to the Indian Institute of Technology (IIT) in the city of Mumbai (Kudaisya 2001), by 2000 India had 12 fully functioning ISPs<sup>2</sup> (Franda 2002a) and Bangalore alone had over 700 cybercafés (Patni 1999).

In addition to the growth demonstrated in Table 2, the National Association of Software and Services Companies' (NASSCOM) 2002 annual report indicates that there were 2,810 IT companies in India, and it calculated IT service/software exports to be US\$7,647 billion. Such growth is remarkable as software exports in 1985 were only US\$26 million (as cited in McDowell 1995) representing a 29,311% increase in 17 years. At the same time, such growth is not limited to specialized technologies within the urban domain. For example, from 1980 to 2000 the number of radios per 1,000 people grew 218% (World Bank Development Group

2003, 2004). However, indicators such as radios and televisions have not experienced dramatic increases compared with mobile phones and cybercafés. Rai (2002) offers an interesting perspective on the speed of technological development in India:

[T]he diffusion of the Net in our society has been much faster in comparison to other technologies. Radio took 38 years to reach 50 million people, television took 13 and the PC no less than 16 years, but within four years the Net could reach 50 million people. (p. 64)

Based on Table 2, the average percentage change of technological development between 1995 and 2000 was 1,110%. But has there been equally impressive development in terms of equalizing the socio-economic status of women in relation to men? The socio-economic indicators chosen for this study consider a broad range of factors that impact the livelihood of both men and women. Indicators set forth in Table 3 were based on some of the social factors suggested by the UN-GDI index in combination with economic factors specific to one's participation in the paid labor force, such as percentage of engineering degrees and workforce participation. Since changes in gender relations take longer to diffuse, and over the past two decades India's development indicators have generally improved, a 20-year time frame of socio-economic data is provided in Table 3.

As a group, women have made significant strides in some areas. For example, the number of women earning engineering degrees increased 1,493% in 20 years. However, in terms of narrowing the male-female socio-economic divide, Table 3 illustrates rel-

2. Franda (2002b) explains that while there were as many as 437 ISP operating licenses offered, the unfavorable regulatory conditions made it impossible for them to go into business.

Table 3. Socio-Economic Indicators based on Gender

	1980			2000			% Chg in M/F Gap
	Male	Female	M/F Gap	Male	Female	M/F Gap	
Mortality rate per 1,000 males and females	261	279	18	222	209	13	-28%
Life expectancy in years	54.4	53.9	0.5	62.2	63.4	1.2	140%
Illiteracy rate (15 and above)	45%	73%	28%	32%	55%	23%	-18%
% of engineering degrees <sup>1,2</sup>	98.5%	1.5%	97%	76.1%	23.9%	52.2%	-46.2%
% of workforce participation	66%	34%	32%	68%	32%	36%	12.5%
# of women ages 65 and above (per 100 men)	100	97	3	100	111	11	14%

Notes: Derived from Parikh and Sukhatme (1992, 2002); World Bank Development Data Group (2002).

1. Engineering degrees are defined as the following majors: Architecture, Computer Science Engineering, Electrical Engineering, Electronics Engineering, Mechanical Engineering, and Civil Engineering.

2. Figures in the 2000 column are based on 1998 data.

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atively disappointing results. While the average percentage change of technological development during a 5-year timeframe was 1,110%, not including ISPs and cybercafé indicators, change in terms of addressing the male-female gap based on the socioeconomic indicators already cited averaged only 12% over a 20-year period. In some cases, such as the percentage of men and women in the workforce, the gap actually widened. Although it would have been interesting to compare and contrast changes in 1980 and again in 2000 between the male-female wage gap or the percentage of IT workforce participation based on gender, at the time of this research such data were not available. However, the 2003 Annual Report by the Ministry of Communications and Information Technology in India reports that 79% of software professionals are men.

### Gender Roles and Female Engineers in India

In 1992, the Indian Institute of Technology (IIT) released its findings based on a detailed national study of women in engineering who graduated from Indian institutions of higher education between 1975 and 1990. The report was based on 2,753 surveys which were received and analyzed in 1990 by the Department of Science and Technology at IIT. As of 1990, the national stock of female engineers in India was estimated to be 18,875. A follow-up study conducted by IIT in 2002 assessed the current job and career status of female engineers. The 2002 findings serve as a platform to compare and contrast changes observed over the past 10 years.

