THE MAKING OF LABORER SUBJECTIVITY AND KNOWLEDGE IN THE INFORMATION INDUSTRY: GENDER DIMENSIONS OF FREE AND OPEN SOURCE DEVELOPMENT

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ABSTRACT

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This study examines female software developers as knowledge laborers with a special emphasis on free and open source software (FOSS) development. In examining female developers as knowledge laborers, this study focuses on both labor and knowledge. Women's low participation in FOSS development is not an issue of recent years, but a consequence of women's overall status in the computing field over the last three decades. In order to explicate women's low participation in FOSS development, a broader historical and economic analysis is needed. Thus, this study explores the historical context of computer science education and industry in the 1980s since this is when the groundwork for FOSS development was laid. Furthermore, the power of cultural discourses that maintain and reinforce the gendered construction of FOSS development is discussed to unpack how the gendered construction is interrelated with the labor relations in the knowledge industry. In addition to the labor relations in FOSS development, this study attends to the knowledge produced by FOSS development. Knowledge gains importance as a sum of values of the knowledge producers. Source codes written by software developers turn into products that engage users with certain utility. Female FOSS developers produce knowledge that reflects their values constructed from their embodied experiences. Attention to the voices of female FOSS developers is significant as their different experiences lead to the ways in which knowledge is produced within FOSS communities.

For all female workers, who live with and live through everyday struggles.

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CHAPTER 1.

INTRODUCTION

In relation to new media technology, women have been viewed as users or consumers while men have been considered creators or inventors (Consalvo, 2006). To some extent, this view reflects the reality. The percentage of female students and professionals in the computing field has decreased for the last decade when that of women majoring or working in other science, technology, engineering, and mathematics (STEM) fields has increased or experienced relative consistency (DuBow, 2011). In the meantime, the view on women as technology users has been fortified by representations in popular culture. Beyond being portrayed as mere users, women are often represented as unskilled at using new technological devices (Dempsey, 2009). Conversely, media representations tend to describe males as computer programmers or developers (Barker & Aspray, 2006). Even if males are portrayed as users, they, particularly white males, appear competent, independent, and empowered.

Scholars using feminist lenses have challenged the general assumption about women as passive users by reevaluating female users' interactions with new media technologies. Research began to emphasize women's empowerment, agency, resistance, and political movement through active utilization of new media technologies (e.g., Harcourt, 1999; Kramer & Kramarae, 2000; Pudrovska & Ferree, 2004; Traverse, 2003; Youngs, 2001). Studies that restore women as empowered and active agents have great significance as women have been consistently represented as passive beneficiaries or victims of new media technologies. However, this line of studies has led to relative inattention to women as creators. Pointing out that feminist research in new information and communication technologies has been missing the component of production, Lee (2006) said that "it is imperative to recognise that some actors actively invent,

design, and distribute certain technologies for specific purposes" (p. 191). Therefore, she called for feminist scholars' investigation of women's various roles—not only as consumers but also as scientists, engineers, managers, investors, owners, and citizens, to name a few—in their areas of study.

As a part of the effort to bridge this gap, this dissertation examines female software developers as knowledge laborers with a special emphasis on free and open source software (FOSS) development. The reasons that I focus on FOSS development are twofold. First, the collaboration among FOSS contributors shows a new way of mobilizing and utilizing a labor force in the information industry. The predominant type of labor performed in the industry is "*immaterial labor*—that is, labor that produces an immaterial good, such as a service, a cultural product, knowledge, or communication" (Hardt & Negri, 2000, p. 290). FOSS development perfectly fits the characteristic of immaterial labor, which is production of values through cooperation among dispersed and decentralized laborers. This characteristic can either make FOSS contributors vulnerable to capitalist exploitation or help them move toward a potential for resistance. Therefore, an examination of FOSS communities can enhance our understanding of the dynamics of the labor relations in the information society. Second, the information good produced by FOSS contributors will serve as infrastructure for society. The responsibility of the public sector to provide public services has been taken over by the private sector. With the increasing importance of technologies in offering and maintaining public services, FOSS contributors have been involved in resolving social issues. As the role of FOSS development in providing public services is expected to become substantial due to its low cost and openness, looking at how knowledge is produced in FOSS communities holds great significance.

There has been little scholarly attention to gender issues in FOSS development despite

the very low percentage of female contributors. As of 2002, the percentage of women involved in FOSS development was extremely low at around 1.1% (Ghosh, Glott, Krieger, & Robles, 2002), and the ratio of women has not grown noticeably larger ("FLOSS," n.d.). This is very low participation even when compared to the percentage of female professionals in the computing field in general, which is approximately 20% (DuBow, 2011). To address this issue, various groups have formed and made effort to demonstrate women's presence, support women, and balance diversity within FOSS communities; LinuxChix, Debian Women, Ubuntu Women, KED Women, PyLadis, and Drupal Chic are examples. While some of the groups had moderate success in their outreach programs, gender imbalance is still a serious concern. Scholars who have examined FOSS communities often have not addressed the gender issues although the male dominance of FOSS development is obvious (e.g., Benkler, 2006; Coleman, 2005; Lessig, 2001). This lack of scholarly attention is problematic since the construction and reinforcement of FOSS culture are greatly influenced by gender relations.

In examining female developers as knowledge laborers, I emphasize both "labor" and "knowledge." Women's low participation in computing as labor has generated scholarly interest. As educational environments are considered to be detrimental to gendered choices of professions, researchers have addressed educational factors that diminish women's interest in the computing field (e.g., Cohoon, 2002; Henwood, 2000; Margolis & Fisher, 2002). In particular, Henwood (2000), opposing an equality or liberal approach assuming neutrality of technology, argued that "constructivist accounts" (p. 211) questioning why and how women are excluded and why technology came to be deemed a masculine realm are more appropriate to provide insights into women's disinterest in computing. She, in turn, suggested that innovative educational tools to deconstruct the close association between men and technology need to be employed.

This was a progressive departure from an equality or liberal approach that aims to merely demonstrate that women's capabilities are comparable to those of men and design recruitment tools to engage female students with the computing field at an equivalent status with men. However, the liberal feminist legacy remained strong, thereby widely producing the discourses of equal employment opportunity in computing professions. In the recently published National Center for Women & Information Technology (NCWIT) Scoreboard, computing is advised as "a secure field for women" (DuBow, 2011, p. 7) because of a low unemployment rate, high salary, and high profitability of the overall industry. This equality approach has its own strengths. Because women's skills at computing have been proven to be at the same level as men's (Beyer, Rynes, Perrault, Hay, & Haller, 2003; Beyer, Rynes, & Haller, 2004), the discourse of equal opportunity can be widely accepted. Furthermore, to pursue equal employment opportunity necessarily requires the advocates to challenge the male-centric culture of the computing field to some extent.

What is missing in the equality approach is (a) the understanding of historical conditions that have constructed computing as a male domain and (b) the effects of economic and political structure that have been reshaped by the emergence of the information society. These two points are not separate, but interwoven. Not only did the information age create a transition in the mode of development (Castells, 2010), but also it brought about rearrangement in labor relations along gender, racial, and national lines (Mitter & Ng, 2005). How the historical and economic backgrounds reshaped computing from a non-gender-specific field to a male domain has been recently documented (e.g., Misa, 2010). However, how FOSS development became predominantly fostered by male developers has rarely been examined. In addition, there was a shortage of analyses on gendered labor relations in the computing field in the 1980s, while the

historical and economic contexts from the 1940s to 1970s were studied. It is notable that in the 1980s the Free Software Foundation (FSF) was started and at the same time the percentage of women in computing began to dramatically decline. Women's low participation in FOSS development is not an issue of recent years, but a consequence of women's overall status in the computing field over the last few decades. Thus, to explain women's low participation in FOSS development, a broader historical and economic analysis is needed.

Along with labor, the other focus of this study is the knowledge created by FOSS development. Although the term FOSS is widely used, FOSS exists in tension. Richard Stallman, founder of FSF, once stated, "We are not against the Open Source movement, but we don't want to be lumped in with them" (2002, p. 55). This tension between the Free Software movement and the Open Source Initiative stems (OSI) from their different views on knowledge, that is, source codes. When looking at how they work in general, there are no distinct differences. Both free software and open source software make their source codes available for users to study, modify, and distribute. However, the Free Software movement prioritizes the value of freedom while OSI underscores efficiency in software development.

In explaining the meaning of free software, FSF says, "To use free software is to make a political and ethical choice asserting the right to learn, and share what we learn with others" (www.fsf.org). FSF clearly expressed its concern about the practices of proprietary software companies that restrict the freedom of users by preventing them from exercising control over their personal information. In contrast, political and ethical aspects of software development are not emphasized as the pragmatic aspect by OSI. OSI defines open source as "a development method for software that harnesses the power of distributed peer review and transparency of process. The promise of open source is better quality, higher reliability, more flexibility, lower

cost, and an end to predatory vendor lock-in" (opensource.org).[1] These conflicting positions within the generalized term FOSS are why it attracts various scholars and practitioners, from critics of intellectual property law to proponents of extended patent rights.

In the current era when intellectual property generates economic, ethical, and political concerns, it is reasonable for debates over knowledge as property to receive the most attention. However, beyond the debates, knowledge gains importance as a sum of values of the knowledge producers. Source codes written by software developers turn into products that engage users with certain utility. In other words, the purpose and design that software developers employ may or may not allow users' access to a product and its functions. Knowledge as value-laden is rarely discussed in the discourses surrounding FOSS development. If there is a value commonly appreciated in FOSS development in producing knowledge, it is innovation. In arguing for FOSS's superiority over or equivalence to proprietary software, innovation in software development, such as fewer bugs, strengthened security, and user customization, is often evidenced. However, values other than innovation are not main concerns in FOSS development. Furthermore, the definition of innovation remains unclear; thus, questions of who defines innovation and who benefits from innovation arise.

One of the rationales behind the efforts to include more women in FOSS development is to enhance diversity in terms of ideas and user base (e.g., Wallach, 2011). However, caution should be exercised in assuming that software developers with diverse backgrounds will result in diversity in development. Since "[s]oftware functionality is embedded in institutional, social, and

[1] Individuals' use of these two terms at times does not strictly meet these definitions. These two terms are sometimes used interchangeably, as seen in the widespread use of the word FOSS. Also, there are often cases in which some contributors use the term open source although they intend to express the ideas of free software. Thus, it is necessary to read between the lines when these terms are used.

organizational structure" (Shaw, 2011, p. 31), diversity might be only a minor consideration if the structure prioritizes other values. In the case of FOSS development, while some projects are launched and performed by individual developers, increasing numbers of start-ups and established companies have decision-making processes influencing the development in a certain way. Yet, as FOSS development has spread to a wider developer pool, it shows potential in which knowledge with diverse values can be produced.

Social values other than innovation are often considered to draw more women than men. In an analysis of gender differences among computer science majors, Margolis and Fisher (2004) found that female students tend to link computing to social concerns and care for others while male students are more likely interested in mastering the machine. To some extent, this argument supports the findings that FOSS developers, mostly males, often participate in its development for the sake of the enjoyment of programming and tinkering (Lakhani & Wolf, 2005), rather than political and social concerns. While these types of descriptions of gendered differences in software design might help in understanding women's difficulties in adapting to the male-dominated FOSS development, they bear the danger of generating an essentialist view. As ethical and moral developments have been explicated through psychological or psychoanalytic tools, there is a risk of perpetuating the argument that different sexes result in different ethical and moral stances in software development if the existing theories are used without reasonable criticism. Thus, this study examines not only what the ethics and philosophies of female FOSS contributors are, but also how they have been shaped.

In sum, this study asks three research questions:

1. How have FOSS communities been constructed as a male domain, and what are the historical circumstances that enabled its construction?

2. How are the experiences of women in FOSS development conditioned by the information economy that shapes and reshapes labor relations along the gender line?
3. How does gender function in forming the ethics and politics of producing and distributing FOSS products as value-laden knowledge?

Gender as an Analytical Category

Several issues are involved in bringing female FOSS developers into the focus of study. The history of FOSS development has been written and is being written as if FOSS is a gender-neutral subject although the communities mainly consist of men. As one of the core principles in FOSS development is its meritocratic ideology that assumes an equal opportunity based on individual merit, gender is not considered to be a factor that constitutes the culture of FOSS development. What is problematic about this gender blindness is its effects of concealing gender relations in creating the discourses of FOSS development. By noting gender relations, I do not intend to simply criticize the ignorance regarding the scarcity of women in FOSS communities. Rather, by gender relations, I mean the values attached to gender which produce the FOSS culture as it is now.

Even if gender is used as a category in analyzing the FOSS movement, there are also risks of underestimating gender relations. Gender has become a term that indicates an individual attribute rather than a socially constructed category, especially in social scientific scholarship. Furthermore, studies that employ gender perspectives often emphasize women's experiences in isolation from those of men (Scott, 1999). These tendencies create two issues: First, gender can be reduced to sexual differences if its social meanings and functions are not properly addressed; second, women's experiences can be interpreted as innately distinctive from men's experiences

when the relational aspects of gendered experiences—women's experiences are constitutive of men's and vice versa—are ignored. Although gender appears to be an important analytical category in a wide range of studies, there are recurring cases in which gender as a social construct and a relational category is not fully explained. It is this context that I revisit what it means to perform a gender analysis and what it means to employ gender as an analytical category.

Scott (1999) provided questions that researchers need to pose to unpack gender relations. Although Scott mainly took historical events into consideration, her suggestions are pertinent to issues in the present time. As she contended, the past is connected to current practices. Since the meaning of gender is constantly re/constructed along history, writing about gender, for Scott, always accompanies the task of rewriting history. Thus, there is no clear-cut boundary between historical and non-historical studies in examining gender. Scott suggested that researchers attend to three points: (a) historical processes rather than historical descriptions, (b) individual subjects as well as institutional structures, and (c) the role of power as dispersed rather than unified and centralized. While she supposed that historical processes of an incident—in other words, how things happen—are conditioned by social structures and power played out within them, she left room for human agency and resistance.

Regarding the first point, this study looks at how the culture of FOSS communities has been created in a gendered way, rather than merely describing the current conditions of women in FOSS development. Technology is not merely the sum of knowledge or a product made for practical purposes, but is intertwined with cultural and social assumptions of what is believed to be practical, who are considered to be the beneficiaries or producers, and what is thought of as ethical concerns at stake in producing the knowledge or concrete products (Law, 2008;

MacKenzie & Wajcman, 1985; Winner, 1986). While gender is not the only factor that constitutes the assumptions, an examination of gender relations serves to unveil a part of how those assumptions are shaped. As historical research on the interrelationship between gender and technology has shown, both private and public lives of women define or are defined by technology (Cockburn, 1985; Cowan, 1985). Furthermore, meanings and performances of gender change in relation to technology. The fact that computer programming once was a feminized task reveals that gender and technology are mutually constitutive.

In terms of Scott's second point, I position the experiences of women in FOSS development within the institutional structures of gender and global information economy while I listen to and analyze their experiences. Although individual experiences of FOSS women are seldom identical, the social institutions generate common ground among women. However, this does not mean that the institutional structures determine what individuals experience. Couldry (2000) explained two different ways of thinking about the relationship between wider social forces and experiences as individuals—"determining" conditions and "constitutive" or "limiting" conditions (p. 51). While the former sees individual experiences as conditioned by wider structures, the latter leaves individuals the potential to act with agency although it is limited. In this study, I take the latter view. The constant struggles of women in the computing field to negotiate their positions indicate the possibility of enacting agency against the wider structure. By examining both FOSS women's individual voices and institutional settings influencing their voices, I attempt to reveal how their agency has been enabled or has failed to be enacted.

The third point—the notion of power as dispersed as in a Foucauldian sense—is linked to the second one. The view of the wider social structure as constitutive or limiting allows us to see power as dispersed rather than centralized and exercised at the micro level as well as the macro

level. Furthermore, the notion of power as dispersed functions as the precondition of resistance. However, the dispersion of power should not be read as guaranteeing resistance or undermining the power played out by the wider social structures. Rather, resistance is latent, interacting with historical contingency or instability and having the potential to be exercised. A historical look at technology shows that the current affinity between technology and masculinity is not inevitable but contingent upon the meanings of gender that are changing by time and place. If the affinity does not come from inevitability and power operates in multiple directions, it is possible to envision resistance against the gendered construction of the meaning of technology and the culture of the current FOSS development.

Literature Review

In the first part of this section, the existing studies on women's deficit in the field of computer science are reviewed. These studies mainly fall into two categories—revisiting the lives of female computer scientists in history and examining the pedagogies of computer science. These studies provide insights into how the field of computer science has been constructed as a male domain and how the masculine culture of the field is maintained by the educational system. In the second part, I review the previous studies of FOSS as a development tool, culture, and labor. In the last part, I discuss the implications of these studies in exploring the gender relations in FOSS communities.

Gendering the Field of Computer Science

Wajcman (1991) noted that the gender politics of science has been addressed by scholars with emphases on (a) biographies of female scientists, (b) women's equal opportunity for education and employment, (c) uses and abuses of scientific knowledge on women, and (d)

scientific knowledge as patriarchal knowledge. Regarding the field of computer science, the first two topics were mainly discussed. As the dearth of women in the computing field is an imminent issue, documenting women's contribution to and encouraging women's participation in the field have enjoyed the most scholarly interest. These are the two topics that have dominated the research on women and computing for the last three decades.

Restoring Women as Computer Scientists. The research on recovering female scientists traces back to the Victorian era when Ada Lovelace wrote the algorithm which is generally considered to be the first computer programming while working with Charles Babbage, the originator of the concept of the programmable computer (Crawford, 2000). *IEEE Annals of the History of Computing* published several articles that revisit Ada Lovelace's conceptualization of computer programming (Fuegi & Francis, 2003; Huskey & Huskey, 1980; Toole, 1996), and several biographies that celebrate her as computer scientist and mathematician have been written (Lethbridge, 2004; Toole, 1998). While her algorithms were not implemented in her lifetime due to incompletion of machines, her contribution was recognized, as evidenced in the computer language Ada, which was designed for the US Department of Defense. What the first computer programming was is a question with contestable answers, as is the question of what the first computer was, because the development of both the computer and computer programming runs along a continuum rather than being a discovery that occurred in isolation from prior processes. Thus, the answer to whether or not Ada Lovelace can be named the first computer programmer is controversial. However, historical documentation about her shows that programming was an area in which women were involved in the early history of computers when machine design was a males' task.

There was a century gap until another female computer scientist, Admiral Grace Murray

Hopper, made a noticeable contribution to the computing field and became known to the public. Since she, being a woman, had an unusual career as computer programmer and Navy admiral, typical formats of biographies introducing pioneering women and their accomplishments are often found in Grace Hopper's biographical accounts (Billings, 1989; Marx, 2003; Williams, 2004). That is, the chronology of early education, entry into a male-dominated career, and adversities with stories about overcoming them was described in these biographies of Grace Hopper. Beyer (2009), compared to other biographers, focused on Grace Hopper's years in the computing field with detailed information on the early development of computers. Although Beyer did not specifically take a gender perspective, his analysis revealed how Grace Hopper was able to flexibly negotiate and define her role as a woman due to the undefined nature of the early computing field.

In addition to the effort to restore individual women's involvement, the contribution of a group of women called human computers, or ENIAC women, was revisited. When the male inventors of early computers were recurring in writings of the history of computer science, the work of these women was veiled (e.g., Burks & Burks, 1989; McCartney, 2001). It is only in recent years that scholars have started to rediscover women's roles in the historical trajectory of modern computer development (e.g., Fritz, 1996; Light, 1999). Fritz's article (1996), "The Women of ENIAC," was one of the first attempts to integrate women's presence into the historiography of computing. Based on interviews with ENIAC women, Fritz illustrated how the intersection of war efforts, women's higher education, and computing as an emerging industry brought unprecedented opportunity to women. Beyond introducing women's roles in the history of computing, Light (1999) took a further step to reveal how the changing notions of femininity and masculinity functioned in the presence of the ENIAC women on the nascent computing

scene and their invisibility since then. She contended that the war provided women with new job opportunities in computing, but it was accompanied with a redefinition of the job as feminine. Sexton's (1969) earlier work supports this: "The computer, in particular, looms ahead as a feminizer of males" (p. 201). Since programming was considered to be clerical service, it was often regarded as feminine whereas inventing machines still remained as men's work.

Abbate (2010), analyzing the historical experiences of women in computing between the 1940s and 1980s, stated, "[T]he image of computing as hostile or unrewarding to women is not intrinsic to the field" (p. 215). This argument is supported by research on the general status of women in computing in the mid-20th century, which demonstrated a significant number of female computer programmers. As Schlombs (2010) and Ensmenger (2010) pointed out, the current association of computing and masculinity is an outcome of the industry's reconceptualization processes of computing as masculine rather than an inevitable result of gendered aptitudes. When the stories of female pioneers in computing are located within the larger historical analyses on gender and computing, they demonstrate that the pioneers' accomplishments were possible due to the newness of the field that was open to association with either femininity or masculinity.