The sample consisted of women throughout the country who graduated with a Bachelor's degree in engineering. Several methods were used to find participants for the study, including newspaper advertisements, information provided by employers of female engineers, and graduate records from technical education institutes. The sample size of the 1990 study, based on the names collected of female engineers who graduated between 1975 and 1990, was 16,162. Of that number, 4,678 women responded to the study and 2,753 surveys were collected. In contrast, the sample size of the 2002 study was 11,778 women, of which 2,310 responded to the study and 1,020 surveys were collected. Both surveys included questions on personal and family background, job status and nature of work, and ca-

reer expectations, values, and professional issues. The 2002 study expanded on the 1990 research by surveying organizations on their views about employing female engineers, along with data on women's employment in their organization.

The findings in Table 3 concur with research conducted by Parikh and Sukhatme (as cited in Jayaraman 1994) who found that, despite the impressive increase in women who earn engineering degrees, their unemployment rate was 5 times higher than men. Ironically, the state of Kerala, which is considered one of the most progressive in terms of equality for women, had the highest level of unemployment among female engineers (35.9%) in 1990 (Parikh and Sukhatme 1992). Eight years later this rate increased to 41.5% and was second only to Andhra Pradesh (45.7%) (Parikh and Sukhatme 2002).

Parikh and Sukhatme's 2002 follow-up of study of women in the engineering field identified two key barriers to employment. (1) Despite admission to an engineering program, women's participation in the educational process is based on a continuum that places them second to men. They are more often denied participation in projects of their choice by male professors and are often required to take summer courses in "design training," because companies are reluctant to put them on the shop floor. Upon graduation, they are at a disadvantage because both academia and potential employers are reluctant to place them in positions that would provide them the opportunity to effectively compete in the marketplace upon graduation. (2) 16.8% of women reported outright that they were not invited for campus interviews. Furthermore, a large number of women reported that they did not participate in any form of campus interviews. Based on the evaluation of qualitative interview data presented in both the 1994 and 2002 study, it seems clear that in many colleges women were not permitted to have campus interviews with employers or they were excluded outright from the process. For example, as described by two respondents in the 1992 study, most companies that came for campus interviews would state that "Ladies may please leave the room" and "In some colleges the forms for campus interviews are not being provided to the girls . . . reasoning that they don't take girls; hence why waste a form" (Parikh and Sukhatme 1992: 188–89).

An additional barrier to consider is the notion that a woman's primary focus is in the area of child-bearing and family, while a man's primary concern is in the production of goods and services for the economic stability of the family. Such gendered perceptions contribute to concerns such as how loyal a female employee will be to a company or if her actual level of contribution will be equal to that of a male employee. This is linked to the assumption that women are more likely to leave their jobs to get married or do not contribute as much as a man once they have families because their primary focus is on raising children. This is exemplified by women who report being asked questions, such as "So how will you manage family and work once you get married?" (as cited in Jayaraman 1994). In addition, 59% of male executives and 42% of female executives expressed concern that a woman would leave a job to get married (Parikh and Sukhatme 2002). Despite education, gendered perceptions contribute to the assumption that women who attempt to have a career outside the home will, in the end, place the demands of their career after those of a family. Such issues are not considered when hiring men because contributing equally within the household is not necessarily considered a barrier to their participation in the employing organization. As stated by one employer in Parikh and Sukhatme's 2002 study:

I do not have specific bias for women engineers. I do agree that they are more competent, intelligent, possess more integrity, and are more efficient than men engineers, but they are helpless. In spite of their full willingness to perform their duty perfectly they are not able to meet with the requirement of the organization in which they are employed due to family responsibilities like their responsibilities towards their children, in-laws, parents, and other social obligations towards family, illness, etc. In Indian culture men expect everything from women. (p. 248)

Based on such a continuum, perhaps some employing organizations, consciously or unconsciously, question whether it is worth the time and money to invest in the development of a woman's skill set when there are plenty of men who are available to

do the work and who are more likely to remain loyal as the pressure to navigate both the *public and private spheres* does not impact their careers as much. At the same time, such gendered perceptions are not necessarily held by men only. For example, Parikh and Sukhatme's 1992 and 2002 studies found that the percentage of women who agreed, fully or somewhat, that they would be uncomfortable if their husbands took care of the home actually increased from 49% to 55%.