Gender and Computer Science Education. Along with the effort to rediscover the hidden histories of women in computing, scholars in technology and education have examined the reasons for the deficit of women in computing, especially in educational settings. In explaining the small number of women who major in computer science, two models recurrently emerge: the women's deficit model and the deficit in pedagogy model (Lagesen, 2008). The first model suggests that female students' personal psychological characteristics are the reasons for the dearth of female students in the discipline. The second model takes a socio-structural

approach that problematizes the pedagogical tools that affect female students' self-conception in regard to the field of computer science.

The first model explains the cause of the underrepresentation of female students in computer science through psychological qualities such as self-confidence, self-efficacy, and attribution of success (e.g., Hargittai & Shafer, 2006; Papastergiou, 2008). Those studies point out that female students tend to have lower self-confidence and disbelief in their computing ability compared to their male counterparts, both leading to or led by the lack of interest and the negative prospect of future success (e.g., Beyer, DeKeuster, Walter, Colar, & Holcomb, 2005; Beyer et al., 2004; Beyer et al., 2003). This model can be divided into two directions. First, one body of studies examines the gender differences in perceiving technology without considering social and cultural factors (Kramer & Lehman, 1990). In a study based on a survey method, Beyer et al. (2005) found that "female students have less computer experience, develop an interest in computers later, and have less confidence in their ability to teach computer skills to others" (p. 393). In the research process, the authors do not attend to the factors that influence female students' lesser use of computers at their earlier stage of education. In a similar vein, in explaining women's less favorable attitudes toward computer use, Dickhäuser and Stiensmeier-Pelster (2002) claimed that the level of intensity in using computers can be predicted based on the computer-specific self-concept of ability and computer-specific expectations.

The other group of studies highlights gender gaps in psychological development as socially constructed by the surrounding contexts that attach different norms and values to each gender. Kramer and Lehman (1990) argued that the existing research on gender gaps in using computers does not address the gendered ways in which computer knowledge is structured. Resonant with this view, Irani (2004) claimed that "social factors such as gendered self-

presentation and communication, rather than objective measures of ability, play a large role in developing confidence" (p. 195). In explaining girls' lower interest and confidence in participating in computer-related activity, Crowley, Callanan, Tenenbaum, and Allen (2001) and Simpkins, Davis-Kean, and Eccles (2005) emphasized the parenting styles and behaviors that encourage boys to have science-related interests and activities. Problematizing the previous research that evaluates female students' interest in computer use without considering sex-stereotyped institutional environments, McCoy and Heafner (2004) found that when female students were exposed to an institutional technological environment, the attitudes toward computer use did not differ between genders. These studies focused on the environmental factors that affect cognitive and psychological differences by gender in regard to computer use. Since educational environments facilitate cognitive and psychological development, these studies often resonate with the deficit in pedagogy models.

The deficit in pedagogy models focuses on pedagogical dimensions that preclude female students from pursuing computer-related professions as their future career. Although female students show the same level of performance as male students, the assumption that frequent and intensive use of computers is typical of computer major students serves to make female students feel a sense of non-belonging (Barker & Garvin-Doxas, 2004). Moreover, "[i]n science the masculine is associated with objectivist, rationalist, emotional detachment, coupled with abstract theoretical and reductionist approaches to problem solving" (Wilson, 2003, p. 128), in opposition to "the holistic approach to problem solving" (Singh, Allen, Scheckler, & Darlington, 2007, p. 508) that is more suited for female students.

A body of research attending to the institutional barriers in educational settings has offered practical recommendations to recruit and retain female students in the field of computer

science. Cohoon (2002) suggested that computer science departments need to take a holistic approach that motivates various levels of agencies—high schools, communities, peers, and faculty members—to help female students receive support. In particular, higher education, Cohoon argued, needs to develop pedagogical tools that offer supportive learning communities and female role models. Sackrowitz and Parelius (1996) stressed the need for preparatory courses for female students. Since courses for computer science majors expect the students to have prior knowledge in the field, they argued that pedagogical support, which helps female students become familiar with the subject, can contribute to the students' success in the major. Likewise, Gokhale and Stier (2004) insisted that technical core courses introducing basic theoretical concepts can benefit female students who lack prior knowledge in technology-related fields. These constructivist approaches to the relationship between gender and computing indicate that the male dominance in the computing field in general and FOSS development in particular is a result of gendered social practices in regard to technology.

FOSS Development

Scholars in various disciplines have examined FOSS development with different foci. While developers and advocates understood FOSS development as an alternative knowledge production to proprietary software development, scholarly interests have extended to include the legal aspects of FOSS, the culture of FOSS, the motivations of contributors, and the business uses of FOSS.

FOSS Development in Relation to Intellectual Property Law. It should be noted that FOSS is a contested term that includes various communities practicing different ethics in producing and distributing digitally mediated knowledge. As Stallman (2002) clarified, freedom is the core principle that defines free software whereas open source software shifts the main

value from freedom to innovative development of knowledge. While free software is not necessarily against the commercial use of software, if that use obstructs access to code, in other words, if the use does not grant access to knowledge, it violates the grounding philosophy of the Free Software movement. However, access to knowledge is not guaranteed in open source as it allows the possibility to veil source codes (Gomulkiewicz, 2009). To give a specific example, GNU General Public License (GNU GPL), originally written by Richard Stallman to materialize the philosophy of free source, requires all derivative works to be distributed under the same license so as to expand freedom as widely as possible. In contrast, open source licenses that are incompatible with GNU GPL allow derivative works to be incorporated into proprietary products, thus restricting freedom. However, the definition of free software is less restrictive than the products under GNU GPL, and free software often includes open source software (Stallman, 2002). Comparing free software to open source software, FSF stated that "the differences in extension of the category are small: nearly all free software is open source, and nearly all open source software is free" (www.gnu.org). Thus, despite the difference in the basic principles between free and open source software, a software product is generally defined as FOSS if it qualifies for the four definitions of freedom, as below:

- The freedom to run the program, for any purpose (freedom 0).
- The freedom to study how the program works, and change it so it does your computing as you wish (freedom 1). Access to the source code is a precondition for this.
- The freedom to redistribute copies so you can help your neighbor (freedom 2).
- The freedom to distribute copies of your modified versions to others (freedom 3). By doing this you can give the whole community a chance to benefit from your changes.

> Access to the source code is a precondition for this. (www.gnu.org).

FOSS development began to gain scholarly attention by critics against the increasingly overprotective US copyright regime, such as Lawrence Lessig (2001) and Yochai Benkler (2006). Both of them used FOSS development as an antithesis of knowledge production and distribution under the current intellectual property law that values individual authorship and constrains publicly available resources for innovation. Lessig (2001) examined the efforts made to create collaborative knowledge in the computing field, such as Free Software Foundation, Linux, and Apache server, and evaluated them as "fuel[ing] a wide range of innovation that otherwise could not exist" (p. 57). For Lessig, who stressed the balance between protecting copyrights and broadening the public domain, FOSS development demonstrates the possibility of striking a balance since it neither denies the originally intended principles of copyright protection nor is against capitalist values, but still expands the public domain. In Benkler's book *The Wealth of Networks* (2006), FOSS development appears as a case that proves the effectiveness of peer production in resolving the issue of information overload, producing higher quality information goods, and facilitating democratic values. For Benkler, FOSS development serves as intriguing evidence of the shifts in the mode of production—from capitalism to peer production—and its legitimacy.

FOSS Culture. In the studies that view FOSS development as an alternative to the proprietary system of knowledge production, there is a lack of understanding FOSS as a community with shared culture. This lack is filled by research that explains the impetus of the community by using geek or hacker culture as its explanatory tool. Kelty (2008) saw FOSS development as a movement as well as a cultural practice derived from the culture of geeks who are associated with each other through the concept of recursive public. By recursive public, Kelty

referred to "publics concerned with the ability to build, control, modify, and maintain the infrastructure" (p. 7) through technological interventions. This public allows participants to develop themselves as "creative and autonomous individuals" (p. 7) who promote rearrangement of knowledge and power. FOSS development is one of the recursive publics where geeks engage in technical and legal practices toward the reorientation of knowledge and power that are incomplete and emergent in the new information age.

Coleman (2005) designated the title "hackers" for FOSS participants since she locates FOSS development within the larger culture of hackers. This designation had already been made by Richard Stallman (2002), who founded the root of free software from the hacker ethics in the 1960s and 1970s when sharing source code was a norm. However, Coleman took a further step to illustrate the philosophical foundations that create and maintain FOSS communities in this given context where collaborative knowledge production is challenged by the current intellectual property framework. Coleman contended that hackers in FOSS communities exercise liberal values, especially self-expression, threatened by the rigid copyright system that oppresses certain coding practices. Furthermore, the collective nature of FOSS development makes it available for participants to utilize and contribute to public resources for self-education and self-cultivation. While critics of the existing intellectual property prioritize FOSS participants' collaboration, Coleman challenged the assumption by arguing that the collectivity serves to acknowledge hackers' individualities because they are meaningful only within their relationships with others.

Like Coleman, Söderberg (2008) also framed FOSS development as a part of hacker culture, but underscored it as a labor struggle that takes a different form from the past with emergence of the information society. Söderberg (2008) defined FOSS development as a "play-activity" (p. 156) that is undertaken outside the capitalistic principle organizing labor power.

Here, the term play is used to refer to labor struggle in a Marxist sense, which challenges alienation and commodification of labor. The play-activities performed by FOSS participants, thus, "strengthen solidarity among players and foster viewpoints that are at odds with dominant ideology" (p. 156).

Turn to Business. While the aforementioned scholars see FOSS development as a movement that rearranges and challenges the hierarchies of power, knowledge, and labor in the information era, FOSS development has also been examined as a business strategy. The value of freedom inherent in GNU GPL was criticized for its viral nature as it impedes business uses of software products licensed with GNU GPL (Suzor, Fitzgerald, & Perry, 2007; Wormser, 2010). A body of research, in turn, has turned the interests into practical strategies and legal issues in using FOSS to gain a competitive edge in the information economy (Boulanger, 2005; Ebert, 2009; Garzarelli, Limam, & Thomassen, 2008). In these studies, free software was left out, with the emphasis on open source software that is business friendly, and consequently the meaning of freedom that originated the idea of open source was lost.

This turn to FOSS development as a business strategy is reflected in the motives that mobilize participants. Elliott and Scacchi (2008) found that the motivations among FOSS participants had shifted in order of freedom, business, and occupational frames. While the value of freedom appealed to software programmers during the early years of free software, the debacle of the dot.com boom attracted underemployed programmers to work on FOSS projects launched by businesses that recognized the benefits of FOSS development. Most recently, as FOSS development has become established by businesses that offer FOSS products and related services or incorporate FOSS development into proprietary systems, the increasing job opportunities serve as motivation to draw participants. Elliott and Scacchi (2008) suggested that

these shifts in frames serve to involve more participants who continue to promote the philosophy of free software. However, studies have shown that a better career path in the industry increasingly motivates participants (Arnold, 2011). This reveals that FOSS communities do not necessarily consist of like-minded participants who appreciate the value of freedom, but include those who want to have a competitive edge in the computing field.

How to Link the Existing Studies?

When juxtaposing studies on women in the computing field and FOSS development, few important implications are found in regard to gender relations. Scholars who examine FOSS development focusing on its relationship with the current copyright system stress the collaborative nature of FOSS development. They generally argue that collaboration among FOSS participants finds its root in hacker ethics, as Richard Stallman (2002) started the Free Source movement to revive the value of sharing among Massachusetts Institute of Technology (MIT) hackers. However, the sharing culture can be traced back to the earlier history of programming that arose in the 1950s. Kurt Beyer (2009) said that Grace Hopper believed in sharing her knowledge with colleagues and contributed to organizing venues for engineers and programmers to exchange information. I do not mean to value Grace Hopper over others. Rather, I argue that attributing sharing knowledge, especially sharing code, to hacker ethics that emerged from a male-dominant academic setting needs to be reexamined.

Inattention to the culture of computer programming in its early age, which was not male-dominated, is related to the writing projects of hacker culture and ethics. When looking at Levy's (2010) introduction to hackers who contributed to the computer revolution, it is noticeable that the history starts around the late 1950s. This period coincides with the time when computer programming as feminized work began to be associated with masculinity. Furthermore, the

characteristics that describe hackers and connote masculinity, such as social ineptness, individualism, and nonconformity, were considered to be aptitudes needed to be successful software programmers (Ensmenser, 2010). That is, the shift in the value of programming from a secondary work to a promising job occurred with alteration of the gendered meaning of computer programming. It would be logically illegitimate to contend that the exclusion of women from writing hacker culture was intentional. It was the time when access to computers in civil life was limited; thus, hacker culture had not yet emerged. However, some writing projects that trace the hacker culture back to the late 1950s, when the computing field started constructing its identity as masculine, are not mere coincidences. Who will appear to play the leading roles, that is, who will have the power in the emerging field of computing, is reflected in the constructed stories of hackers.

The body of research that examines the ways to achieve equal opportunities for women, to some extent, challenges the construction of the computing field as a male domain. In particular, the research that sees the culture of computing as an obstacle to women's participation criticizes the mythical images of male hackers that affect the perception of computing by both men and women. Judy Wajcman (1991), however, problematized this approach as it "locates the problem in women (their socialization, their aspirations and values)" (p. 3) and does not question science or technology itself. As noted earlier, FOSS participants who share hacker ethics have reoriented power and knowledge in the information economy (Kelty, 2008; Söderberg; 2008). Then, the fundamental questions that need to be asked are how women's exclusion in the reorientation process will generate a certain rearrangement of power and knowledge and how women's participation would bring changes in the power and knowledge structure.

As FOSS development has faced the turn from a freedom-focused to a business-focused

frame over the last two decades, there have been ongoing efforts to rearrange power and knowledge in the information economy by being involved in FOSS development. As FOSS development is at a critical juncture that is subject to changes in its direction depending on who is involved, it is salient to look at how women's inclusion into or exclusion from FOSS development will influence the direction. This is the missing part from the existing literature this study attempts to fill. Gender is not the only category that can intervene in the discourse of FOSS development; race, ethnicity, and other social and cultural aspects also can. While I do not underestimate the role of other aspects in constructing the hacker culture and FOSS development, I focus on gender as the analytical category, expecting to link this study to those focusing on other aspects.

Theoretical Frameworks

This study was informed by two theoretical frameworks—feminist political economy of communication and politics of technology. The feminist political economy of communication is not a solely developed framework, but an amalgamation of political economy of communication and socialist feminism (Lee, 2011a). Specifically, I use the framework developed by Lee (2010) as it sees gender relations not as ancillary to but as integral to the structure of production, distribution, and consumption of communication goods and resources. In terms of the second framework, Winner's (1986) and feminist epistemology theorists' perspectives on technology as value-laden guided this research. Their views are interrelated with feminist political economy of communication in that both theoretical frameworks deny the idea that the ways in which technology as a communication-related good is developed and circulated is an inevitable outcome of linear innovation or free market principles.

Feminist Political Economy of Communication

Definition and Assumption. Researchers have made little effort to define what a feminist political economy approach means in communication studies and what subject areas scholars in feminist political economy of communication examine. This does not mean that there is no such research that can be called a feminist political economy study. For instance, the book *Sex and Money: Feminism and Political Economy in the Media* (Meehan & Riordan, 2002) was dedicated to case studies of feminist political economy in the media. A problem is that, without clarifying what scholars in feminist political economy of communication attempt to research and theorize, the importance of the studies can be diminished. In the book *The Political Economy of Communication*, Mosco (2009) introduced feminist political economy as one of the branches of political economy theories. His description of feminist political economy solely focused on its contribution to acknowledging reproductive labor. Similarly, in the book *The Laboring of Communication*, co-authored by Mosco and McKercher (2009), an entire chapter titled "Women and Work: Feminism and Political Economy" was devoted to the issue of domestic labor.

Acknowledgment of reproductive labor, without doubt, is among the most profound achievements of feminist activists and scholars. However, this emphasis on reproductive labor is problematic because it reproduces the dichotomous view on the private and the public sectors in relation to women's labor, thereby failing to reveal the interlocking between capitalism and patriarchy in the public sphere. A part of the reason for this ignorance can be found in the lack of theorizing and establishing feminist political economy of communication. There can be a risk to naming and defining a theoretical perspective since they can bring about rigid scholarly practices based on what research does or does not fit the perspective. However, I see a feminist political economy perspective as a basic common ground for looking at the gendered structure of

communication goods and resources rather than an attempt to confine researchers within a limited set of theoretical practices.

Lee (2006) problematized the lack of research examining communication issues from feminist political economy perspectives in her earlier article. However, she later found that, in fact, valuable works from the perspectives do exist but they have not been uncovered. Concerning no working definition of what it means to be conducting feminist political economy of communication studies, she defined it as "the study of the gendered production, distribution, and consumption of goods and resources and the examination of how ideology is used to stabilise the unequal relations" (Lee, 2011b, p. 83). Since she partly borrowed the concept from political economy scholars, Lee focused on the unequal production, distribution, and consumption of communication-related goods and resources. However, unlike scholars in political economy of communication, she sees gender relations as an integral part of generating the inequality. It should be noted that Lee did not claim gender as the sole reason for the inequality; rather, she argued that along with gender, race, class, and other social divides, gender is one of the factors that condition the allocation of resources, goods, and wealth in a historical context (Lee, 2011a).

Lee (2010) introduced three assumptions in this approach. First, "material relations are dialectical to social relations, including gender relations" (p. 108). Influenced by socialist feminism, Lee contended that access to wealth and resources is unevenly given to men and women. A feminist political economy approach explains how this uneven access came to exist by looking at historical material relations between men and women. The assumed gender roles that legitimize the private sector as a woman's place and the public sector as a man's result in unbalanced material relations between genders. These unbalanced material relations, then, fortify

the existing gender relations by restricting women's opportunities to work in the public sector. As Lee made clear, gender relations is one of the various social relations; thus, other social relations such as race and geographic location are constitutive of material relations and vice versa.

The second assumption is that "powerful actors actively control resources so that they make maximum profit without redistributing the gains to those who engage in production" (Lee, 2010, pp. 108-109). Like scholars in political economy of communication, Lee argued that the market does not function by following the logic of the free market. Rather, corporations, governments, and special interest groups intervene in the flow of wealth and resources, often in invisible ways. She argued that the current global economy is an intriguing example of the power played out in controlling resources. Rejecting the idea that "economic globalization is an inevitable and irreversible outcome of history" (p. 109), Lee pointed out the role of transnational corporations in arranging the current global economy. Since unequal distribution of power is regarded as a historical consequence by both political economy of communication and socialist feminism, they necessitate historical analyses of power relations.

The third assumption of a feminist political economic approach is commodification. Lee attended to the ways in which both rival and non-rival goods and resources are commodified for the powerful few to accumulate wealth. As Schiller (2010) noted, commodification as a process of transforming use values into exchange values involves historical changes in the meaning of resources and values. For instance, the exchange value of information as a communication resource is not intrinsic throughout history, but has been determined by the powerful few. Lee stated, "The process of commodification not only alters material relations, but also social relations" (2011a, p. 109). Commodification increases the material gap between haves and have-nots since access to communication goods and resources, especially in the information age, is a

way to accumulate wealth. The material relations altered by commodification processes buttress unbalanced social relations by firmly establishing gendered, racialized, and geographic hierarchies.

In general, Lee shared basic assumptions with the scholars in political economy of communication. However, she viewed gender, race, geography, and other social relations as integrated into, rather than secondary to, the unequal production, distribution, and consumption of goods and resources. For feminist political economic approaches to respond to the status of the current global economy, Lee called for attention to global feminism. Not all issues that are posed in political economy of communication are global. Yet, she contended that global feminism's strength in looking at the intersection of gender, race, and other social relations and its historical approach to explicating it can broaden the view of feminist political economy.

Influence of Political Economy of Communication. The definition and assumptions of feminist political economy of communication offer insights into the interlocking between material and social relations. However, it does not give an understanding of how we should think about knowledge or information, which is the emphasis of this study. As Lee focused her research on telecommunications and the information system, she attempted to incorporate the system into the existing scheme of political economy of communication that puts more emphasis on mass communication (2004). She stated, "Economically, mass communication, telecommunications and information system are increasingly forming one single market" (p. 29). Thus, establishing a boundary between older and new media, or among mass communication, telecommunications, and information systems, is not clear-cut.