### **All Engineers Are Not Created Equal**

Between 1994 and 1998, approximately 27,462 women earned engineering degrees from 67 technical teaching institutions (Parikh and Sukhatme 2002).<sup>3</sup> While Table 3 illustrates a remarkable increase in the number of female engineers, it is important to consider whether their admission to the various engineering programs continues to reflect a social structure that places women on a career track that is secondary, and therefore, offers limited access to positions that entail the development of management and leadership skills. While the field of architecture is the most egalitarian in terms of equal access to education (see Figure 2), its status and prestige are relatively less compared with other engineering fields (Parikh and Sukhatme 2002). Though women who enter the architecture field report lower levels of unemployment (1.5%) compared with electrical engineering (29.2%) or mechanical engineering (16.9%), their pay scale is also very low compared to the other fields.

Within the field there is a divide between what is considered the hardware and software aspects of engineering. Based on 20 years of experience in the IT sector, Premal Shah<sup>4</sup> notes that software and finance positions employ more women, while hardware and materials positions primarily employ men. She explains that hardware is viewed as hands-on and considered to be man's work. It is held in higher regard compared with software engineering and is considered more prestigious. When applying this division to the *public versus private sphere* model, it could be asserted that hardware is considered the primary driving force, therefore masculine, while software, though also important, is considered secondary and therefore feminine. If this is the case, do

3. When accounting for all 232 technical teaching institutions in India, Parikh and Sukhatme (2002) estimate that 99,500 women earned engineering degrees.

4. Name has been changed to protect the identity of interviewee.

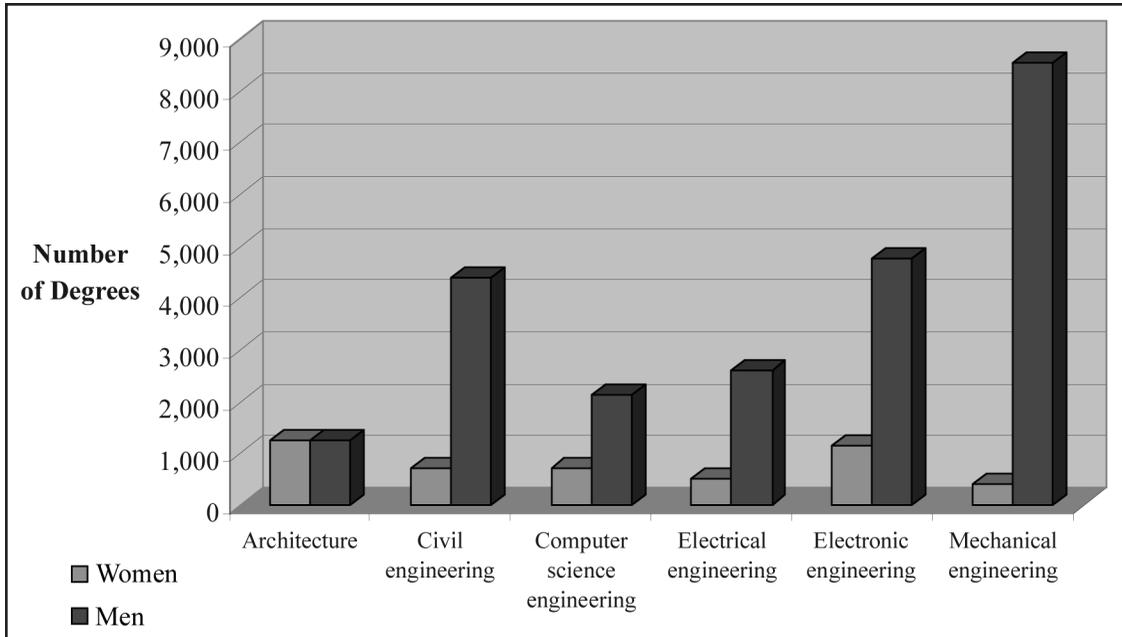


Figure 2. Engineering degrees awarded from 1994 to 1998. Note: Derived from Parikh and Sukhatme (2002). Note that 67 out of 232 technical teaching institutions provided the data illustrated in Figure 2.

women’s education and participation in the engineering field follow a similar trajectory? Qualitative indicators, such as Premal Shah’s observations in conjunction with Parikh and Sukhatme’s employer interviews, along with quantitative analysis, suggest that this is the case.