As Mosco (1988) noted, "A fundamental source of power in capitalist society is profit from the sale of commodities in the market place" (p. 3). Information, like other resources, is

also transformed into a commodity form that has exchange value. In a similar vein, Schiller (1988) described the historical changes in which information became not only a commodity but also "a fundamental source of growth for the market system as a whole" (p. 27). Neither Mosco nor Schiller saw commodification as an inevitable process to all resources in capitalist society although capitalism often drives capitalists to make profits by transforming resources into commodities. As Schiller (1988) rightly pointed out, "Only under particular conditions can they [resources] be transformed into commodities" (p. 33). Thus, Schiller criticized the scholarly argument that the nature of information innately differs from other resources on the basis of information's intangibility and minimal cost for reproduction. Since a commodification process is based on particular conditions that interact with power structures, historical accounts are necessary in understanding the current status in which information as a commodity is taken for granted.

Knowledge Labor in the Information Society. Schiller (1986) explained the historical context in which information industry became the impetus for economic development in both North America and other developed countries after World War II. While the end of the war was accompanied by various social and economic crises, he stated, "Most troubling of all, unemployment, regarded as a minor nuisance in the 1950s and 1960s, and not expected to exceed four percent of the labor force at its worst, is back at, or near, double digit levels" (p. 1). A significant implication in his study is that new information technologies were considered to combat the Western economic crisis not only by commodifying information but also by creating jobs. Thus, labor issues are an essential part of the emerging information economy since the shift to the information industry also brought changes in the nature of labor and the ways in which a labor force is mobilized and managed.

Hardt and Negri (2000) used the term "immaterial labor" to refer to the type of labor that produces immaterial goods such as "knowledge, information, affect, and communication" (p. 285). Two distinctive characteristics of immaterial labor are related to FOSS development. First, goods are no longer produced by the factory but are produced by the society. That is, the society itself becomes the factory. As there is no fixed place for labor, it becomes difficult to measure labor. Second, "cooperation is completely inherent in the labor force" (p. 295). Resources with which to produce goods cannot be purchased from the market, but acquired through affective relationships and communications with others.

Labor has drawn the attention of scholars in political economy of communication in terms of the shifting aspects of labor relations with the application of new technologies, international division of labor, and resistance through unionization and commodification of labor (Mosco, 2009). Mosco introduced labor as one of the current trends in political economy of communication. What is notable in his work is that he sees gender and labor relations as if they are separate issues. Although implicitly discussing gender, Hardt and Negri also did not see gender as an integral part of the operation of the information industry. This is where socialist feminism can provide insights into the gendered power structure of labor as well as production, distribution, and consumption of communication goods and resources.

Influence of Socialist Feminism. Lee (2004) developed her idea of feminist political economy of communication partly informed by socialist feminism. Steeves and Wasko (2002) also attempted to motivate the alliance between feminist theory and political economy by specifically focusing on the theory and praxis of socialist feminism. While socialist feminism has lost its momentum since the late 1970s with feminist scholars' turn to post-modernism, it still bears importance in examining the material existence of women in both the private and the

public sectors. While socialist feminism is simply described as a conjunction of Marxist and radical feminism in the 1960s, it has a more complex history of theoretical development.

In explaining socialist feminism's applicability to unpacking the telecommunications and information system, Lee mainly relied on dual-systems theory, one of the lines in socialist feminism. The main tenet of dual-systems theory is that patriarchy and capitalism are separate systems although they are often interrelated in oppressing women (Young, 1980). Hartmann's (1979) argument that women's oppression existed even in pre-capitalist society seemed to be irresistible evidence of the tenet. However, Young (1980) opposed this idea because dual-systems theory does not explain the condition of women who are increasingly working outside the private sector. Furthermore, dual-systems theory views women's oppression as if it continues to have the same form throughout history, thereby falling into the trap of a historical material analysis. Most importantly, dual-systems theory retreats into economic reductionism by leaving Marxist theory unchallenged. The demise of socialist feminism is partly attributed to its failure to respond to these criticisms (Ferguson, 1999).

As an alternative to dual-systems theory, Young (1980) proposed the concept of "capitalist patriarchy" (p. 28), which views capitalism and patriarchy as a united system. Intriguing evidence of capitalist patriarchy is gendered division of labor. Young contended that division of labor is more concrete than the concept of class since it reveals that women most often take disadvantageous positions in their economic activities regardless of their class. As socialist feminists argued, unequal division of labor applies not only to gender but also to race. Young's stress on division of labor informed feminist political economists of communication of unpacking gender relations in information society where labor is divided along the lines of gender and race, both domestically and internationally. Furthermore, the notion of capitalist

patriarchy applies to distribution and consumption of communication-related goods and resources as they are hierarchically and differently allocated and consumed by gender, race, and geographic locations.

Politics of Technology

The theoretical framework that sees technology as political emerged from criticism of the theories that explicate the processes of technological development in apolitical manners. Theories of the social shaping of technology contributed to deconstructing the myth that technology is developed in a linear manner. However, they failed to unveil how power plays out in the process by implying that interest groups can equally participate in deciding the course of technological development. Feminist studies of technology, influenced by feminist epistemology theorists, also rejected the assumption that technological development is a value-free process, thus aligning with theories that frame technology as political. In this section, I narrate the theories of the social shaping of technology and examine how the theoretical framework that looks at political aspects of technology can be a useful tool for understanding knowledge production in the information age.

Social Shaping of Technology. Pinch and Bijker (1984) contributed to developing an early discipline of the social shaping of technology, termed the social construction of technology (SCOT). As the title implies, SCOT does not suppose that technology develops in a linear manner. Rather, SCOT focuses on involvement of human actors and their interpretation in shaping technology. To understand development of a specific technology, three steps are required (Pinch & Bijker, 1984). The first step is interpretive flexibility, which means "not only that there is flexibility in how people think of, or interpret, artefacts, but also that there is flexibility in how artefacts are designed" (p. 421). This step is followed by closure and stabilization in which

problems and controversies regarding a technological artifact are resolved. The most distinguished aspect of SCOT from previous technology studies is the third step, the wider context. Pinch and Bijker argued that the relationship of "a technological artefact to the wider sociopolitical milieu" (p. 428) needs to be considered.

Along with SCOT, the science, technology, and society (STS) program has been developed as one of the branches of studies in science and technology related to the social. The origin of STS was influenced by Kuhn's work, which helped to see science as culture and practice. However, STS has developed its own culture since the 1980s. Feminism has informed STS in elaborating its analysis of scientific reality and objectivity (Law, 2008). Feminist theorization of gender is likely to have shed light on social constructionism since gender, which had been assumed to be an inherent nature, was challenged by feminist scholarship. Moreover, feminist epistemology helped STS to blur the line between objectivity and subjectivity (Law, 2008) and recognize situatedness (Haraway, 1988) that inhibits or encourages access to social reality. However, it should be noted that, despite the influence of feminist scholarship on STS, feminist politics to challenge institutional discrimination against women and the marginalized was not incorporated into STS.

SCOT and STS have contributed to viewing technological development as not inevitable. However, what roles they play in reality are unclear. While Pinch and Bijker (1984) criticized previous technology studies for their descriptiveness, SCOT fell into the same trap although its scope of description is wider. STS also revealed how scientific and technological realities and representations are constructed, but how these findings can have usefulness in reality is not asked. This might come from the antipathy toward technological determinism that focuses on consequences of technological changes. However, studying technology in relation to the social is

not a complete departure from studying the consequences. Especially from critical perspectives, if social factors encourage technological development that excludes or discriminates against certain groups, those factors should be challenged rather than merely explained.

Turn to the Politics of Technology. Scholars of the social shaping of technology have been criticized for their value-free stance and indifference to power relations. Russell (1986) particularly attacked Pinch and Bijker. Suggesting that their neutral and impartial approach to social relations is relativism, Russell proposed a critical approach. He contended that why a specific choice was made among alternative options should be asked in understanding technological development if it is not inevitable as SCOT scholars argued. To respond to this question, Russell contended that various political and economic contexts, such as "economic imperatives, government industrial policies, regulations, legal duties and constraints, political strategies and tactics, bureaucratic procedures and cultural traditions" (p. 336), should be examined. Although SCOT scholars do not consider power relations as sources in resolving technological problems and controversies, what ultimately directs the path of resolution cannot be explained without examining political and economic contexts.

Beyond Russell's argument that focuses on political and economic structures shaping technology, Winner (1986) moved to claim that technology itself is political in some cases. His view on technology is twofold. First, the design and invention of certain technological artifacts function to resolve issues in a community. As an empirical example, a low overpass that discourages the passing of public transit is a case that segregates the lower socioeconomic classes and racial minorities that normally use public transportation. This view does not differ from Russell's in that external factors determine the technological design. Second, the adoption of technology generates the consequences that structure and condition human interaction. On the

one hand, technology can be authoritarian. For instance, a nuclear reactor necessitates authoritarian management since the dangers of nuclear materials should be strictly monitored for safety reasons. On the other hand, technology can be democratic. For instance, if the Internet is decentralized and non-hierarchical and facilitates human interaction free from authorities as some argue, the Internet can be considered democratic.

At first glance, Winner's position seems to reflect technological determinism, which refers to "the idea that technological innovation is the basic cause of changes in society and that human beings have little choice other than to sit back and watch this ineluctable process unfold" (1986, p. 10). However, his view is not necessarily resonant with technological determinism. If development of nuclear power were not inevitable, we still could ask why a nuclear reactor should be built when there are alternatives that are not authoritarian. Far from technological determinism, he explicitly attacked "the status-quo and its ills and injustice" (1993, p. 372). He suggested that scholars studying the relationship between the social and technology should have "an evaluative stance or any particular moral and political principles" (p. 371) that can constitute resources for people to judge technologies given to them.

From Winner's critical perspective, SCOT's and STS's approaches are problematic. Above all, Winner (1993) criticized SCOT and STS scholars for being relativistic in their accounts of technological development and contents. Social construction, the idea upon which SCOT and STS rely, is not necessarily problematic. As feminist scholarship has proved with the concept of gender, a social constructionist approach can be used to challenge institutional power that causes oppression and discrimination through mythical category makings. However, some SCOT and STS scholars have used social constructionism in a way that gives equal value to different accounts of technological development. This position is well described in a question

from Woolgar (1991), one of the early STS scholars: "What is it that makes one reading of the text (technology) more persuasive than another?" (p. 41). In the same sense, SCOT's notion of interpretive flexibility, which acknowledges different interpretations of a technology from different groups, is debatable. Winner saw this postmodern stance as "politically naïve" (p. 374).

Feminist approaches to technology are in general resonant with Winner's position. Grounded in feminist politics, feminist approaches analyze technology with moral and political values. As Wajcman (2004) noted, the technologically deterministic view is often prevalent in feminist scholarship, being divided into technological utopianism and dystopianism. The 1970s debate around in vitro fertilization (IVF) shows these polarized views: While a group of feminists hailed the potential of control over women's own bodies, others expressed concern about the biotechnology that affects women's bodies and nature (Jones, 2002; Sommer, 2002). However, as these reactionary positions lost their power to fundamentally challenge the gendered nature of technology itself, feminists developed an alternative position that sees gender and technology as mutually constitutive (Wajcman, 2004). That is, feminists began to contend that not only does technology shape gender but also that gender shapes technology, thereby both avoiding technological determinism and attending to effects of technology.

Relevance of the Politics of Technology to This Study. Computer programming is often considered apolitical since in most cases software is designed to satisfy users' needs. Although the Free Software movement is tied to moral and political values, the movement applies those values to production and distribution processes rather than to programming. Criticism of Microsoft came from its closed way of distributing programs, not from programming itself. However, computer programming is a highly moral practice. As explicitly mentioned in *The Software Engineering Code and ACM Code,* those who produce computer-related knowledge

need to consider the users' quality of life, especially that of marginalized groups, in terms of their physical ability and socioeconomic status. Furthermore, Bjerg (1996) argued that developing and distributing computer technologies are involved in constant political choices over conflicts in ethics, morality, power, and dominance. This argument is not only applied to programs that are purposefully designed to harm certain groups, but also to programs that are generally made to meet the users' needs. Vaidhyanathan (2011) noted that Google's choice not to add a delete function to Gmail in its initial design could possibly violate users' privacy. Although the initial design was purely logic-based in an attempt to prevent users from deleting important messages, this design could have facilitated surveillance.

Computer programming is a less contested area of technology than other areas such as biotechnology and agricultural technology. However, the influence of programming can be considerable when it is used to exercise power. Terranova (2004) called this invisible power without material force soft control. When a software program is designed in favor of power, whether it is market or state power, it is convenient to argue that the social shapes technology. However, when the intention seems logical and apolitical as in the Gmail case, how the social shapes technology is unclear. From the views of SCOT and STS, at best, the Gmail case would be regarded as one of the varieties which the culture surrounding technological development can generate. As Vaidhyanathan (2011) emphasized, Google has a strong engineering culture that most values logical thinking. However, from Winner's and feminist perspectives, the Gmail case is highly problematic. For Winner, the design would be considered inherently political since it removes freedom from users in managing their own information. For feminists, the seemingly logical and universalistic thinking itself is a problem. Furthermore, an apolitical stance itself is a type of political stance if it bars the producers of technology from seeing contextual texts that

make an apolitical position impossible. The important aspect of Winner's and feminist approaches is that they have explanatory power when the social qualities of technology are invisible and subtle. Computer programming is one of these cases. As Lessig (2006) succinctly described, the code is the law in the digital environment. This statement implies that the code is inherently political, and even if a coder claims to be apolitical this stance itself is political as it helps to obscure the consequences.

Another important aspect of the Winner and feminist approaches is that they take end-users into consideration. In particular, marginalized groups that do not have access to the technology but will be affected by its development were also included in the discussion. As I mentioned earlier, software programs are important means of creating human interaction. When they are developed from coders' perspectives, technologically marginalized groups would not fully use the programs. As software programs often do not generate contested outcomes, public debates cannot be easily organized. In the absence of direct interactions between producers and users, producers' perspectives on end-users should be examined.

Methods

Data for this study were collected through four main sources: historical documents, online forums, fieldwork, and interviews. Chapter 3, which examines the historical context of the computing field in the 1980s, is based on historical documents such as the early issues of *Communications of the ACM* and *Computerworld* and oral histories of early computing professionals. Online discussions on Slashdot were used as the primary data for chapter 4 so as to examine FOSS contributors' construction of their own identities and culture. The analyses in chapters 2 and 5 are mainly grounded in my experiences at FOSS conferences and interviews

with FOSS contributors.

Historical Documents

To analyze the historical context of the computing field in its nascent stage, early issues of *Communications of the ACM* and *Computerworld* were examined. *Communications of the ACM* is a monthly magazine published by Association for Computing Machinery (ACM). Along with the Institute of Electrical and Electronics Engineers (IEEE) Society, ACM is one of the two main organizations for academics and professionals in the field of computer science. ACM was the leading organization in designing computer science curricula in the higher education setting in the US. Early issues of *Communications of the ACM* are good historical records of computer science education as the magazine extensively published articles about discussions surrounding computer science curricula. While *Communications of the ACM* is a source that helps to explore the history of computer science education, *Computerworld* is a magazine that offers insights into the business world. Although *Computerworld* first targeted the US population, it became an international magazine with its increasing influence and popularity. The magazine was widely circulated among professionals in the computing industry and served as one of the main news sources in the industry. Moreover, I used the oral history collection of the Computer History Museum (CHM) and Charles Babbage Institute (CBI) to supplement the two magazines. CHM (Mountain View, CA) and CBI (Minneapolis, MN) initiated oral history programs to uncover the lives of computing professionals in the early age of the industry and expand the understanding of the industry's history. The transcriptions of oral history interviews are publicly available on the CHM and CBI websites. In particular, oral histories of previous female professionals were examined with special emphasis to understand individual women's experiences of working in the newly emerging industry.

Online Forum

Slashdot was chosen as the source to examine FOSS cultures. While each FOSS project has its own distinctive ethos, there is a shared culture among a wide range of contributors regarding the values of freedom and meritocracy. Launched in 1997, the website aimed to focus on introducing Linux and FOSS-related news articles and promoting discussion among users. As I will briefly mention in chapter 5, Slashdot was the website that people often visited to learn about and discuss FOSS. The influence of the website was very strong, as demonstrated by the Slashdot effect, which refers to the huge influx of web traffic to websites that offer original sources to Slashdot (Rouse, 2005). While some users have criticized Slashdot for immature discussions, a closer look at the comments shows that a fair proportion of commenters participate in discussions in a deliberate manner.

For this study, discussion forums regarding FOSS culture and gender between 1998 and 2012 were examined. To search related forums, 12 keywords and their equivalent or opposite words were used: "gender," "sex," "female" ("male" as the opposite word), "women" ("men" as the opposite word), "femininity" ("masculinity" as the opposite word), "open source" ("free source," "FOSS," "OSS," "free software" as the equivalent words)," "programmer," "coder," "developer," "geek" ("nerd" and "hacker" as the equivalent words), "diversity," and "outreach." After limiting the scope to the forums whose titles contain the aforementioned keywords, I further narrowed them down to the forums that address three themes: the identity of FOSS developers, gender issues in FOSS communities, and gender issues in the computing field in general. While the last theme is not directly relevant to FOSS development, I chose it to see whether there is a distinction in regard to gender issues between FOSS development and the computing field in general.

Fieldwork

While FOSS development is assumed to take place online, offline gatherings and networks are important ways of joining a project. Offline FOSS conferences are where FOSS contributors build their networks. To explore the roles of FOSS conferences in contributors' interactions with each other, I attended several conferences. I chose to attend DrupalCon Denver 2012, Penguicon 2012, Open Source Bridge 2012, LinuxFest Ohio 2012, and Wikimania 2012 after considering the type and size of conferences. DrupalCon was the biggest conference with a focus on business uses of Drupal. Open Source Bridge is not specific to a FOSS project; rather, the sessions tend to address more general themes. Since the conference was first initiated by FOSS contributors who were concerned about the corporatization of FOSS, it focuses on maintaining the spirit of the Free Software movement. LinuxFest and Wikimania are volunteer-run conferences that address a variety of themes regarding each project, such as governance, community building, technological development, and culture of Linux and Wikipedia. Penguicon blends FOSS technology, especially Linux, with general geek culture, such as science fiction, crafting, and costuming.

Interviews

I interviewed 13 computing professionals—9 female FOSS developers, 3 female non-FOSS developers, and 1 male FOSS developer. The interviewees were recruited in three ways. First, I personally contacted female contributors based on the contact information available online. Many FOSS contributors maintain their personal blogs or homepages as a means of advertising themselves to the job market and communicating with anyone who is interested in their ideas. As there are few female contributors, such blogs and homepages are also limited in number. Thus, I contacted most of the female contributors who are based in San Francisco and

Portland and whose contact information was publicly available. Second, I used tech-mailing lists such as Debian women and GNOME women to ask mailing list subscribers to participate in an interview. I introduced the rationale for my research in the e-mail. Furthermore, I linked a temporary blog that had more detailed information about the research as well as my curriculum vitae so that interested individuals could find more information. Finally, the interviewees introduced me to some contributors.

I conducted 10 interviews in the Bay Area and 1 interview in Portland. The rest of the interviews were carried out online due to physical distance. The interviews lasted from 50 minutes to three hours. Two interviewees had non-resident status in the US and one was based in a country located in South America. The interview material from this South America-based interviewee was only used as a reference as there are considerable differences in FOSS development between South America and the US. In order to maintain confidentiality, pseudonyms were used in this manuscript, and the interviewees' personal information was altered to the extent that the alterations do not change the intentions of interviewees.

Conducting Feminist In-Depth Interviews. Oakley's (1981) book chapter "Interviewing Women: A Contradiction in Terms" has been influential to scholars who conduct feminist research by using an interview method. Criticizing interviewing from a masculine paradigm, she discussed what it means to conduct a feminist interview. The term feminist interview should not be interpreted as an interview by feminist scholars or interviews with only female participants. The word can generate this misunderstanding, but what Oakley ultimately attempted to encourage in the book chapter was contemplation of how researchers can conduct a better interview that leads to achieving the research goal. She focused on interactions with female participants since the article was written from her interview experiences with women.

However, her approach can be applied to all interviews regardless of the participants' gender if the researcher is doubtful of the linear and hierarchical ways of conducting interviews.

Oakley offered two main criticisms of traditional interview paradigms. First, the interview is conducted in a linear manner. There is a clear boundary between the roles of interviewer and interviewee, the former asking questions and the latter answering them. While the participants often question back, the interviewer is not supposed to answer to avoid the risk of projecting his or her thoughts on the participants. This does not mean that the interviewer appears unfriendly. Displaying friendliness and constructing rapport are still significant components in the interviewing processes from the traditional paradigms. However, their purposes are often to have the interviewees consent to the interview rather than to build reciprocal relationships. When the interviewees are considered to be a means of data collection and rapport simply functions as a courtesy to access data, both the interviewer and interviewees become impersonalized. Oakley's other criticism of the traditional paradigms is the hierarchical relationship between interviewer and interviewee, which she suggested originates from psychoanalysis practices. In this relationship, the interviewer throws questions to find the truth that he or she sets out to uncover, and the interviewee expects the interviewer to find the truth about him- or herself.

Oakley argued that reciprocal and non-hierarchical interview relationships can better serve a research goal. As opposed to the ideal image of objective and detached researcher, she has practiced reciprocal relationships by allowing participants to question back and exposing her own experiences, thereby breaking through the hierarchical barrier between her and the women she researched. Through this approach, Oakley was able to have her interviewees not feel exploited and be fully informed of the research goal. In turn, the interviewees responded to her

by showing genuine interest in research and putting in effort to collaboratively achieve what the research intended. In this way, Oakley involved participants with shared concerns voluntarily in research.

Following the principles of Oakley's interview method, I attempted to position myself as a listener and a learner rather than a researcher while I was interviewing. Since the interviewees were experts in the area of the study, it was unlikely for me to have a higher position in the interview hierarchy. Thus, my interviews and I were able to proceed with interviews, questioning and questioning back to each other. Furthermore, the fact that the interviews and I are put in a similar working environment as precarious knowledge laborers helped us have reciprocal relationships.

Interpreting Interviews. The legacy of liberal feminism is deep-rooted in feminist studies, and this legacy often attempts to empower voices even when they are not empowered, as feminist scholars have asserted. Feminist epistemology that values women's voices and researchers' self-reflexivity generated this problem. In a study of female call center workers in India and Malaysia under the title "Valuing Women's Voices," Ng and Mitter (2005) conducted interviews with workers. Before presenting selected interview content, the researchers explained the institutional problems female workers face, such as the glass ceiling, surveillance of labor, routinized labor, transitory status, and work-life balance. When only these problems are posed, the possible conclusion would be that female call center laborers in developing countries are working under exploitative environments. However, as excerpts from interviews are presented, the conclusion takes a different direction. Despite these unfavorable working environments, the workers proposed positive sides of the job such as decent salary, learning from customers in different countries, freedom from domestic work, and increasing power in their relationships

with husbands and in-laws. The researchers concluded that although the workers face difficulties, the working experiences gives women agency. It is true that the working experiences are neither absolutely exploitative nor entirely liberating. However, this middle ground conclusion should be cautiously made based on critical analyses of women's voices.

Couldry (2000, 2010) focused his research on the relationship between broader socio-political structures and individual voices. In his earlier study, his interest was in how the culture and individuals constitute each other. However, in his most recent book, he expressed concern about neoliberalism and its role in limiting voices other than consumer voices. He argued that neoliberalism tends to undermine and deny voice, and whether given conditions can organize human life and resources that help voice to be heard needs to be studied. Furthermore, he stated, "I offer 'voice' here as a connecting term that interrupts neoliberalism's view of economic and economic life" (2010, p. 2). In Couldry's sense of voice, two factors should be examined in listening to women's voices. First, whether the larger structure, in particular, neoliberalism, bars voices from being put into practice needs to be asked. Neoliberalism shapes voice in certain ways. A continuing process of self-development is one of those ways. Referring to the example of call center workers, learning through work is an aspect of self-development. However, when extremely limited time is given to deal with customers under the surveillance of a recording machine, learning from customers does not seem feasible. Thus, how that voice was made should be put under scrutiny. Second, whether the voice can produce ruptures in neoliberalism needs to be examined. If the first condition is not met, ruptures would not be made.

The information age was claimed to offer both consumers and producers freedom from authoritative and hierarchical power. Scholarly work also supported the claim, arguing that consumers are provided with information that would not be accessible otherwise, and producers

have freedom they did not have under the scientific management of labor (Benkler, 2006; Lessig, 2001). However, these empowerment discourses turned out to have negative sides. The market logic restructuring itself in a way that is coherent with the empowerment discourses (Castells, 1991), in fact, began to exercise power in more subtle and invisible manners. Thus, listening to and valuing the voices of women as both consumers and producers in the information age should be practiced to locate and challenge the power behind the empowerment discourses.

Another problem with the example outlined above is in its explicit aim of feminist politics. Law's notions (2004) of presence and absence better elaborated this problem. According to him, a method is not simply an instrument or set of steps to access and reveal reality. Law's criticism of the method that reveals only clear and apparent reality is well summarized in this one sentence: "Always, what is absent is a set of potential patterns that buzzes and dazzles and dances, that is too complicated to condense, to make present" (p. 117). Feminist studies is, or used to be, resonant with Law's position. Women's issues were not as obvious as they are now when feminist scholars began to study. As gender became a category for conducting research and analyzing data, the issues came to be visible. The method assuming universality of human beings, which was adopted before feminist studies, was too simplistic to contain the abstract and complicated aspects of life, that is, gender relations.

Then, why does gender not work as an analytical category as it used to? A method as performativity gives a partial answer. A method is not a fixed set of steps but has a performative quality, which is enacted and reenacted as traces that were hidden appear (Law, 2004). As gender as a trace of assemblage is revealed, other hidden traces should surface. However, this does not mean abandonment of gender. Gender as a part of assemblage is interlinked with other traces whether they are already discovered or are to be discovered. The contention that feminist

methodology has too much focus on gender relations is in this context. As it was revealed that gender relations play an important role in shaping every aspect of human lives, it is evident that researchers would always find the function of gender relations in given research areas. When those areas are considered to be gender neutral, it is worth using gender as the major analytical category. Feminist scholars' attention to science, which has been believed to be objective and value-neutral, is one case. However, it is no longer new to think that science is a culture sustained by a set of rules and beliefs. Thus, feminist scholars should move on to follow other hidden traces that interact with gender.

My concern with feminist epistemology, in particular listening to women's voices, comes from the skepticism toward the failure of communication studies in attending to women's voices. This does not mean that no studies have focused on women's experiences. Instead, this is a concern of how standpoint theory—which is widely used in media and communication studies and becoming legitimized as a communication theory is practiced in the scholarship. The theory is at times understood as a simple method that listens to women's voices and presents them. This is not a problem that is only applied to communication scholarship, but a problem across disciplines and even in feminist scholarship.

Standpoint theory might be better explained by Collins' notion of black feminist thought (2009). In Collins' analysis, African-American women's experiences are considered central to explicating the interrelationship among race, gender, and class. However, the experience on its own does not offer a meaningful tool for analyzing the interrelationship. For Collins, the experience should be developed into black feminist thought that involves black women's standpoint and self-consciousness. As black feminist thought, what is important in standpoint theory is that not only does the marginalized identity give better access to the reality, but it also

provides a better understanding of where to start resistance (Harding, 1993). That is, merely listening to women's voices without considering ways of resistance is problematic. Thus, this study attempted to reveal how the interviewees' voices can be developed into the resources for resistance in the knowledge industry in which the neoliberal politics makes the laborers' voices unheard.

Chapter Breakdown

This study consists of four analysis chapters. First, I begin by explaining the background information of the Ada Initiative's launch and its main activities. The Ada Initiative is a non-profit organization that promotes women's involvement in open technology and culture. Although the Ada Initiative claims that it does not represent female FOSS contributors as a whole, it has grown into a group that systematically addresses gender issues within FOSS communities, speaking for individual FOSS contributors whose voices were often unheard. Above all, this chapter pays close attention to the Ada Initiative's framing of participation in FOSS development as labor not as a hobby, as often claimed by FOSS contributors. This framing gives insight into gendered labor relations in FOSS development as an example of knowledge labor.

While chapter 2 discusses the current gendered labor relations in FOSS development, chapter 3 explores the historical context that affected the labor relations. In particular, this chapter focuses on the context of computer science education and industry in the 1980s because this is when the groundwork for FOSS development was laid. Computer science education and the computing industry became established in the 1980s as the significant role of computers was recognized. Construction of the computing field as a male domain was seen in the maturation

process. This chapter assumes that the historical context of this time period was likely to influence gender relations in FOSS development at its beginning.

Chapter 4 examines the power of cultural discourses that maintain and reinforce the gendered construction of FOSS development. FOSS developers often define their identities by emphasizing the value of freedom they foster through participation in FOSS. This emphasis on freedom often results in alienation of women in FOSS development. This chapter looks at how the everyday discourses of FOSS developers contribute to making FOSS development consistently male-dominated, and how these discourses help FOSS developers construct knowledge workers' subjectivities that suit the neoliberal politics.

Finally, chapter 5 attends to the voices of female FOSS developers to examine how their experiences are conditioned by the institutional and cultural power that has helped FOSS development to become male-dominated. Furthermore, this chapter problematizes the prevalent assumption of FOSS developers as males with typical life histories as it marginalizes women who often take different routes to become FOSS developers. Attention to the voices of female FOSS developers is significant as their different experiences lead to the ways in which knowledge is produced within FOSS communities.

CHAPTER 2.

THE ADA INITIATIVE: EMERGING FEMINIST LABOR MOVEMENT IN FREE AND OPEN SOURCE

Mary Gardiner, co-founder of the Ada Initiative, stood on the stage at the opening plenary session of Wikimania 2012 to deliver her keynote address, *Fostering Diversity: Not a Boring Chore, a Critical Opportunity*. Wikimania is an annual international conference that began in 2005 for users of Wikimedia Foundation projects to discuss related issues, including Wikipedia, Wiki culture, Wiki technology, access to knowledge, and education. Wikimania has grown into a well-established event on free knowledge, attracting more than 1,400 attendees from 87 countries in 2012 (Bashour, 2012c). Each year, the conference has featured several keynote and plenary speeches by prominent male figures in free culture, such as Richard Stallman, Lawrence Lessig, and Yochai Benkler. However, there have been only two main female speakers in the eight-year history of Wikimania. Mary Gardiner was not only one of these women along with Eliane Metni, director of the International Education Association, but also the first female keynote speaker at the conference (Bashour, 2012a).

Mary Gardiner's presence at Wikimania 2012 was noteworthy because women had not been provided opportunities to present major speeches at the conference and the Ada Initiative, which Gardiner represented, was a fairly new organization founded in 2011. When the Wikimedia Foundation announced that Mary Gardiner would be the keynote speaker at the conference, the Ada Initiative had just marked its first anniversary. Despite its short operating period, the Ada Initiative had become a well-regarded organization in FOSS communities. Mitchell Baker of the Mozilla Foundation, Sue Gardner of the Wikimedia Foundation, and Karen Sandler of the GNOME Foundation are among the influential figures who have served or are serving as Ada Initiative board members or advisors. Preeminent companies and organizations

that work on or support FOSS development, such as Google, O'Reilly, the Wikimedia Foundation, and the Mozilla Foundation, have received consultation services from the Ada Initiative on fostering gender diversity (Aurora, 2012a). Furthermore, the Ada Initiative was the organization frequently referred to by my interviewees as a resource to which I should pay attention.

The reason for undertaking the analysis of my dissertation with the Ada Initiative is twofold. First, the activities of the Ada Initiative indicate critical gender issues in FOSS communities. On its website, it states, "[the Ada Initiative] does not represent the women in the open technology movement as a whole" (adainitiative.org). In fact, there are numerous types of FOSS companies and organizations, especially in terms of their service/product, organizational structure, profit model, and working environment. Thus, the Ada Initiative cannot play a role as an umbrella organization in a practical sense. More importantly, the two co-founders would be aware of the ethical and theoretical feminist stance that women's experiences are not unitary and that representations of women's experiences from a narrow viewpoint, especially that of the privileged, are problematic. In fact, through their talks and writings, co-founders Mary Gardiner and Valerie Aurora have demonstrated their keen sensitivity to the different experiences of women who are influenced by their race/ethnicity, sexual orientation, and degree of disability.

Although the Ada Initiative does not represent women in FOSS communities as a whole, its activities reveal current gender issues concerning FOSS development. The two co-founders have been advocates for women's involvement and a women friendly environment in FOSS communities for more than a decade. As early as 2000, Australian-born Mary Gardiner started working as a volunteer for LinuxChix, a community for female users and supporters of Linux and free software, which was founded in 1999 and is still active. Gardiner launched the

LinuxChix mini-conference at linux.conf.au in 2007, and it served as momentum for founding AussieChix, the Australian LinuxChix chapter. Valerie Aurora is also an early member of LinuxChix, and her well-known piece *HOWTO Encourage Women in Linux* (Hansen, 2002)[2] helped gender issues to surface in FOSS communities. Gardiner and Aurora might not be the savviest of non-profit organizers, but their long-lasting advocacy on gender issues in FOSS communities has led them to develop penetrating insights into the urgent matters that female FOSS contributors face.

Second, the Ada Initiative's activities shed light on gendered labor relations in FOSS development. The Ada Initiative does not identify itself as a labor-related organization. Rather, the organization only vaguely defines its identity as "a non-profit organization dedicated to increasing the participation and status of women in open technology and culture" (adainitiative.org). However, the Ada Initiative's main activities, which are increasing the number of female developers and preventing sexual harassment and gender discrimination in FOSS workplaces, fall into what has been done in the past in the name of equal employment opportunity. As discussed earlier, the Ada Initiative does not represent the interests of women in FOSS development as a whole, and its activities are not collective actions by interested individuals and parties. Furthermore, the organization attempts to resolve gender issues not by demanding legal intervention but by raising awareness within the communities. In this regard, the Ada Initiative's activities differ from those of traditional feminist labor movements.

In part, the reason that the Ada Initiative focuses on self-conscious and voluntary changes from the community is because a significant amount of FOSS development is still completed by decentralized contributors. Since FOSS contributors are often not bound to any organizations,

[2] This piece was published under Valerie Aurora's former name, Val Hansen.

systemic interventions to encourage diversity cannot be easily created and administered. In addition, even if FOSS contributors work for organizations or companies, they tend to feel antipathy toward the involvement of authorities. Among FOSS contributors, freedom is the most appreciated value, and any top-down measures governing their behaviors are deemed threats to their freedom. From this perspective, efforts to foster diversity and reduce inequality through organizational procedures are considered to be against freedom. Thus, as a study on gender in FOSS development keenly pointed out, "Anything that connotes special help based on gender is likely to undermine rather than assist [in achieving gender equality within F/LOSS communities]" since they think of themselves as "already working for equality and social justice through meritocratic organisation" (Nafus, Leach, & Krieger, 2006, p. 6). The co-founders of the Ada Initiative fully recognize these distinctive characteristics of FOSS developers, and this is why they endeavor to help the contributors understand the structural problems rather than ask authorities to rashly employ systematic measures. The Ada Initiative's work demonstrates what could be an alternative model of the feminist labor movement when the boundary between free and paid labor becomes blurry and the value of meritocracy makes gender invisible among knowledge workers.

By looking at the establishment and activities of the Ada Initiative, this chapter aims to unpack gendered labor relations in FOSS development and examine how they led to a new form of feminist labor movement. This chapter consists of three sections. First, I will introduce the Noirin Shirley incident that served as the driver of the Ada Initiative's launch, as well as its implications for gender issues in FOSS communities. The second section addresses the strategies that the Ada Initiative takes to resolve gender issues in FOSS culture and how they reflect labor conditions in FOSS development. Finally, I will discuss how the Ada Initiative shapes an

emerging feminist labor movement in the knowledge industry.

The Noirin Shirley – Florian Leibert Incident

In November 2010, Noirin Shirley, prominent member of the Apache Software Foundation (ASF),[3] wrote a blog post on her experience of sexual harassment at ApacheCon North America 2010. ApacheCon is an annual conference held in both North America and Europe to stimulate innovation and collaboration among Apache developers and users. In 2010, Shirley was on the board of ASF. Because of Shirley's position as a widely known public figure in the community, she anticipated that her public disclosure of sexual harassment would draw attention from people in the Apache world. On the last day of the annual conference, Shirley wrote about details of the incident, including what she wore, how she behaved, how the suspect assaulted her, how she reacted to the suspect at the moment of the harassment, and what procedures she went through on the following day. An excerpt of the post is worth quoting although it is somewhat lengthy. What she described shows that she did not intend to appear to be a naïve woman victimizing herself; rather, she tried to explain the context of the night in an objective and straightforward manner:

> He brought me into the snug, and sat up on a stool. He grabbed me, pulled me in to him, and kissed me. I tried to push him off, and told him I wasn't interested (I may have been less eloquent, but I don't think I was less clear). He responded by jamming his hand into

[3] The ASF is a US non-profit organization that supports Apache software projects which are FOSS-based. The Apache HTTP Server is the foundation's best-known project, initiated to "provide a secure, efficient and extensible server that provides HTTP service in sync with the current HTTP standards" (apache.org). As of June 2013, about 200 projects were listed on the foundation's website. ASF promotes FOSS development by offering "organizational, legal, and financial support" for these projects.

my underwear and fumbling.

> I had a few drinks. I was wearing a skirt of such a length that I had cycling shorts on under it to make me feel more comfortable getting up on stage and dancing. I had been flirting with a couple of other boys at the party (Shirley, 2010).

Shirley's intent was to make it clear that what she wore and how she behaved are independent from the harassment incident; she stated, "I don't give the wrong impression, and it's simply not true that guys can't read me right. I don't want to be assaulted, and the vast majority of guys read that just fine" (Shirley, 2010). In response to her post, many of the commenters were supportive. Some expressed sympathy for her, recounting their own stories of sexual assault and rape. Others appreciated her courage to speak out and name the suspect despite an anticipated backlash. A fair number of the commenters accused the person who assaulted Shirley of being unable to behave with the minimum respect and civility.

Comments that blamed Shirley's behavior on the night of the incident and her following actions were made as often as comments that supported her. From the outset, considering a long-standing custom of victim-blaming in rape and sexual harassment incidents, Shirley's public announcement of the incident involved some risk. Often, the comments were aligned with the deep-rooted rape discourses that discipline a women's body and normalize men's impulsivity. Shirley's behavior was read as "encouraging it" if not "asking for it" (Kalib, 2010). In a similar sense, Shirley was advised to "stop waving [her] tail" (Coz, 2010) because she did not take preventive actions even though she had experienced sexual harassment before. Furthermore, she was criticized for not offering evidence concerning the incident via claims that the harassment was based on her subjective perception and writing in a "melodramatic and novelistic" (Jason, 2010) way.

In addition to judgments of Shirley's behavior in the incident, there was an accusation against her for publicly disclosing the suspect's name. While a few commenters were concerned that Shirley's decision to name the suspect may count against her in possible legal procedures, others subtly implied that Shirley falsely accused an innocent man, destroying his future career and personal life. Moreover, some of the commenters cast doubt on the seriousness of the incident and the genuineness of Shirley's statement, pointing out that she did not report the case to the police and instead wrote a blog post. But, in fact, Shirley contacted the police after the incident and clarified that by adding acknowledgments to the police to her original post.

Gender was not necessarily the factor that created polemic interpretations of the incident. It was impossible to track the gender of all commenters since some responded anonymously. However, based on responses that gave clues to the commenters' gender, women also levied a wide range of criticisms about public disclosure of the suspect's name and legal validity of the accusation. At times, even *ad hominem* remarks were made without providing justification for the criticism. Plus, it was clear that male commenters encouraged Shirley as much as the females did, and self-reflexivity as males working in technology fields was embedded in some of the remarks.

Equal Opportunity Unprotected

Although Shirley did not use the term "sexual harassment," what she described is considered to be a sexual harassment incident or a sexual harassment claim from a layperson's perspective. However, the incident is beyond the scope of sexual harassment in a legal sense. Sexual harassment is a type of discrimination on the basis of gender which is prohibited by Title VII of the Civil Rights Act of 1964. Contrary to the widespread belief that sexual harassment encompasses unwanted sexual advances, remarks, and behaviors, it is a violation that occurs in

employment practices. What Noirin Shirley experienced, rather, is categorized as street harassment, a term that refers to unwanted invasive remarks and actions by strangers in public places (Ramakrishnan, 2010).

Two important points should be made in regard to the scope of Title VII of the Civil Rights Act and the Shirley incident. First, the current legal system is not sufficiently inclusive to cover the flexibility of workplaces in the knowledge industry. For knowledge workers, a workplace is not necessarily a fixed location, but can be multiple locations that are either directly or indirectly related with the work conducted. In particular, technology conferences are venues specifically designed and organized to facilitate exchanges of sources that benefit the industry. Attending technology conferences is highly encouraged, if not necessary, for FOSS developers to learn new technological advancements, market their services/products, expand their career opportunities, and network with people. While there are FOSS conferences that are free of charge or have low registration fees, some conferences charge from several hundred dollars to more than 2,000 dollars, including training and other additional benefits. Furthermore, going to a conference involves spending on travel to and lodging in midsize or large cities. This considerable cost implies that employers often financially support their employees' attendance at a conference as an investment or an extension of work.