Figure 2 clearly illustrates a gender-based continuum in the pursuit of engineering degrees. For instance, a mechanical or electrical engineering degree, which is the gateway to prestigious positions in the field of hardware development, continues to be male-dominated, 91% and 66%, respectively. In contrast, women’s participation is primarily in the less prestigious field of architecture, which pays much lower salaries. Based on data compiled for Figure 2, the number of women and men earning engineering degrees, 4,843 and 23,718, respectively, leaves a 66.1% gap between the educational attainment of women and men.

**Got the Job, Now What?**

For women who manage to step beyond the educational and employment barriers, what are their roles in the employing organizations? As of 1998, women comprised 4.6% of the mechanical engineers in India (Parikh and Sukhatme 2002). Did this elite group

of women become active agents in the world of hardware development or do many of them continue to be placed in positions that are secondary and limited in terms of advancement? Unfortunately, the 2002 study found that employers continue to turn away female mechanical engineers. Reasons cited by respondents for being turned away ranged from employers not wanting women in the factory to not wanting them in positions that were for men only (e.g., night duty). Due to lack of opportunities for women in the field of mechanical engineering, many shifted to software development or other positions unrelated to their education. As stated by one woman in Parikh and Sukhatme’s 2002 study:

In our country job opportunity for women are very less that’s what I feel. Being the only lady mechanical engineer from our college, and that too being second topper in my class and having secured 74% in university exam, I had to sit at home for 10 months after my graduation applying for jobs in different companies. Then I got a job in . . . , a job that was not at all connected with my education. So I had to leave that job and join as a lecturer in the same college where I did my B.E. (p. 77)

Table 4. Perceptions of Female Engineers

Statement	% That Agree Somewhat or Fully with Statement		
	1992 Study	2002 Study	% Chg
Professional women end up in secondary roles doing routine jobs.	58.2%	60.6%	4.1%
Compared to a man, it is harder to be fully accepted in a professional work group.	71.5%	65.0%	-9.1%
Women have to do better than men to get equal professional recognition.	66.4%	70.5%	6.2%
A career should be secondary to a married woman's responsibility as a wife and mother.	54.8%	55.4%	1.1%
It's acceptable for women to assume leadership roles in industry as often as men.	77.2%	86.0%	11.4%
Small children suffer when mothers work full-time.	85.6%	84.6%	-1.2%
Men can raise small children just as women can.	59.8%	58.9%	0.2%

Note: Derived from Parikh and Sukhatme (1992, 2002).

Source: 1992 findings based on responses from 2,753 questionnaires. 2002 findings based on responses from 1,020 questionnaires.

In an interview with Premal Shah, she contends that there is much improvement in terms of gender equality as more women become engineers. However, she also concurs that in her experience women continue to be primarily in software positions and much fewer are in hardware. Therefore, adding women to this work force is not enough because their participation adapts to the gender roles already in place. Technology in and of itself does not change such roles if women's participation is based on the *public versus private sphere* perceptions (Table 1), which places them in *secondary* positions. Based on a broad perspective, Table 4 outlines the responses of female engineers from all disciplines on a variety of issues related to the professional and personal aspects of one's livelihood.

While the gap between the number of men and women earning engineering degrees decreased 46.2% in the past 20 years, the majority of women, 60.6%, still find that they are placed in jobs that are *secondary* (see Table 1) and routine in nature. For example, as explained by a respondent in the field of civil engineering (Parikh and Sukhatme 2002):

Being a woman we are allotted only office work. There is no choice in office work. Any sort of tedious work is allotted to us. But the very basic

thing in Civil Engineering is to have site experience. We're never allowed to go on sites though they are easily accessible, for the only reason that we are girls. This does influence our office work because until you know practical things you cannot produce better in theory and they blame us that we don't know every small thing. (p. 50)

This suggests that women's opportunities in the paid labor force operate on a continuum that places them in roles deemed supportive and, therefore, secondary in terms of access to positions and training opportunities that would provide them with the skill set necessary to be effective leaders and role models in an organization. In a telephone interview with Jyothi Desai,<sup>5</sup> she concurs that she also witnesses such gendered divisions in a "back-end transaction processing" department. Women are not working as supervisors and managers in the department because of discriminatory practices by current managers, and therefore, work primarily as data processors.

In addition, 70.5% of women agreed that they have to do better than men to get equal professional recognition (see Table 4). This could be linked to the notion of women's work being inherently *invisible* (see Table 1). Therefore, within the paid labor

5. Name has been changed to protect the identity of interviewee. Ms. Desai, born and raised in India, has over 15 years of experience in the IT sector. She has managed international development teams in England, India, and the United States for a Fortune 500 company and currently resides in India.

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force, a woman would have to achieve more in order to gain equal recognition. For example, Dr. Desai recalls how in 1996 during a position held in Bangalore, the men in her group were at first very egotistical toward her as they were not used to dealing with a woman who held a leadership position over them. Women there were hired primarily for maintenance positions. At the time, her male colleagues were unaware that Dr. Desai graduated from an elite technical university in India and went on to earn a Ph.D. in Electrical Engineering at an ivy league institution in the United States. Once her colleagues learned this, they treated her with respect. Her degrees were considered a high achievement, as neither they nor their bosses could gain admission to the academic institutions she attended. In addition, Dr. Desai holds patents for her work and has been published in academic journals. In terms of women having to do better than men to receive equal recognition, she offers the following perspective:

Even if a woman is three or four times better, your academic and management achievements are far more important. Also, in India, management achievement is equated with intellect. India is very academic oriented. (personal communication, June 14, 2003)

While Dr. Desai has been able to successfully navigate the paid labor force based on her tenacity, outstanding academic credentials, and management savvy, one must consider how many women in India have the familial support and financial opportunity to study at elite universities in India or abroad. For those women who don't have these advantages, how do they gain respect and access to opportunities in a system that, on one hand, expects more from women academically, yet at the same time educates them on a continuum that leaves them on the periphery of an organization?

From the perspective of female engineers, contradictions abound in terms of the integration of gender roles, in particular navigating between one's *reproductive role in the household* and *productive role in the paid labor force* (see Table 1). While 86% of women agree that it is acceptable for women to assume leadership roles in industry as often as men, 84.6% of women agree that small children suffer when mothers work full time. How women are supposed to compete in the workforce for leadership

positions and raise their children "effectively," when the underlying message is that both pursuits require full-time attention, is unclear. At the same time, 58.9% of women believe that men can raise children just as well as a woman, and 55.4% believe that a career should be secondary to a married woman's responsibility as a wife and mother. While men are arguably the recipients of far more privilege under the current gendered paradigm, this analysis illustrates that some women participate, whether by choice or not, within a set of gendered rules that are at times contradictory and counterintuitive to their success in an organization.

In conclusion, gender roles, as defined by the feminist *public versus private sphere* model, have a negative influence on women's job roles in the field of engineering. As the number of women earning engineering degrees increased almost 1,500% over a 20-year period, one would expect that barriers facing women in the paid labor force, such as the persistence of traditional gender roles, would be reduced. However, this research clearly illustrates that this is not occurring. In general, both academia and industry fail to consider women as equal, contributing participants in the realm of technological development because the existing social structure enforces strictly defined gender roles and views women's participation in the paid labor force as *invisible* and *secondary* to their *reproductive* role in the household. Furthermore, this study demonstrates that five of the six traits defined by the *public versus private spheres* in Table 1 apply to the findings of this research. The trait of *unpaid labor versus paid labor* was not analyzed because gender-based salary data were unavailable. Yet, as women continue to be placed in positions that offer little opportunity for advancement or are forced to pursue jobs outside of their academic training, it is likely that their salaries will be less than men's. Further research needs to be done on whether the perception of women being linked with unpaid labor (e.g., domestic activities) affects their wages in the IT sector.

## Conclusion

For those living in the urban domain and working in the IT sector, India has undergone exponential growth in regard to technological development (Table 2). As suggested here, academic and popular

sources, as well as policy makers, contend that technology has the potential for significant social change, ranging from a redefinition of traditional gender roles to “equalizing” job roles in the paid labor force (Castells 2000; Drucker 2001; Kelkar and Nathan 2002). The Indian government not only equates the growth of the IT sector with development and modernization, but its 2003 Annual Report by the Ministry of Communications and Information Technology suggests that gender issues have been resolved within the IT sector. However, as illustrated here by the educational and occupational barriers facing female engineers in India, combined with a quantitative analysis of technological development indicators in relation to gender-based socioeconomic indicators, it is clear that the IT sector in India is far from resolving gender issues. This is surprising if the IT sector is considered to be a revolutionary force capable of dramatic socio-economic change. One would expect higher levels of gender integration in the engineering workforce as it attracts some of India’s most highly educated citizens. Since education is equated with development and modernization, it is assumed that India’s best-educated citizens would be the first to contribute to the breakdown of traditional gender roles. However, education, like technology, does not inherently cause a redefinition of gender roles nor deterministically enhance women’s socio-political power, but can be neutral, or even reinforce the status quo.