Shirley's presence at the conference was certainly a part of her work as someone invested in FOSS development. The fact that the incident occurred at a pub makes the context of the event as work-relevant uncertain. In fact, one of the debates among the commenters to Shirley's blog post was over the status of the after-conference party where she was harassed; the commenters questioned whether it was part of the conference. Based on my experiences at FOSS conferences, parties are an integral part of the whole conference organization. It is common for the organizer

to hold an official party, providing free drink tickets to registered attendees. In addition to an official party, organizers also hold smaller parties, inviting individuals with similar interests so that people can network. These parties are advertised as if an individual, when not attending, misses opportunities for both enjoyment and career advancement. In this sense, the nuanced argument about Shirley's experience being irrelevant to the conference is not convincing.

Even if Shirley had been assaulted at a conference venue during the official conference schedule, it would not make a difference to Shirley's legal rights or the suspect's legal accountability. Both a conference venue and the pub are classified as public places, and the legal force that can be imposed on harassers remains the same for both. A general assumption among the commenters to Shirley's post was that the police and the legal system would readily intervene in the incident to the extent that Shirley's description held true. However, the real practice tells a different story. Ramakrishnan (2011) pinpointed a legal loophole by saying, "Notwithstanding the numerous harms that women face as a result of street harassment, such harms do not fit neatly within any civil or criminal causes of action" (p. 321). Furthermore, because of the prevalence of street harassment, a victim should be able to prove that the harassment's impact "rises above the ordinary annoyances" (Bowman, 1993, p. 534) and "constitutes exceptional, unreasonable, or outrageous behavior" (Ramakrishnan, 2011, p. 322) in order to seek redress. Whether supporting Shirley or not, there was a consensus among the commenters that what she went through is not uncommon. Thus, it is predictable that Shirley's case is not likely to be addressed in court.

The other point is that knowledge workers, especially FOSS developers, often work in an environment where they are not regarded as employees eligible for legal claims. Shirley served as a member of the Apache Foundation board of directors as well as an organizer of the

conference. In the meantime, she also worked as a technical writer for Google. Not only Shirley but also many other FOSS developers tend to be involved in several FOSS/non-FOSS projects and organizations through different forms of employment and volunteer work. That is, the traditional full-time employment model is not common among FOSS developers, and this is an anticipated employment condition that would be applied to an increasing proportion of the information technology (IT) industry (Market Wire, 2009). This non-traditional employment model makes it difficult for a victim to claim employer accountability. Title VII of the Civil Rights Act reads:

> The term "employer" means a person engaged in an industry affecting commerce who has fifteen or more employees for each working day in each of twenty or more calendar weeks in the current or preceding calendar year, and any agent of such a person…

When this definition is used, entrepreneurs who rely on contingent professionals are likely to evade responsibility for taking action to prevent and end discrimination since contingent or flexible workers are often categorized as independent contractors. Considering that numerous small ventures rise and fall rapidly, it is reasonable to suppose that knowledge laborers who do not work as employees under the rules of common law are vulnerable to unfair treatment in worksites.

The current legal system fails to protect the rights of knowledge laborers and other members of the labor force with similar working conditions. The legal system does not reflect the reality that knowledge workers constantly train and retrain themselves outside of the workplace, and they maintain, promote, and negotiate their career positions through off-the-job networking. Neither is the legal system attentive to the status of contingent and flexible laborers, whose numbers are continuously increasing.

FOSS Community as a Tribe of Men

As mentioned earlier, Shirley's disclosure of the suspect's name resulted in controversy among the commenters. Some thanked her for the disclosure since it could prevent other women from being assaulted by the same person. However, others bitterly accused her of naming the suspect without any witnesses or evidence. Several commenters pointed out that the public disclosure would not provoke a controversy if the incident were another type of crime, such as theft or robbery. The widespread victim-blaming culture in sex crimes adds weight to this argument.

While claims of sexual harassment often trigger people's hostile reactions because of prevalent myths and misconceptions about sexual harassment, they are not the only reason that gave rise to some commenters' criticism of Shirley. The characteristic of FOSS developers as a group of closely interconnected people also elicits defensive reactions when someone is accused. The metaphor of the tribe is sometimes used to refer to a group of contributors to a specific FOSS project or the FOSS developer group in general, and it signifies the cohesiveness among the members (e.g., Basset, 2005; Rusovan, Lawford, & Parnas, 2005). Given the intimately constructed relationships among FOSS contributors, it is less acceptable to accuse a fellow contributor.

Blogs, technology-related forums, and mailing lists are the primary tools used to connect FOSS contributors. Shirley's blog post was soon linked to technology-related websites such as TechCrunch, Reddit, and Gawker, and hundreds of readers commented to the posts. Furthermore, individual bloggers covered the issue on their own blogs; just as one of Shirley's critics was appalled at the disclosure of the suspect's name on a publicly accessible blog "[i]n the most blog-happy community on the internet" (Jason, 2010), numerous bloggers excitingly, or sometimes

cautiously, voiced a variety of opinions. The fact that Shirley and the suspect worked for companies with overlapping business areas—Google and Twitter, respectively—further stimulated their interest. Needless to say, the story spread through tweeting and retweeting.

Even though FOSS communities are scattered in a geographic sense, they build close relationships through Internet communication. In this male-dominated network, female developers are under pressure not to disturb the male cohesiveness. In the long list of sexual harassment incidents posted on Geek Feminism Wiki, there had been no incident in which an individual contributor publicly accused another individual in the communities until Shirley's case was posted. Most of the incidents were categorized into (a) sexually assaulting remarks or behaviors with witnesses and evidence, (b) gender-based violence toward more than one individual, and (c) presentations and releases of products with sexist connotations. Noirin Shirley's incident was the first time a female contributor had identified a suspect of sexual assault as an individual. However, the type of sexual harassment Shirley described is not rare in FOSS communities. Personal accounts of sexual harassment experiences at conferences are easily located on female FOSS developers' blogs, and responses narrating similar incidents often follow. However, the victims leave the harassers unnamed, and backlash from the communities would be an important reason for their discretion.

Reactions to FOSS community leaders' sexist remarks also reveal how difficult it would be for both female and male contributors to address the issue of sexism when a strong sense of loyalty and cohesiveness exists among contributors. In 2009, two well-known FOSS leaders, Richard Stallman and Mark Shuttleworth, made sexist remarks while they were giving keynote speeches at international conferences. Stallman used the metaphor of "virgin" and "virginity" to describe women who are new to Emacs, a text editor (Byfield, 2009), and Shuttleworth

mentioned that Linux work is "hard to explain to girls" (Skud, 2009a). Not only did both of them denigrate women's contribution to FOSS development, but also their word choices were problematic. It took from several months to a year for these two male leaders to issue public apologies.

A well-known public figure's sexist remark at a public event will attract a great deal of media attention. However, FOSS special journalists' reactions to Stallman's remark were lukewarm. Bruce Byfield (2009), a journalist specializing in FOSS, well explained the reason, saying, "You can understand why journalists are reluctant to report on the matter. Who wants to be accused of attacking the founder of the free software movement? Nor am I any exception." Byfield's remark shows that Stallman became a cult figure in FOSS communities whom no one would dare think of criticizing. Group cohesiveness surrounding Stallman was shown in other cases as well. When Lefty, a male FOSS contributor, wrote a blog post about email exchanges between him and Stallman regarding his requests for an apology and Stallman's refusal (Lefty, 2009), some of the commenters condemned the blogger for making the email content public. Observing the debate, another male blogger left a short commentary:

> [W]hat's equally unsettling [along with Stallman's evasive, bizarre, and unpleasant response] is the tone of some of the comments on this post. Who are these people? Do blog posts like this just bring out the worst commenters, or is this representative? They seem much more concerned about Richard Stallman's right to email privacy than appropriate conduct at a technical conference that both men and women are attending (Styx, 2009).

In addition to comments wandering off the point, some commenters made excuses on behalf of Stallman, arguing that Stallman's remark was humorous and not intended to be sexist. This was

not only the case for Stallman, but for Shuttleworth as well. At times, support for these leaders was expressed to a level of absurdity. When Geek Feminism Blog publicized a lengthy post about FOSS contributors' evaluations of Shuttleworth's remark, a commenter defended him for reasons of "jet leg," "end of the day low blood sugar," or "a couple of neurons" that stopped functioning (Jef, 2009). The strong support for FOSS leaders and contributors led victims of sexual harassment to refrain from creating any issues that led to flame wars.[4]

Individualized Problem-Solving

In their communities, female FOSS contributors who are exposed to gender-based discrimination often are placed in situations where they need to handle the issue without support. The case of MikeeUSA is an example illustrating the burden that individuals carry when they encounter sexist behaviors. MikeeUSA is a pseudonym of a self-identified man as well as a former Debian contributor who has made sexist and violent remarks to female FOSS contributors in the form of his own blog posts, responses to female contributors' blogs, and personal emails since 2005. His verbal attacks against women's rights and the feminist movement are pale in comparison to the death threats he has made to individual female contributors. *PSA: MikeeUSA's Hate Speech and Harassment*, a post on Geek Feminism Blog, was the first case in which MikeeUSA's violent remarks were publicly released. Skud, the writer of the post, explains why his case is not widely known despite the seriousness of his violence:

> While some of the women who received his emails shared them with others and banded together to deal with the problem, others thought they were his only target, and deleted his emails and did not initially let anyone know about them.
>
> This is completely understandable—our first reaction, and the traditional wisdom

[4] A flame war refers to a heated argument on online forums. Individuals involved in a flame war often make derogatory remarks that are off topic to the topic, resulting in unconstructive discussion.

> of how to deal with trolls, is to ignore them and hope they go away. But the effect on each of us, when we try to deal with this stuff alone, is to make us feel isolated, afraid, and impotent (Skud, 2009b).

Skud's description of how female contributors feel in the face of unanticipated violence is grounded in her own experience of being the target of sexist attacks. After Skud gave a keynote speech about women's experiences in FOSS communities at OSCON 2009, she suffered from hundreds of messages that denigrated her. Also, the conference organizer and Skud's employer had to cope with the aftermath of the talk. This experience led Skud to initiate the Geek Feminism Blog in 2009 in which a group of contributors and interested individuals discuss gender issues on STEM fields in a constructive manner (Skud, 2011).

Even before the launch of the Geek Feminism Blog, some groups to support female contributors and foster diversity had been formed, including LinuxChix, Debian Women, and Ubuntu Women. These groups are invaluable resources for both current and prospective female contributors to form networks, share information, and find encouragement. However, when it comes to gender-based discrimination, how effective these organizations are in addressing those issues is somewhat suspect. For instance, Ubuntu Women, which is a relatively active community both online and offline, focuses its activities on career development, introduction to achieving female contributors, and presentation of innovative work by women. In other words, empowerment and self-development are the keywords in the community. While it is undeniable that the existence of women-centered communities itself is encouraging, emphases on individualized empowerment and self-development may prevent these communities from challenging the systematic discriminations found in FOSS.

It should be noted that women-centered communities in FOSS development would face

considerable difficulties if they were to address any structural gender issues. As will be discussed in chapter 4, a common assumption is that sexism does not or cannot exist in FOSS communities. Even if the existence of sexism is admitted, the need to improve the working conditions in FOSS communities is often denied. Given that there is a lack of understanding that the scarcity of women in FOSS communities is a systemic issue, it is not easy to speak out against sexism. LinuxChix, the first community for women in FOSS development, has been criticized for offering special treatment for women and diverting contributors' attention away from technological elements. Furthermore, female contributors often have a close affinity with the fellow male contributors whom they work with, which leads to hesitation in overtly criticizing sexism in their own communities.

The Geek Feminism Blog was the first collective to discuss gender issues in so-called geekdom beyond the scope of a specific institution. While the blog does not limit its areas of discussion to FOSS communities, many of the contributors are involved in various FOSS projects. The Geek Feminism Blog along with its affiliated wiki, Geek Feminism Wiki, has endeavored to record women-related issues and raise diversity awareness in geek cultures. It has succeeded in that it offers invaluable references for coping with gender-related issues in geek communities and has initiated constructive discussions regarding structural gender issues. However, direct interventions in discriminatory practices have been beyond the scope of the Geek Feminism Blog because it addresses the issues of the relationship between gender and geek communities only at the discursive level. It is this context within which the Ada Initiative was launched to provide solutions that would bring actual changes to FOSS women's experiences beyond the discursive level.

Activities of the Ada Initiative

Valerie Aurora quit her job as a kernel developer at Red Hat soon after Noirin Shirley's sexual harassment incident at ApacheCon and launched the Ada Initiative in 2011. Although she did not explain in detail, Aurora specified that incident as the motivation that drove her to commit to feminist activism earlier than she planned. She stated, "[A] friend was groped at an open source conference—and then attacked for blogging about it. Within three days, I realized that I had to start working on women in open source now, not later" (Aurora, 2010b). While their friendship could have been a strong motive, it seems that Aurora felt urgency because of the attack directed at a victim.

Among the Ada Initiative's various activities, the campaign to help conference organizers adopt anti-harassment policies is most notable. While there has been animosity toward the campaign, it has attained considerable success, resulting in more than 100 conferences adopting a policy within three years (adainitiative.org). In addition to the anti-harassment policy campaign, the Ada Initiative has closely worked with FOSS organizations, advising them to evaluate the gender sensitivity of their employment practices. Furthermore, the Ada Initiative has undertaken outreach work aimed at women in FOSS technology and culture by speaking at numerous events and conferences and setting up the AdaCamp, "an unconference for people interested in supporting women in open technology and culture" (adainitiative.org). This section discusses three activities of the Ada Initiative to show how the organization has addressed the gender issues manifested in Shirley's harassment incident.

Conference Anti-Harassment Policy: Intervention in Employment Practices

The conference anti-harassment policy campaign began in November 2010, driven by Valerie Aurora and other FOSS culture and technology conference organizers (Aurora, 2010a).

Noirin Shirley's incident fueled this campaign. The fact that there were no appropriate measures to address Shirley's case drove Aurora to initiate the campaign even before the Ada Initiative was officially launched. In late November 2010, an example of a conference anti-harassment policy became publicly available so that conference organizers did not have to write their own from scratch (Aurora, 2010a). The scope of the example was comprehensive as well as detailed enough to help conference attendees get a clear idea of how they were expected to behave. Furthermore, it also provided conference organizers with practical guidelines on what actions they should take in various circumstances.

The conference anti-harassment policy campaign was a notable success. Not only FOSS conferences but also conferences related to general geek culture adopted an anti-harassment policy either voluntarily or at the request of attendees. No numerical data are available to indicate how the policy positively affected the conference ambience. However, a policy clearly publicized and strictly enforced seems to be effective in addressing harassment issues at FOSS conferences. When I attended Wikimania 2012, the conference coordinator asked attendees to comply with the conference's Friendly Space Policy at the opening plenary. On the second day of the conference, a presenter had "two sexual images" (Bashour, 2012b) in the presentation, and the conference organizing committee soon knew about the incident. On the same day, a discussion session took place with the presence of the presenter, attendees, and the conference organizing committee. The goal of the session was not to accuse the presenter, but to have conversations about how the incident was received by different attendees. Based on a brief description of the session, both criticism of the incident and concern about censorship coexisted (Bashour, 2012b).

It should be noted that the Wikimania organizing committee made the incident a matter

for all attendees rather than the few people who were vocal about it. At the closing plenary that was held a day after the incident, the conference coordinator reported what had happened and how it had been handled. The virtue of Wikipedia culture, which is prompt documentation of almost everything, stood out even on this occasion. The description of the incident and the conference organizers' following actions were linked to the Wikimania 2012 official wiki. The name of the presenter was kept confidential and no harsh penalties were assessed. However, the incident was reported to more than a thousand attendees as a violation of the conference policy. This case stands in striking contrast to the Richard Stallman and Mark Shuttleworth cases, which lingered for a few months and resulted in a lukewarm apology.

The rationale behind the conference anti-harassment policy was not to merely create a friendly atmosphere at the conference for the attendees. At a fundamental level, there was a realization that conferences are a good venue for job searches in the world of computer professionals. In 2012, Valerie Aurora updated a lengthy post to the Ada Initiative blog to address the harassment issue at DEFCON, one of the world's largest annual hacker conferences. Under the subsection "Why Harassment Matters," Aurora stated, "I'll start with the most obvious benefits of attending DEFCON: jobs. Did you know that Twitter is recruiting computer security experts at DEFCON? So are Zynga and the NSA" (Aurora, 2012b). To further explain, she introduced her own experiences of attending the conference even before she entered into college and learning new materials by subscribing to the conference mailing list and reading related magazines. She continued to state, "Giving the right talk at DEFCON can make your entire career and net you dozens of offers for jobs, contracts, and book deals."

FOSS conferences are also where career opportunities are provided. Andy Lester (2012), software engineer as well as a writer who is heavily invested in FOSS, once wrote about the

effective ways for a FOSS contributor to get a job and mentioned that "[n]etworking and personal contacts are the most productive source of leads in [one's] job search." Giving presentations, joining birds of a feather (BOFs),[5] and participating in hackathons[6] are some of the common channels through which attendees advertise themselves and network with other contributors. As FOSS became an established way of software development with an increasing number of paid positions available, the stereotypical image of a FOSS developer as someone who collaborates with other contributors online and expresses self only in the form of coding no longer accurately represents many of the contributors.

FOSS conferences as a tool for career opportunities have also been seen in the recent trend of self-development, or career sessions. When I attended Ohio Linuxfest 2012, one of the tracks was dedicated to career development, mostly organized by hiring companies. The description of the track read, "Please join us at our first Career Track, a way to meet with with [*sic*] hiring companies, who will share information about their culture, organization, and open positions, as well as hear about improving and managing your career and job search" (http://www.ohiolinux.org/). Ohio Linuxfest's decision to include this track clearly indicates that career opportunities do not necessarily come from informal hallway conversations or hiring companies waiting for potential employees to come to their booths; rather, recruiters, especially from small or medium-sized companies, actively use offline venues to hire talented workers.

The Ada Initiative's campaign for a conference anti-harassment policy is an intervention in employment practices for FOSS in the given context where a significant proportion of FOSS

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[5] BOF sessions refer to informal meetings among conference attendees interested in particular subjects.

[6] A hackathon is an event in which programmers and other interested individuals intensively work on software projects in a short period of time. A hackathon is held either independently or as part of a conference.

has transitioned from free labor to paid labor. This intervention in employment practices is subtle and less obvious as the Ada Initiative does not foreground the implication of conference anti-harassment policies in gendered labor relations in FOSS development. Whenever the issue of imbalanced gender ratio in FOSS communities arises, the contributors who are against affirmative action or positive discrimination often vigorously attack an argument for gender diversity. The rationale behind this is that participation in FOSS development is entirely a matter of free choice and women should not be forced to do what they do not like. It is predictable that the conference harassment policy would face strenuous objections when its role in encouraging equal career opportunities for female contributors is emphasized. Rather, the Ada Initiative implicitly works toward equal employment opportunities for women and other marginalized race/ethnic groups by appealing for the basic rights of conference attendees.

Male Allies Workshop: Dismantling the Male-Centered FOSS Tribe

Allies workshop is another main activity that the Ada Initiative has created since its launch. The Ada Initiative defines allies as "people who may or may not be women in open technology and culture" (http://adainitiative.org) but who are willing to support female contributors in their communities. Matthew Garrett, Linux kernel developer, and Matt Zimmerman, Linux distribution developer, are male allies well-known for their public condemnation of sexist practices in FOSS communities. The Ada Initiative offers in-person allies workshops for groups based in either San Francisco or Sydney, where each co-founder resides. The entire curriculum is publicly available to reuse or adopt in the spirit of FOSS. The Ada Initiative explains the purpose of this workshop as follows:

> People often respond much more positively to men advocating for women than women themselves. If, as a man, you are worried about being attacked for advocating for women,

> don't predict the responses based on how you see people react to women. Men will still face criticism, but are also quite likely to be praised, thanked, and respected ("Allies workshop," n.d.).

Whether male allies are praised or criticized seems to depend heavily on the context of each individual and case. One of my interviewees, who actively works to foster diversity as a male developer, made it clear that his participation in various diversity awareness activities had not changed other male developers' views of him. However, when Ted Ts'o, who is the so-called "Linux lieutenant" (Moody, 2002, p. 175) because of his commitment to Linux, argued that many women make false rape claims, the situation was very different. After his argument on false rape circulated through a mailing list, Matthew Garrett wrote a blog post criticizing Ts'o for being a rape apologist (Garrett, 2012). More than 200 comments were made to Garrett's post; a considerable number of the commenters supported Ts'o, and Garrett deleted most of the comments, suggesting that the comments were not appropriate to be viewed by the public. Possibly, Linux contributors' respect for Ts'o would have sparked the flame war on Garrett's blog along with the prevalent rape apologetics in society in general.

Although male allies are not free from attacks, their existence has positive effects on gender relations in FOSS communities. The Ada Initiative encourages male allies to be aware of the privileges they have by just being a male. To give male allies a practical guideline, Geek Feminism Wiki offers the *Open Source Male Privilege Checklist*, which lists what may appear to be norms or non-issues from a male contributor's perspective but discriminatory or even hostile to women. This approach to male allies makes it clear that the organization does not simply seek ad hoc solutions to gender issues. When a physical sexual harassment incident occurs, one of the most frequent responses from males is "I wish I could be there and punch him." Mary Gardiner

(2010) once warned against this type of response because it can disguise the fundamental issue in FOSS communities, which is the ignorance of structural sexism among contributors. The Ada Initiative, instead, calls for male allies' self-reflection and constant self-learning.

The most important effect of male allies is that they can challenge the closely tied tribal culture among male developers. As I will discuss in chapter 4, FOSS contributors have constructed their identities by contrasting themselves to proprietary software developers. The scarcity of women in FOSS is interpreted as an indication that women are materialistic beings like proprietary software developers who work for monetary values. However, the existence of female contributors is undeniable, and it requires male developers to rationalize this reality. A frequent way to rationalize this is by treating female contributors like honorary guys—in other words, one of the boys. Even if the majority of male contributors does not hold the presumption that women are materialists, this is the argument used by male contributors who are vocal about normalizing the gender imbalance in FOSS communities.

The male-centered FOSS tribal mentality is difficult for female developers to challenge since they are regarded as either honorary guys or Others. Female developers are often placed into a situation where they conform to the norms of male developers to prove their legitimacy. This is more likely to bolster the tribal culture since women themselves appear to deligitimize other women's experiences. However, when male developers distance themselves from a certain group of male developers and show sympathy with women, the sturdy boundary between male FOSS developers and female non-FOSS developers become blurry. That is, encouraging male developers to be allies brings the potential to dismantle the male tribe from within rather than through external forces.

Public Presentation: Myth Busters

As implied in Aurora's motive for launching the Ada Initiative, she was concerned about individual female contributors who need to deal with sexist and discriminatory treatment by themselves. Individual contributors often had to be silent to such degrading treatment, believing that it was a personal matter and the best and fastest way to solve the issue was to leave it behind. When they decided to become vocal, they became the targets of massive attacks. At times, employers of those vocal contributors were exposed to criticism as well for hiring such women and thereafter threatened to fire them. The fact that there was no organized body of FOSS contributors prevented gender issues from being addressed in a systematic manner.

The Ada Initiative began to serve as a representative of and resource for female contributors. On the one hand, the co-founders specified concrete actions that FOSS communities should take, such as gender-sensitive recruitment, anti-harassment policies, and child-care service at conferences. This type of recommendation is aligned with women's labor movements, which demanded that employers ensure equal opportunities and facilitate women friendly working environments. On the other hand, the co-founders endeavored to challenge the discourses about diversity in FOSS communities by explaining how discriminatory practices in the communities contradict the values they believe they foster. Dismantling those discourses is often attempted through talks at various events and conferences since public discussions are easily extended to a wider audience via tweets, blogs, news articles, and online forums. Mary Gardiner's keynote address at Wikimania 2012, without provoking flame wars, responded to the skepticism regarding fostering diversity among FOSS contributors in a subtle manner.

Gardiner effectively addressed three issues in her keynote speech. First, there had been a backlash against the claim for gender equality in FOSS communities because diversity does not

necessarily serve to increase the quality of FOSS products. This criticism is rooted in the belief that meritocracy does work as the governing rule of FOSS development and that the most qualified contributors are developing FOSS products. In response to this, Mary Gardiner explained what she termed "instrumental diversity," a view that sees diversity as a tool for business and public relations. In other words, those who foster instrumental diversity would argue that a diverse developer pool results in a wider user base since a product made by contributors from various backgrounds has better representativeness. Also, supporting diversity to improve a company's image is another example of instrumental diversity. In fact, diversity advocates in FOSS communities are often instrumental diversity advocates because this is one way in which diversity can be supported while causing fewer conflicts.

Mary Gardiner, although not entirely arguing against instrumental diversity, pointed out that "it's not fair to the people you are asking to give to you." She continues to introduce the phrase "nothing about us without us" to emphasize that the interests of diverse developers should be taken into consideration for reciprocal exchanges between those who benefit from diversity and those who offer diverse insights as resources. Gardiner's framing of diversity is fairly different from the one in the past. While advocates have somewhat begged for diversity to be valued in FOSS communities, Gardiner reversed the framing.

Second, Gardiner challenged the idea that women participate less in FOSS development since they pursued monetary values rather than moral values by introducing the GNOME Women's Outreach Project. This project was modeled after the Google Summer of Code to offer less-experienced female developers the opportunity to contribute to GNOME. While the Google Summer of Code failed to attract any female applicants, the GNOME Women's Outreach Project appealed to a considerable number of women although the stipend was less than that of Google

Summer of Code . Gardiner emphasized that women would be involved in FOSS development when they feel that they are desired.

Finally, Gardiner implicitly problematized the naïve belief that taking gender-neutral stances means having gender sensitivity. As will be further discussed in chapter 4, some contributors tend to believe that participation in FOSS development is equal to everyone as far as there are no explicit practices of sexism. Furthermore, any events, groups, or recruitment practices that encourage women to join through a special emphasis are condemned as affirmative action or positive discrimination. However, Gardiner indicated that gender-neutral words in the invitation are still more likely to attract male contributors since our default image of a developer is a male. To the contrary, language that targets women would send a message that women are welcome to join.

New Feminist Labor Movement

While the Ada Initiative does not define itself as a labor movement, it is closely related to the past actions of feminist labor movements and women's labor organizations. In particular, campaigns for an anti-harassment policy, equal opportunities, and child-care facilities at FOSS events are an extension of the most salient features of women's labor movements in the 1970s and 1980s, which were rooted in second-wave feminist movements. However, the type of labor in FOSS development differs from the labor of the past in that there is no clear boundary between free labor and paid labor. While most FOSS contributors begin in development as free laborers, they are often hired as paid laborers as they gain experience. In this sense, FOSS development is not entirely free labor but takes a transient position between free and paid labor. This characteristic of FOSS development differentiates the Ada Initiative from the previous

feminist labor movement. In this section, I will uncover three characteristics of a new kind of feminist labor movement that the Ada Initiative represents.

Voluntary Change

While the previous women's labor movements urged employers to treat female employees fairly on the basis of legal measures, the Ada Initiative promotes voluntary shifts by contributors themselves. Three main factors of FOSS communities explain this difference. First, problem-solving is a keyword that represents the nature of FOSS developers, and gender inequality is a problem that needs to be solved by FOSS contributors themselves not by external forces. Second, the workplaces for FOSS developers are often beyond the scope of legal protection. Conferences, local events, and online forums where FOSS contributors actively participate are not regarded as workplaces even though activities in these places are heavily work-related. Third, legal measures are not effective in most cases of subtle discriminatory treatment, which is frequently observed in FOSS communities. The government's recent efforts to facilitate better working environments for women reveal why the interventions cannot work well in the context of FOSS communities and other similar working environments.

In 2011, the National Science Foundation (NSF) launched a new initiative that helps postdoctoral fellows and early-career faculty members strike a work-life balance. The initiative focuses on parental leave and postponement/extension of a grant period. While the intention comes from goodwill, NSF's initiative was very limited. First, while the initiative is inclusive of postdoctoral fellows, they are less likely to take parental leave or apply for postponement/extension of a grant period since they are hired on a one- to few-years contract basis. Under this unstable condition, it is not tenable to discontinue work. In recent years, contract-based employment has been applied not only to postdoctoral fellows but also to faculty

members to a greater degree than before. In this regard, NSF's initiative is not a good working model since it is inconsiderate of the reality of young academics.

Second, young female professionals in STEM fields do not necessarily want to take a long maternity leave to care for a newborn child. Especially in natural sciences, researchers are aware that their productivity does not last long, and they try to garner their achievements as early as possible. In this sense, female professionals prefer sharing the child-care responsibility with their partners or the institutions that they belong to through on-site child-care systems. Allowing parental leave for a longer period may seem helpful at the surface level, but the indication is that child-caring is still an individual woman's responsibility.

Finally, NSF did not consider the possible disadvantages for women after taking a maternity leave or postponement/extension of a grant period. When an employer or a grant-offering agency decides on an employee or grant recipient, someone's likelihood of taking a leave may affect the hiring party' decision. Also, it is possible that someone's history of career discontinuation would affect the person's chance of being promoted. That is, maternity leave or postponement/extension of a grant period is not a well-considered solution to female researchers' discontinuation of their careers in STEM fields.

It is difficult to find such efforts to facilitate better working environments for women in knowledge labor other than in higher education or large-scale companies in the knowledge industry. However, what the NSF envisioned for young female scholars does not reflect the instability of knowledge labor. The initiative might work well for female knowledge laborers in supportive and stable working environments with additional personal resources, but this case would be rare in the current labor market. Working conditions for FOSS female contributors are more fluid and unstable even compared to those for entry-level female researchers. Thus, it is

untenable for FOSS communities to rely on government-initiated policies or legal procedures. Furthermore, an NSF initiative type of solution is likely to be read as affirmative action, which has constantly sparked flame wars in FOSS communities. This women-centered approach does not serve well in either FOSS communities or other knowledge-based fields where meritocracy is highly valued. A women-centered approach also often fails to dismantle the culture that sustains a subtle discriminatory environment. For FOSS developers who like to act on logic, efforts without strong rationales are not welcomed.

Enforcement

Even if the Ada Initiative strives for the betterment of working conditions for women through FOSS-suitable strategies, still the matter of enforcement remains. Since one purpose of social movements is to make tangible changes in people's action, the Ada Initiative needs to pressure FOSS contributors to comply with the needs of the organization. The Ada Initiative encourages voluntary efforts from FOSS contributors since freedom is the most appreciated value among them. Once FOSS contributors decide to participate in making gender-sensitive environments with their own will, they are more likely to comply with their decision. The OSCON anti-harassment policy incident clearly shows the power of FOSS contributors' voluntary action in fostering safe FOSS environments. Right before the beginning of OSCON 2011, Noirin Shirley wrote a blog post concerning OSCON's failure to adopt a code of conduct at the conference, exposing the attendees to possible sexist, racist, and other discriminatory behaviors. She wrote:

> After I was assaulted last year, an awful lot of people pointed out that if I go into dangerous situations, I should expect bad things to happen, and that if I don't want bad things to happen, I shouldn't go into dangerous situations.

Her entire post plainly explained what she could have missed by not attending one of the biggest FOSS conferences and sought advice from readers on what would have been a better decision for her. After Shirley wrote the blog post, "a hectic few days" (Aurora, 2011) followed. Michael Schwern, a well-regarded Perl developer, took decisive action by withdrawing from two talks accepted at OSCON that year. Responding to Shirley's blog post, he stated, "Non-participation is the next step I'm taking. I've spoken at OSCON for over ten years. I will no longer be speaking at O'Reilly events until they have a policy." Although the tone was still gentle, Schwern's remark showed his mistrust of O'Reilly, the hosting organization of OSCON. He made it clear that ample resources are available on conference anti-harassment policies, and O'Reilly must have known the causes behind the anti-harassment policies.

Some speakers at the conference changed their profiles on the conference website to include a comment that they supported a code of conduct to be adopted by O'Reilly. Showing the characteristic of FOSS developers, they made a template profile and allowed others to copy and paste it. Valerie Aurora initiated a petition that asked O'Reilly to adopt a code of conduct at OSCON and other O'Reilly events, and dozens of FOSS contributors and other interested individuals signed the petition. Meanwhile, this informal campaign spread through tweets and blog posts. As Valerie Aurora noted, all these events occurred within "a hectic few days." It took only four days until Tim O'Reilly, the founder of O'Reilly Media, officially responded to these requests after Shirley's posting. The day before OSCON 2011, O'Reilly Radar released Tim O'Reilly's commentary saying that he had been attentive to fellow FOSS developers' concerns and would not condone any type of harassment at O'Reilly events. He continued to state that all the staff members would put effort into making the conference welcoming to all attendees.

Tim O'Reilly's response was insufficient in that he misunderstood the advocates'

arguments for an anti-harassment policy. While the Ada Initiative purposefully did not use the term "sexual harassment" to make it clear that everyone, regardless of their gender, can be exposed to harassment, Tim O'Reilly seemed to view women as potential victims and men as potential harassers. Furthermore, whereas the Ada Initiative emphasized the effect of the policy in preventing harassment as well as its role in dealing with after-the-matter issues, Tim O'Reilly said that he had not heard of specific cases of harassment at O'Reilly's events and that is why he was not convinced to adopt the policy. It appeared that he had not paid close attention to the anti-harassment policy campaign and offered an ad hoc solution in response to the stream of criticism from FOSS communities.

Apart from O'Reilly's insufficient answer, its immediate reaction to requests for a code of conduct is notable. Whereas the organization did not take individuals' criticisms seriously, it showed strong sensitivity to the group of anti-harassment policy advocates. While the Ada Initiative advised O'Reilly to recognize the harassment issues at conferences the day before the release of Tim O'Reilly's commentary, its role was limited on this occasion. Rather, the roles of individual contributors were more substantial, leading O'Reilly to endorse its commitment to safer and more welcoming conference environments. Since human capital is the most important resource in FOSS communities, O'Reilly could not afford losing its credibility. Although there was no legal enforcement, this type of voluntary action to foster diversity may have stronger power in FOSS communities.

Pseudo-Government

What the Ada Initiative has done regarding gender issues in FOSS communities often falls into the role of government and women's labor movements. As mentioned earlier, women's labor movements demanded that government intervene in employment practices by regulating

employers. However, the Ada Initiative encompasses both roles; on the one hand, the organization locates the gender issues prevalent in FOSS communities and examines the possible solutions and, on the other hand, it intervenes in the labor structure in the communities and produces visible outcomes.

For the Ada Initiative to conduct its activities, financial resources are necessary. As a non-profit organization, the Ada Initiative relies on donations and sponsorship for its operation. For-profit companies such as Google, Intel, and Microsoft have been major sponsors of the Ada Initiative along with non-profit organizations such as the Linux Foundation, Github, and Linux Australia. There are different ranks of sponsors, including Individual donors who donate within the limits of their financial resources, Bronze sponsors that donate from $1,000 up to $1,999, Venture Philanthropist sponsors that donate from $2,000 up to $9,999, and Major sponsors that donate more than $10,000. These sponsors are displayed on the Ada Initiative website during their year of sponsorship. Sponsors can use this public acknowledgment to advertise themselves as diversity sensitive although some sponsors are truly concerned about the gender imbalance in FOSS communities regardless of the advertisement effect.

While the Ada Initiative works toward the public good, the organization does not or cannot benefit from public financial resources. Instead, individual volunteerism and corporate benevolence are the major elements that make the Ada Initiative financially functional. A wide range of tech companies sponsors not only the Ada Initiative but also other organizations that work to foster diversity in FOSS communities. The sponsorship does not necessarily mean donating money; among the regular updates that I receive on events in support of women in the computing industry, many of the sponsors often provide meeting places, technological facilities, and food. Volunteers normally cover the labor force for events. Meetup, a social networking

service that facilitates offline networking among people with the same interests, lists numerous technology-related events propelled by individual volunteers and corporate sponsors.

Etsy's funding for women to attend Hacker School is a good example of solving gender issues in the computing field through volunteerism and corporate benevolence. In 2012, Etsy announced that the company would provide $5,000 grants to 10 women who would attend Hacker School, a three-month free programming training school based in New York City. The school can be operated free since "startups pay [them] to recruit" (www.hackerschhol.com). In opposition to traditional computer science education, the attendees of Hacker School write FOSS to make the code useful. As a company that supports mainly female small business owners, Etsy decided to reach out to female programmers, making the school appealing by hosting school sessions in its headquarters and covering expensive living costs. After this new attempt, Etsy excitingly reported the result:

> With help from all of you, Hacker School received applications from 661 women, nearly a 100-times increase from the previous session. (As they put it, they received more applications this time from women named Sarah than all applications from women for all previous sessions combined.) Hacker School has admitted 23 of those women for the summer program, exceeding our original goal by 3.

One of the roles of the Ada Initiative is to encourage individuals and organizations—either for-profit or non-profit—to solve the gender issues at stake by themselves like Etsy did. By adopting this new way to solve gendered labor issues, the Ada Initiative replaced the traditional role of the government in ensuring equal opportunities in workplaces.

Conclusion: Failures of the Public Sector

Noirin Shirley's case and the launch of the Ada Initiative suggest failure of the public sector in three aspects. First, the public sector failed to expand the scope of its policies to include employment practices in non-traditional, knowledge production work settings. This does not mean that the public policies have been successful in protecting the rights of laborers in other fields. Rather, I use the term failure in the sense that there is no proper category to refer to a FOSS-type of occupation, which crosses the boundary between hobby and work. In the knowledge industry, businesses often extract value from semi-skilled workers' free labor. The AOL Community Leader Program is a well-known example of such practices. The community leaders were responsible for providing services for AOL users and moderating the AOL environment by working as volunteers online. As the intensity of labor became greater and the reciprocal relationship between AOL and the volunteers no longer continued, some of the community leaders filed a class action lawsuit against AOL in 1999. It took 11 years for the lawsuit to be settled, which indicates the difficulties in drawing the boundary between labor and volunteer service. While utilization of free labor like the AOL case has become more normalized, there is no working guideline to define and protect the rights of those ambiguous laborers. The working status of female FOSS developers reveals that the public sector's reluctance to recognize changing labor relations makes the precarious workforce vulnerable.

Second, the public sector failed in that the laborers lost trust in it. Part of the reason why women's labor movements demanded that the government intervene in employment practices was because of their belief that their voices should be heard through their collective actions and democratic processes. The Civil Rights Act of 1964, the launch of the Equal

Employment Opportunity Commission (EEOC) in 1965, and the EEOC's decision to include sexual harassment as a form of sex discrimination in workplaces are examples showing that the government heard the voices of marginalized workers. However, since the early 1980s, the government's efforts to advance working conditions for disadvantaged populations have been rarely observed. Explaining voice as a value, Nick Couldry (p. 2010) stated that "treating voice as a value means discriminating against frameworks of social economic and political organization that deny or undermine voice, such as neoliberalism" (p. 2). The lack of voices from laborers since the Reagan era reflects the power of neoliberal politics that has made voices go unheard. The Ada Initiative's collaboration with businesses and organizations in the private sector reveals that the public sector is mistrusted and neglected as a mediating agent to solve labor issues.

Third, the public sector failed to play a role as social services provider, and the role has been transferred to the private sector. Google, which acts as the most benevolent business in FOSS communities, has also been a regular sponsor of the Ada Initiative. Although Google represents itself as concerned about labor issues by funding organizations like the Ada Initiative and providing decent child-care services, it is secretive about inside gender issues. *Mercury News*, a Silicon Valley-focused online magazine, fought for 18 months to get information on gender and race ratios from Google (Swift, 2010). Along with Apple, Yahoo, Oracle, and Applied Materials, Google won the fight because the information constituted a trade secret. How the Ada Initiative would spend the funding is a different matter from how insensitive Google is to the gender structure inside the company. However, global IT companies like Google and Yahoo are most influential in the IT labor market. When social services are provided by the private sector at the expense of giving large business an

exemption from accountability for its internal issues, corporate benevolence would not be sustainable in the long term.

The Ada Initiative is a type of women's labor organization that was enabled by the turn to neoliberalism and the failures of the public sector. The organization has been successful in problematizing the structural issues of gendered labor relations and generating tangible progress. The growth of the Ada Initiative should be called into play in that it has potential for having the voices of female knowledge workers heard and challenging neoliberal politics.

CHAPTER 3.

WOMEN DISAPPEARING FROM THE COMPUTING FIELD:

HISTORICIZING COMPUTING EDUCATION AND INDUSTRY IN THE 1980S

The beginning of FOSS development can be traced back to 1985 when Richard Stallman founded the Free Software Foundation (FSF). While Stallman had initiated the GNU project[7] as early as 1984 (Stallman, 2002), the project became more systematic with the launch of FSF. Furthermore, it was through FSF that the notion of free software and its associated philosophy circulated to a wider audience. However, six years passed before the well-known practice of FOSS development—software development by collaboration of numerous contributors on the web—emerged. Linus Torvalds released the first version of Linux in 1991 and its modifications and redistributions were followed with the massive participation of developers throughout the world (Moody, 2002). The commercialization of the Internet had not begun, but academic institutions and computing-related organizations provided access to the Internet, thereby helping people contribute to Linux development.