Despite increased access to education, why is women’s overall participation in the paid labor force decreasing in relation to men’s participation? And, why in the educated job markets of the IT sector, are women’s roles subordinated to those of men? This study suggests that the participation of women in engineering and IT continues to be influenced by traditional gender roles, as defined by the *public versus private sphere* model. In spite of attaining some of the highest levels of education in Indian society, such women are still associated with traits that include being *secondary*, *invisible*, *reproductive* (i.e., children), and *unpaid*; in general, they are assumed to take the role of a *follower* (Anderson 1988; Peterson and Runyan 1999). In contrast, men continue to be associated with traits that include being *primary*, *visible*, *productive* (i.e., goods and services), and they are assumed to be *leaders*. As women attempt to navigate the paid labor force, such distinctions are a key disadvantage to their ability to

compete effectively and on an equal footing with men in the marketplace. The persistence of traditional gender roles not only has a negative impact on women’s participation in the engineering field, but also has ramifications for India’s development.

While Sen (1999) explains that “empirical work in recent years has brought out very clearly how the relative respect and regard for women’s well-being is strongly influenced by such variables as women’s ability to earn an independent income, to find employment outside the home, to have ownership rights, and to have literacy and be educated participants in decisions within and outside the family” (p. 191), this study also clearly illustrates that it is misleading to assume that technology alone, like education, will resolve basic gender equity issues relating to capabilities and opportunities. Just as education does not always serve to undermine the preference for male children by the middle and upper classes, participation in the IT sector, via the field of engineering, does not necessarily provide women with the opportunity to be equal, contributing participants in the realm of technological development. As demonstrated by the secondary roles most women are placed in, they remain on the periphery of the workplace. Further research needs to be done on the long-term economic impact to India’s IT sector because of the persistence of traditional gendered perceptions. What is the cost to a society as a whole when some of its best-educated citizens lack the opportunity to have their skills used to their full potential? In addition, while many male engineers—single or married—are free to pursue opportunities in the engineering field abroad, are women also able to pursue such options, independent of a husband, or is their opportunity to migrate linked primarily by marriage to a man already abroad? Such research is necessary to promote the understanding of the development of women from the perspective of having the freedom to pursue one’s socio-economic objectives, independent of traditional gender roles.

Finally, it could be argued that women’s burgeoning employment in offshore call centers in India could, in the long term, have the potential to disrupt the perpetuation of traditional gender roles. After all, while the job opportunities available to women in this industry certainly reflect the feminine traits defined by the *public versus private spheres*, it can also be seen that such positions offer women

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an opportunity to work outside the home, and thus, provide them with an increased level of socio-economic freedom which could contribute to future changes in gender role perceptions. On the other hand, with women's labor deemed as *secondary* and *invisible* compared to men's labor, it could be that, despite education, women risk being left further behind because they will continue to be excluded from the top echelons of the IT sector. As "knowledge work" becomes more highly skilled, it will be even harder for women to participate because their skill set will be based on training for job roles that are limited in opportunity and advancement. As the IT sector grows, women risk being placed further on the periphery of organizations or left out completely if the education they receive in universities and their opportunities in the paid labor force continue to be secondary to men. While there are certainly exceptions to this, as demonstrated by the success of both Ms. Shah and Dr. Desai, research conducted by Parikh and Sukhatme (1994, 2002) clearly indicates that the majority of female engineers continue to experience gender-based barriers in the paid labor force. Therefore, unless and until the impact of traditional gender roles on the socio-economic disparities found between men and women can be addressed, this study concludes that the status of women in India, specifically those working in the field of engineering, will remain static compared to the status of men. Thus, so far bridging the digital divide does not necessarily mean bridging the gender divide. ■

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