The years between the launch of FSF and the release of Linux were salient in FOSS history because those years laid the groundwork for FOSS development. The same period was critical to women in computing since this is when the percentage of women in the computing field dramatically dropped after two decades of steady progress. In the higher education setting, the percentage of female undergraduate students in computer science gradually increased after 1967 and peaked in 1984 (National Science Foundation, 2011). In part, women's entrance into

[7] Richard Stallman initiated the GNU project to develop a computer operating system consisting of free software. This is the first FOSS project with a publicly announced aim of giving users freedom. For detailed information on this project, refer to the first and second chapters of *Free Software, Free Society: Selected Essays of Richard M. Stallman* (2002).

computer science reflected the overall improvement in women's participation in higher education. The 2011 National Science Foundation (NSF) report noted that the percentage of bachelor's degrees awarded to women increased by 8% between 1966 and 1984. The mathematics and engineering fields, which had strong affinity with computer science, had better records during the same time span, growing by 11% and 15%, respectively. However, more than a 20% increase had not been seen in any STEM fields other than computer science (see Figure 1).

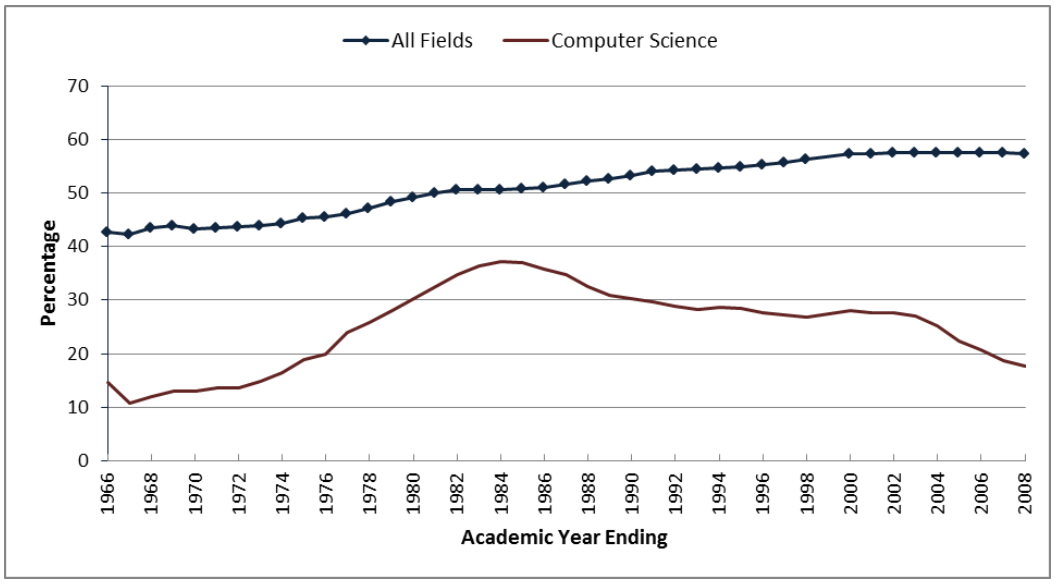
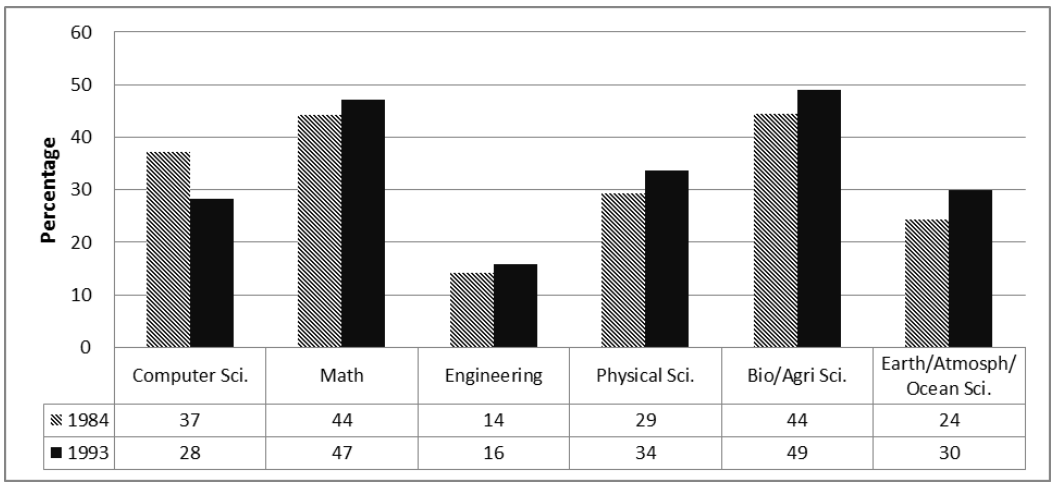


Figure 1. Percentage of female bachelor's degree recipients in all fields and computer science between 1966 and 2008. Adopted from *Science and Engineering Degrees: 1966-2008* by NSF, 2011.

As seen in Figure 1, the percentage of women who received bachelor's degrees in computer science began to decline in 1984. One might speculate that this is a mere drop in percentage, not in absolute numbers. This speculation proved to be true for 1985 and 1986, but the number fell from 1987 to 1994 as well. Across the STEM fields, the case of computer science was unusual. While the percentage of female computer science majors declined for 10 years after 1984, all other STEM disciplines showed gradual progress, growing by 3% in mathematics, 2%

in engineering, 5% in physical sciences, 5% in biological and agricultural sciences, and 6% in earth, atmospheric, and ocean sciences (NSF, 2011). Each discipline has its own history regarding women's status; thus, it would be unfair to make a direct comparison between computer science and other disciplines. However, this general trend in STEM fields disproves the prevailing assumption that women participated less in computer science because of their disinterest or incompetence in mathematics or science (see Figure 2).



	Computer Sci.	Math	Engineering	Physical Sci.	Bio/Agri Sci.	Earth/Atmosph/ Ocean Sci.
1984	37	44	14	29	44	24
1993	28	47	16	34	49	30

Figure 2. Changes in the percentage of female bachelor's degree recipients in STEM fields between 1984 and 1993. Adopted from *Science and Engineering Degrees: 1966-2008* by NSF, 2011.

The computing industry witnessed a similar path with higher education. Based on the Current Population Survey by the Bureau of Labor Statistics, Hayes (2010) found a strong correlation in the proportion of female bachelor's degree recipients and professionals.[8] In general, the proportion of women in the professional computing workforce corresponded to that of female computer science majors with a 3-year delay. That is, 1987 was the peak in the

[8] Caroline Hayes provided comprehensive analyses of quantitative data in regard to women's participation in the computing field based on the National Science Foundation and Bureau of Labor Statistics database. See "Computer Science: The Incredible Shrinking Woman" in *Gender Codes: Why Women Are Leaving Computing* (2010) for further information.

percentage of female computing professionals, which is 3 years after the percentage of female students in computer science had been at its highest. Since then, the percentage by and large declined until the mid-1990s. According to Hayes (2010), this correlation suggests that newer graduates, after some delay, would have replaced older professionals at a similar rate. Although this hypothesis is plausible, it does not explain why female students became less interested in majoring in computer science. As Hayes suggested, an investigation of social factors that affect women's major and career choice would offer more comprehensive views on the changes in the 1980s.

This chapter examines historical factors that influenced women's decline in the computing field after the 1980s to explain the reasons for the scarcity of women in FOSS development. The fact that FOSS communities have always been male-dominated was assumed by some of my interviewees as the reason for the lack of women. Others pointed out that the small proportion of women in the computing field in general would have inevitably led to women's limited involvement in FOSS development. While these arguments may be valid, they do not help to answer a fundamental question about the gendered construction of the computing field. Computer historians have demonstrated that there were no strong gendered connotations attached to programming in the early history of computing, disproving a widely held belief that computing has been always a male domain (e.g., Ensmenger, 2010; Light, 1999). Aligned with these efforts of computer historians, this chapter aims to write a part of computing history from a gender perspective.

The first section of this chapter begins with a short description of the debates over early computer science education to reveal uncertainties and ambiguities surrounding the discipline at its beginning. Following this description, I will explain three signs of the discipline's maturity in

the late 1970s and early 1980s, as well as the effects of the growth on women's participation in the computing field. The second section examines working conditions for women in the IT industry with an emphasis on the 1970s and 1980s context. This section looks at two main ways of working in the industry—independent contracting and employment—to offer a comprehensive understanding of female professionals' status in the field.

Constructing the Identity of Computer Science

Early Debate over Computer Science Education

While computer science is often considered a male domain, its gendered connotation was much less obvious in its early stage. Five decades ago, even the concept of computer science was scarcely known. Some universities were ahead of the curve in offering computing-related courses through mathematics and electrical engineering departments in the late 1950s (Gupta, 2007). However, the idea of computer science's value as a legitimate field of study in higher education was contested (Morse, 1960). Furthermore, many colleges and universities opened computing courses for the sake of having a computer in their institutes. IBM gave free or heavily discounted computers to universities with the proviso to provide computer courses so that the universities could produce a trained workforce to sell and use IBM computers (Fein, 1959). Louis Fein, an early advocate of computer science education, expressed his dismay at this circumstance by saying, "It is fair to say that, in many cases, to the extent that a university computer activity has a purpose at all, it has been made for them by IBM" (p. 9).

The efforts to designate computer science as a distinct discipline began in earnest during the early and mid-1960s. In 1962, Purdue University founded the first computer science department, and the Association for Computing Machinery formed the Curriculum Committee on

Computer Science (C^3S) (Gupta, 2007). There were two main rationales for establishing computer science as an independent field of study. First, in a theoretical sense, computer science was considered to be different from mathematics and electrical engineering although the difference was not clearly defined. Richard Hamming, who was trained as a mathematician and contributed to the computing field, evinced this attitude toward computer science. At a conference on the use of computers in engineering classrooms, he noted:

> You could not expect computing to be taught well by mathematicians. It is a separate discipline as separate from mathematics as is statistics. Certainly it makes use of the same background and symbols, but it is a way of life and a philosophy which is fundamentally different from mathematics (as cited in Katz, 1960, p. 523).

Hamming further challenged the practice of using computers as an easy way to find answers in engineering classrooms, which he called "a super sliderule" (as cited in Katz, 1960, p. 522). To prevent students from perceiving the computer as a supplement for solving engineering problems, he emphasized the need for a computer appreciation course in which the capabilities and potentials of computers could be introduced to students.

Second, in a practical sense, another justification was the shortage of workforce in the computing and related industries. In the early years of commercial computers, the workforce was often filled by those who did not have formal computing education but learned to operate and program on computers through on-the-job training or government- or manufacturer-run courses (Keenan, 1964). This type of labor force began to be devalued by academics who supported the establishment of computer science as a discipline. To legitimize the practicality of computer science, devaluation of the existing workforce would have been inevitable. Apprenticeship, self-study, and manufacturer-run training were considered "very inefficient" (Atchison & Hamblen,

1964, p. 225), and professionals who were instructed through these methods were thought to be "less satisfactory" (Keenan, 1964, p. 208).

In the ACM (Association for Computing Machinery) Preliminary Recommendations for undergraduate programs in computer science published in 1965 (Conte et al., 1965), these two rationales—developing a new academic discipline and creating a workforce—were emphasized. Among the four objectives of the recommendations, two of them explained the need for formerly trained professionals and the rest objectives reiterated future students' roles in contributing to the methodology and discipline of computer science. With further revisions based on the Preliminary Recommendations, the ACM released *Curriculum '68: Recommendations for Academic Programs in Computer Science (Curriculum '68)*, which detailed the courses recommended for computer science education. *Curriculum '68* became an important reference for higher education institutes that had or planned to establish computer science or relevant departments and it went through several revision processes.

The early debates on computer science as an academic discipline showed uncertainties and ambiguities in defining the nature and role of the discipline. Since the field was very young and unknown, it was not strongly associated with a specific gender. While a computer science department was often housed in male-dominant fields, such as engineering and mathematics, its insecure status would have contributed to a less hostile environment for women. When compared to engineering, how the uncertainties of computer science would have helped women to be more accepted in the discipline becomes clearer. Unlike computer science, engineering had already been a male domain before it was established as a discipline in higher education settings. As engineering professions anticipated a high demand for employment with massive industrial development in the late 19th and early 20th centuries, engineering education expanded while

privileging middle-class male populations (Frehill, 2004). Given this historical context, the long years of gender imbalance among graduates in engineering fields do not come as a surprise. The field of computer science had not been entirely gender-neutral in its early stage, but was certainly less exclusive to men until the field reached its maturity.

Maturation of Computer Science as an Academic Discipline

In the late 1970s, computer science began to be established in higher education. After all, the two important rationales for creating the department—workforce supply and development of its own curriculum and research areas—had been realized. Furthermore, the discipline's status was solidified with an increasing number of students and financial support from government agencies in the form of research grants. While there would be more indicators that point to the growth of computer science scholarship, three main aspects described below capture the consequences of the maturation of computer science.

Workforce Supply. A critical concern for both educators and employers was whether computer science or equivalent departments could produce a labor force that would meet the needs of industry. Until the beginning of the 1970s, a lack of practical training in computer science education was criticized. Abraham Kandel (1972), an eminent scholar in computer science, wrote a commentary criticizing the education system by saying, "Industry gets graduates from computer science departments with a bag full of the latest technical jargon but no depth of understanding of real computer systems" (p. 470). Somewhat defensive responses immediately followed. Peter Wegner (1972), editor of Communications of the ACM, defended academia by arguing that development of practical courses is more difficult than development of theoretical courses. Louis Fein (1973) shifted the blame onto industry for not being explicit as to the qualifications it expected from graduates. However, none of these responses refuted Kandel's

core argument that computer science departments did not create a workforce equipped with practical knowledge. In industry, recruitment of graduates from computer science and related fields provoked some negative reactions as well. The biggest issue was graduates' lack of knowledge of the business world and communication skills. Furthermore, employing entry-level computer professionals from outside the company was sometimes considered less cost-effective than internal transfers (Nelson & Lowrey, 1982).

Despite the concern over practical aspects of computer science education, the graduates did start meeting a portion of the workforce demand in the computing industry. The issue of practical knowledge among graduates was not completely resolved, but it is certain that industry anticipated benefits from hiring degree holders in computer science and related disciplines. The extent to which the graduates filled needed positions is difficult to trace, but it seems that the mid-1970s was the point at which a degree in computer science began to be preferred or required for some positions. At the beginning of the 1970s, there were almost no such positions announced in *Computerworld*, one of the most widely read technology magazines of that time. Even a bachelor's degree was not a requirement for most positions in both hardware- and software-related businesses; instead, experience in the field was the most appreciated quality. However, in the mid-1970s, formal higher education in computer science or other related fields began to appear as a preferred or required qualification.

Table 1 provides an overview of employers' preferred majors or degrees, tabulated based on position announcements in *Computerworld* from 1971-1980.[9]

[9] Five issues of *Computerworld* from each year were chosen. Due to random availability, it was not possible to select the issues at regular intervals or within the same period of time. Yet, to minimize the effect of seasonality and maintain consistency, issues between June and August were used except for 1971, whose available issues online were limited. Positions in higher education (e.g., faculty,

Table 1.

Preferred or required majors for positions in the computing industry between 1971 and 1980

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Unspecified	3	5	9	19	23	43	57	85	86	59
CS	1	-	4	5	5	15	33	35	61	55
Science/Engineering	-	-	5	1	5	8	19	31	32	31
Business	1	-	1	1	3	5	0	7	4	8
Misc.	-	-	-	2	-	1	1	0	0	0
Advanced	-	-	-	2	2	11	2	20	22	7
Total	5	5	19	30	38	83	112	178	205	160

Notes: The numbers were adopted from Computerworld from 1971 to 1980.

As seen in Table 1, degrees in higher education were increasingly desired and required by employers throughout the 1970s. Except for 1980, which is assumed to be affected by the early 1980s recession, there was a rise in the requirement for bachelor's and advanced degrees. The number of job openings had multiplied to keep pace with industry growth, and the number of positions that specified a preference for computer science majors reflected this growth. However, most noteworthy is that the ratio of preference for computer science degrees had increased overall, reaching its highest point in 1980. This growing percentage attests to the industry's recognition of the value of formal education in computer science.

The 1980-1982 recession was an adverse condition for graduates, as businesses reduced the number of new hires at the entry level (Scannell, 1982). Despite this unfavorable circumstance, graduates from the computer science field did enter industry thanks to the overall shortages in the workforce. For instance, the banking industry preferred bachelor's degree holders in computer science, and this was also the case in government agencies and insurance

instructor), other non-technical professions (e.g., technical writer, auditor), and executive-level management (e.g., center director) were excluded from the counts.

and consulting companies during the early 1980s (Blakeney, 1982). During the recession, the demand for entry-level positions was not as high as for positions in the higher ranks (Scannell, 1982), but it was still growing. In addition, as the economy recovered, computer professionals with degrees in computer programming and engineering were more actively sought.

Explosion in Enrollment. A growing number of students who majored in computer science also indicated the maturation of the field. At Purdue University, the number of freshmen who declared their major as computer science during the early 1970s was around 80 to 100. The figure increased to about 300 by the end of 1970 and to more than 500 in 1981, generating a crisis of faculty shortages in the department (Rosen & Rice, 1990). The student explosion in computer science was not unique to Purdue University, but a nationwide phenomenon (Margarrel, 1981). Promising career opportunities and anticipated role of the computer regardless of the field of study spurred students to enroll in computer science courses (Roberts, 1999).

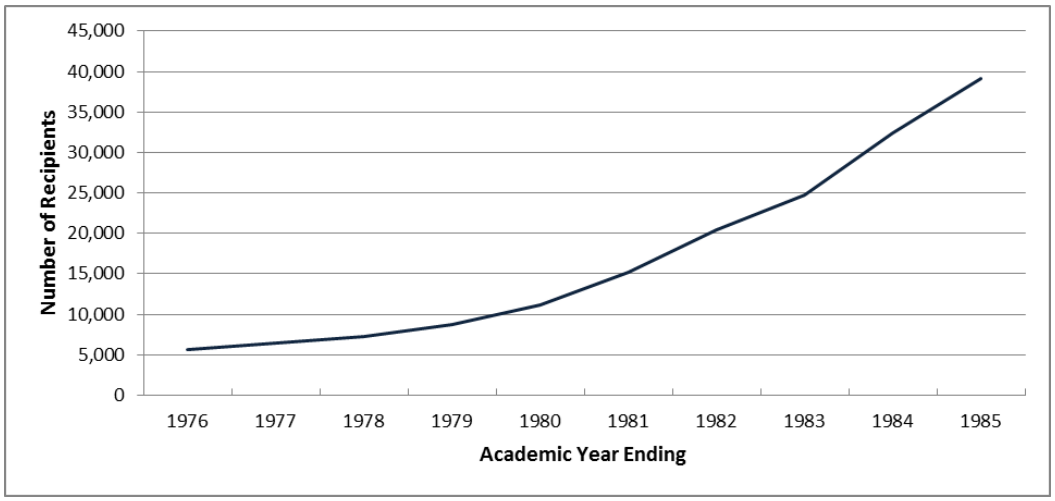


Figure 3. Number of recipients awarded bachelor's degree in computer science between 1976 and 1985. Adopted from *Science and Engineering Degrees: 1966-2008* by NSF, 2011.

The curve shown in Figure 3 well captures the accelerating rate of enrollment in computer science. While the number of bachelor's degrees awarded in computer science was around 11,000 in 1980, the number almost doubled in 1982 and quadrupled in 1985 (See Figure

3). The growth in student enrollment in computer science surpassed that in other fields, which was below 10% (NSF, 2011). Thus, the enrollment explosion in computer science was a distinct phenomenon that differed from the gradual enrollment increase in higher education in general. Bruce Webster (2008), who was once a computer science instructor at Brigham Young University, described the atmosphere in the 1980s:

> When I graduated with my BS in computer science from Brigham Young University in 1978, we had roughly 120 undergraduate students in the CS program. When I came back to teach in 1985 — just seven years later — there were over 1,000 undergraduate students in the program, and you actually had to apply to the CS program and be accepted in order to major in computer science….
>
> From what I could tell as a CS instructor during that period, this massive surge of enrollment was due largely to the hype surrounded [*sic*[the advent of personal computers, with a particular focus on the attention given to Steve Jobs at Apple and Bill Gates at Microsoft.

Since an upsurge in the number of computer science majors began to be observed in the late 1970s, it is somewhat inaccurate to attribute the popularity of computer science to young computer entrepreneurs who became successful in the 1980s. Rather, the arrival of the home computer era with the introduction of microcomputers and the BASIC programming language was more likely to have contributed to the increased interest in majoring in computer science. However, as Webster said, young computer gurus were central to popularizing the computing field in the early 1980s. Steve Jobs and Bill Gates made their *Time* magazine cover debuts in 1982 and 1984, respectively, with the successes of the Apple II computer and Microsoft Windows. Headlines on the covers—*Striking It Rich* and *Computer Software: The Magic Inside*

Machine—implied a general view of the computer industry as financially promising and intellectually appealing. Furthermore, commercialization of personal computers such as the Atari 400/800, Commodore VIC-20/64, and Apple II moved the computer industry closer to young people's lives.

Standardized Curriculum. As the 1970s came to an end, computer science education became standardized. This implied that the uncertainties and ambiguities about the identity of computer science and the doubts over the necessity of its education had been mostly resolved. The publication of *Curriculum '78: Recommendations for Undergraduate Programs in Computer Science (Curriculum '78)* was one of the most important events that both indicated and influenced the standardization of computer science education. C^3S of the ACM prepared the report, reflecting the academic development in computer science after the release of *Curriculum '68*. While the focus of *Curriculum '68* was on developing a new computer science curriculum at the higher education level, the emphasis of *Curriculum '78* was on refining the curriculum.

One of the major differences between *Curriculum '68* and *Curriculum'78* was that the definition of computer science had shifted from "a theoretical, mathematically based discipline that studies information structures into a programming and applications-centered discipline" (Tedre, 2006, p. 292). Whereas it was required for students to take eight math courses in the scheme of *Curriculum '68*, *Curriculum '78* reduced the number to five. Ralston and Shaw (1980) sharply criticized this change, arguing that mathematics is an integral part of any science or engineering field and computer science still needs mathematical thinking to mature sub-areas in their infancy. Furthermore, compared to *Curriculum '68*, *Curriculum '78* was more specific in outlining each recommended course, thereby helping the classes and textbooks to be less

divergent across institutions (Merkel & Mercer, 2003). As Ralston and Shaw argued, this curricular shift toward teaching standardized practical skills may have hampered the growth of computer science as a field of science; however, it helped the discipline form a solid base in higher education settings by satisfying the needs of academic administrators to produce a workforce.

Standardization of the computer science curriculum at the undergraduate level was reflected in graduate school and secondary school education. In an advanced education setting, the Graduate Record Examination (GRE) Advanced Test in computer science was introduced in 1976 and has been regularly administered since 1977. The GRE Advanced Tests, now called Subject Tests, are used for graduate studies application in a few academic fields. In the process of developing the test, it was asked whether computer science satisfied the Educational Testing Service's criteria, and one of the criteria as followed:

> (iii) It should be possible to construct a test to GRE standards. For example, the field must be reasonably homogeneous and amenable to a test which can be scored reliably, continually validated, and administered with standard procedures consistent with other Advanced Tests (as cited in Austing, 1977, p. 643).

The field of computer science still varied across institutions when the test's content specifications were discussed in the early 1970s. However, there were efforts to reach an agreement on what should be taught in the discipline (Austing, 1977).

In secondary schools, the curricula were developed in a way that prepared students to further study computer science in universities. *Curriculum '78* expressed concern about the transition between secondary and higher education in teaching computer science by stating, "With computing becoming more prevalent at that level, however, it is highly useful and

appropriate for a department representative to maintain contact with those local secondary schools which offer, or desire to offer, courses in computing" (Austing, Barnes, Bonnette, Engel, & Stokes, 1979, p. 165). In 1984, along with foreign language, mathematics, and other science fields, an advanced placement exam in computer science became available for high school students. The content of the exam was similar to CS1, the most elementary computer science course in higher education. According to ACM's recommended curriculum for CS1, which updated and elaborated on the description of CS1 in *Curriculum '78*, students who had taken the advanced placement course and passed the exam could earn credits for the course in advance depending on each institution's decision (Koffman, Miller, & Wardle, 1984). Debates over what should be taught in computer science classes have continued even up to now. However, in the 1980s, the field's curricula became homogeneous to the extent that essential materials could be evaluated on the same ground.

Gendered Effects of Maturation of Computer Science

Changing Status of Female Professionals. How the increasing number of computer science graduates affected the status of female computer professionals is not completely certain given that not enough data have been collected and analyzed. In particular, to have an overview of the impact of computer science education, chronological data on employment rates of computer science graduates by gender are critical. In addition to these quantitative data, qualitative accounts from those who worked in the 1970s and 1980s can provide a better understanding. Although further explanations should be filled in based on these data, one supposition can be made.

The increasing number of computer science graduates would have affected the status of female computer professionals, especially at the entry level since making a career transition from

non-computer to computer jobs became a less viable option for women. During the early years of the computer industry, lower level jobs were open to various populations, including women, African Americans, and Native Americans (e.g., Bernstein, 1971; Computerworld, 1975). However, women were more likely to receive the benefits of the new field, especially since clerical positions, which were female-dominated, were closely related with data management. It should be noted that data processing (DP) was the umbrella term used to refer to the jobs performed by programmers, system analysts, machine operators, and data entry workers, and the term was widely used until the late 1970s when information processing emerged as the new name. Since women had been heavily involved in data processing through their positions as key punch operators, they were included in the DP field with relative ease in relation to other marginalized populations. Grace Gentry, who worked as a programmer and became an entrepreneur of a brokerage business, described the environment of the field as follows:

> Payroll clerks know how payrolls were supposed to work, and payroll clerks were quite often women. So female bookkeepers were actually, certainly in government they were, prevalent perhaps in corporations, too—I'm not as sure about that. Initially in the computer industry there were a lot of women that were taken out of their jobs that were about to be eliminated. They were never eliminated, of course. . . . And they were trained as programmers to take advantage of their experience in that particular field (Gentry & Yost, 2008, p. 15).

During the 1970s and 1980s, women accounted for a significant proportion of machine/computer operator positions, which was the lowest level in the computing field (Arnst, 1975a; Zientara, 1982a). In the career ladder, programmer was the position right above the machine/computer operator. Since the programmer position was the starting job for computer science majors,

female machine/computer operators had more difficulty in crossing the border with the rise of the education hierarchy.

Discouraging Female Students. As mentioned above, the early 1980s witnessed an explosion of student enrollment in computer science. This surge of students caused shortages of faculty and facilities (Yau et al., 1983), which in turn led to competition among students. While the increase in the number of students did not seem to have gendered effects on the surface, it became clear that male and female students experienced the competitive environment in different ways. Table 2 gives good insights into the gendered effects by comparing the percentage of graduates from computer science to the percentage of students who intended to major in computer science in their freshman year. Assuming that the majority of students graduated in a timely manner, four years were added to the freshman surveys in making the comparison. For instance, a survey conducted in 1978 was juxtaposed with the graduates in 1982.

Table 2.

Percentages of CS graduates and wannabe CS majors by gender in the 1980s.

	Percentage of Graduates		Percentage of Wannabe CS Majors					
			Average		4-Year Colleges		Universities	
	Female	Male	Female	Male	Female	Male	Female	Male
1981	1.0	2.2	0.8	1.15	0.9	1.2	0.7	1.1
1982	1.5	2.8	1.3	1.75	1.4	1.8	1.2	1.7
1983	1.8	3.2	1.8	1.85	1.6	1.5	2	2.2
1984	2.4	4.2	2.25	2.9	2.1	2.6	2.4	3.2
1985	2.9	5.1	3.1	4.35	2.9	3.6	3.3	5.1
1986	3.0	5.2	4.15	5.35	3.7	4.7	4.6	6.1
1987	2.7	5.4	3.9	5.6	3.4	4.7	4.4	6.5
1988	2.2	4.9	4.45	4.35	2.2	3.7	2.7	5.0
1989	1.8	4.4	1.6	3.7	1.2	3.6	2.0	3.8
1990	1.5	3.9	1.15	2.6	0.9	2.3	1.4	2.9

Note: The data were adopted from Science and Engineering Degrees: 1966-2008 by NSF, 2011, and the

American Freshman by American Council on Education ⬩ University of California at Los Angeles, 1981-1990. The numbers were rounded to the nearest tenth.

As seen in Table 2, before the student explosion in computer science, the proportion of students who intended to major in computer science was lower than the proportion of graduates. Of note is that the gap between the two proportions was much narrower in the case of female students than their male counterparts. For instance, between 1981 and 1984, the percentage of female graduates was 0.15% to 0.2% higher than the average percentage of female wannabe computer science majors from both four-year colleges and universities; however, the gap was around 1.2% for their male counterparts. The bigger gaps among male students imply that they were more likely to be motivated and encouraged to study computer science once they entered college.

Furthermore, from 1981 to 1984, when there was a surge of wannabe computer science majors, the percentage of female students who wanted to major in computer science exceeded the percentage of female students who earned bachelors' degrees in the field after four years. In contrast, this excess occurred with male students only once, in 1987, with a 0.2% gap, which is fairly narrower than that of female students, 1.2% in the same year. The fact that the percentage of female graduates surpassed that of wannabe majors right after the explosion period indicates that these quantitative data are not a result of mere coincidence. While male students were not discouraged from majoring in computer science, female students were likely to be advised not to select computer science as their major. Even today, female students are deterred from entering into STEM fields by their advisors and professors (Bayer Corporation, 2010), and the atmosphere during the 1980s was not likely to have differed from the present.

CS Curriculum Detached from Society. There were two main foci in standardizing computer science education in the earlier years of the field. On the one hand, establishing

computer science as a legitimate discipline was important. Thus, *Curriculum '68* emphasized theoretical and methodological development of the field to fit the name computer *science*. On the other hand, it was important to provide a workforce with the qualifications preferred by industry, and this led *Curriculum '78* to be more practical and programming-focused. The establishment of the field in a relatively short amount of time created some issues in curriculum standardization.

Of these issues, a lack of education in social aspects of computers was criticized by some educators. *Curriculum '78* included a course called "Computer and Society" (Austing et al., 1979, p. 155) as one of the advanced electives. Compared to *Curriculum '68* in which such courses were nonexistent, this was considered good progress. However, *Curriculum '78* "displayed ambivalence towards including the societal aspects of computing" and publications on computer science curriculum had shown decreased attention to the social aspects since the release of *Curriculum '78* (Miller, 1988, p. 37). Another issue was indifference to developing pedagogies that suited the new field. The standardization of the computer science curriculum concerned what should be taught rather than how the field should be taught. In addition to the general indifference, supplying teachers was a more urgent matter than pedagogical development because of the shortage of qualified faculty members and teachers in both higher and secondary education (Deek & Kimmel, 1999; Denning, 1981; Poirot, Luehrmann, Norris, Taylor, & Taylor, 1985).

Inattention to social aspects of computing and pedagogies of computer science was unfavorable for women. Margolis and Fisher (2002) suggested that female students tend to value the usefulness of computers rather than the inner workings of the machine and prefer application-centered approaches to learning over courses taught in abstract ways. In the earlier development

of computer science curriculum, these gender and individual differences were not taken into consideration. It has been only a decade or so since computer science educators started to develop and revise their teaching methods. The scarcity of women and racial/ethnic minorities was the main reason for the change although a fundamental motivation was the increasing disinterest in computer science in general.

It would be wild speculation to say that the educators purposefully developed the curriculum in a way that systematically disadvantaged women. However, it is certain that the abstract ways of teaching and the imbalances between theories and applications are not a mere coincidence but a consequence resulting from systematic problems. In the late 1970s, women accounted for less than 10% of ACM members (D'Auria, 1977); as noted earlier, ACM is the organization that took the lead in preparing and publishing recommended computer science curricula. Not surprisingly, very few female professors were involved in writing recommended computer science curricula.

Furthermore, how the field of computer science was funded also contributed to the lack of education in social aspects of computing. The early growth of computer science would not have been possible without financial support from the federal government and manufacturers. In a survey on expenditures and sources of funds for research and instruction, contracts with or grants from the federal government accounted for 40% of the total spending on the utilization of computers in higher education (National Science Board, 2012). A similar amount of funding was provided by manufacturers, especially in the form of rentals and purchases of equipment and related assistance. With the decreasing price of equipment, the proportion of support from industry seemed to decrease while reliance on the federal government increased. In 1975, academic research and development (R&D) funds provided by the federal government in

computer sciences reached 74.3% of total funds, and the Department of Defense became one of the primary financial resources (National Science Board, 2012).

Beusmans and Wieckert (1989) argued that academic institutions graduated a significant number of computer science majors who would work for national security without providing students with any courses that address the use of technology in the military. They lamented, "Reflection requires information and discussion. Academic computer science departments rarely support serious consideration of even general issues under the social and ethical implications of computing" (p. 940). They criticized the funding structure of computer science departments that hinders discussion on not only highly sensitive social issues but also general public concerns. This seemingly neutral approach to teaching computer science could have served as a determent to female students' engagement in computer science.

Careers in the Computing Industry

Professionals in the computer industry took two major routes to pursue their careers. On the one hand, they worked as independent contractors as they gained experience and acquired expertise in their own areas. While this route did not guarantee the advantages that were offered to formal employees, such as health and social security benefits, the independent contractor model provided the merits of a flexible career path, higher compensation, and tax deductions. On the other hand, the employee model was another major option for computer professionals. The computer industry experienced high turnover as the accelerating technological development often required business restructuring and resulted in an unpredictable rise and fall. However, being employed provided relatively stable working environments, depending on individual life values and patterns. When the gender issue in the computer field is addressed, the second model

is often emphasized because of the data available. However, this emphasis leads to less comprehensive views on labor relations in the field. Thus, this section examines how these two different career routes affected female computer professionals in different but interacting ways.

Independent Contracting

Under Section 530 of the Revenue Act of 1978, also commonly known as the safe harbor provision, computer professionals were able to work as independent contractors without legal constraints (Ludlum, 1987). In most cases, when determining the employer-employee relationship, the usual common law rules apply. Unless an individual is classified as an independent contractor by the rules, the individual works as an employee, letting the employer withhold federal income, social security, and medicare taxes. However, the safe harbor provision gave temporary relief from the common law rules to certain types of jobs by classifying the workers as non-employees (Ludlum, 1987). To benefit from the provisions, an industry had to satisfy one of the reasonable basis requirements imposed by the Internal Revenue Service (IRS). According to the third requirement, "Employers may also rely upon industry custom or practice, if such custom or practice is a long-standing custom or practice of a significant segment of the industry" (Weissman, 2009, p. 8). Independent contracting had been a customary practice in the computer field before the provision was enacted; thus, technological service employers and workers were able to benefit.

In two aspects, independent contracting has been a useful model in the computer industry (Gentry & Yost, 2008). First, when a company needed a transition, whether it was new equipment, language, or system, independent contractors with more experience often led the conversion and trained the existing staff. This way, the company did not necessarily change its employment structure, but still could effectively adapt to shifting technological environments.

Second, independent contracting was a convenient way to supplement personnel to meet short-term needs. In the computer industry, small- and mid-size businesses were often project-oriented, which means that those businesses offered clients technological services as they obtained orders. Since the number and quality of staff members were subject to an order, independent contracting was necessary to keep the number of employees to a minimum and to facilitate agile project management.

In the U.S. context, the period when independent contracting experienced its emergence and burgeoning varied depending on the region. However, the company histories of the National Association of Computer Consultant Businesses (NACCB) members showed that broker services began to be launched in the early 1970s on the West Coast and then spread to other regions (SI SIG, 2007a). The recollections of broker service entrepreneurs revealed what the opportunities were for service providers as well as individual professionals in the formative years of independent contracting. Two of the NACCB members who made a career transition from programmer to broker service demonstrate the contrasting lives of employees and independent contractors, particularly in a financial sense:

> I was writing operating systems. They [the company] were leasing operating systems, at 30 thousand dollars a year; and I was being paid 12 thousand dollars a year. I would go to my boss and say, "Well, I am bringing in all that revenue," and he would say, "But you have not been here for 15 years (SI SIG, 2007a, p. 12).

> I went out to find full-time employment at a company in our area, American Satellite. During the interview, I said to the guy, "Well, you know, I would really like to do this as an independent contractor." He said, "Okay, we can do that." I said, "I will do it for 25 dollars an hour," and they said, "Fine" (SI SIG, 2007a, p. 13).

The computer industry had already gained notoriety for excessive work hours without awarding proper compensation. For full-time workers who were dissatisfied with this working condition, independent contracting was an attractive option.

Brokerage services were also regarded as a promising business model. Many of the broker service providers had been affiliated with the computer industry as programmers, system analysts, or salespersons (SI SIG, 2007a). Brokerage service owners had seen companies hire experienced professionals even though it meant offering highly competitive salaries. Since the service providers had knowledge of the operation of the computer industry, had gained expertise in technology, and had built networking through previous working experience, they were able to start the business with lower risk. Furthermore, broker services had low entry barriers, and some entrepreneurs even started their business without a proper office. The most critical factors for success were credibility and networking (SI SIG, 2007a).

Female Friendly Model. At the beginning, the independent contracting route was appealing to female professionals. This is attributed to the male breadwinner model that was still prevalent throughout the 1970s. Grace Gentry, one of the female pioneers in brokerage services, explained the gender difference in the perception of independent contracting at its nascent stage:

> The contractor was a self-employed businessperson and had to handle their own social security, any benefits, taxes, etc. . . . So, it looked insecure for a man. Nobody really had heard about working in this particular format that much and what was going to happen after that project was over? But for women, at that time all the women were married, their husbands had benefits and they had benefits as spouses and dependents. And so from their point of view, this was just terrific money because a good programmer analyst back then made around twelve, fourteen thousand dollars a year, but at ten dollars an hour—

> since they were going to get paid for every hour they worked—they could easily estimate they'd make twenty thousand a year (Gentry & Yost, 2008, p. 27).

At the beginning of her business, the individuals Gentry hired were the women she had worked with in her previous job (Gentry & Yost, 2008). As the independent contracting model attracted female professionals, the number of women Gentry's agency hired increased from five to more than two dozen. Dave Williams, another brokerage service provider, also recollected that the independent contracting option was suitable for dual-income households in which one spouse can ensure health care coverage (SI SIG, 2007c). In the 1970s and 1980s, it was more likely that wives received health benefits through their husbands' employment when both spouses were employed (Schur & Taylor, 1991). While Williams did not mention the gender ratio, one can assume that married women viewed the independent contracting option as less risky than their male counterparts.

When it comes to hiring women, the independent contracting model proved successful in the European context. Among brokerage agencies, F International Group based in the UK was the best known for providing home-based contracts for women. Formed in 1962, the company grew to hire more than 600 independent contractors by the early 1980s and opened branches in other European countries (Simons, 1981). Most of the contractors were women with children or elderly dependents or people with disabilities (Computerworld, 1979). Contracts were assigned taking women's role as primary caregivers into consideration. In terms of the working week, those female contractors were part-time employees, who often face disadvantages in promotion. However, F International worked toward having those female contractors obtain managerial positions rather than leave the company to repeat the same level of technical work (Simons, 1981).

The success and creative business model of F International inspired Luanne James and Burton Grad to found Heights Inc. in the United States. Affiliated with F International, Heights Inc. also used the home-based contract business model that primarily hires working mothers, single fathers, or people with disabilities. Grad remembered that there were "hundreds of women who wanted to work on this part-time basis, work at home" (SI SIG, 2007a, p. 17). Heights Inc. was not just interested in establishing a new profit model in the computer industry. Rather, it was deeply concerned with the career development of female professionals who were talented but forced to leave their professions to perform care work at their homes (Dooley, 1979).

It was not that the hiring practices in independent contracting businesses were inherently favorable to women. Above all, the critical factor was the ownership of the brokerage business since the main source for recruiting contractors was personal networking. Since the computing field was centered on male networks, men held an advantageous position in recruitment. However, thanks to the lower barriers to brokerage service businesses, women entrepreneurs were able to launch their businesses, thereby providing female professionals with opportunities to be recruited. Gentry did not purposefully hire only women; she claimed to be "not a person who sits around and counts minorities or sexes or anything" (Gentry & Yost, 2008, p. 38). Rather, it was because the people she networked with were all women. In this regard, it is hardly surprising that the founders of F International and Heights Inc. were women who knew how to utilize female professionals' talents and networks. Regional conditions were another important factor that affected gender relations in independent contracting businesses. Chicago-based entrepreneur Phyllis Murphy found that California, where Gentry and Johnson founded their firms, was more liberal and friendly to female-owned businesses (Murphy & Yost, 2008). When these factors worked synergistically, the independent contracting model could work well for

female professionals.

Disappearing Female Independent Contractors. As professionals in the computing field began to prefer the independent contracting model, women seemed to lose their footing in working as contractors. Around the late 1980s, Grace Gentry, who hired only women at the beginning of her brokerage business, saw the pool of female workers decrease in the independent contractor market. Gentry believes that the main reason was the professionalization of contractors that resulted in a competitive job market where "you really have to sell yourself" (Gentry & Yost, 2008, p. 38). Professionals who wanted to work as independent contractors had to be their "own sales person" (Gentry & Yost, 2008, p. 39) and women were not as aggressive and assertive as men in the job market.

Responding to a question about characteristics of an independent contractor, Jane Ross, who owned a broker business with her spouse, answered, "You needed to find somebody who was a little bit of an entrepreneur, somebody who liked working for themselves, liked the idea of not having to be in the same job year after year and building up some kind of a retirement thing" (SI SIG, 2007c, p. 8). Ross did not mean to be discriminatory, but her description seemed to apply to only a small proportion of the population, which consisted of mostly young single males (or females occasionally) without family responsibilities. Brokerage service owners and independent contractors in the 1970s and 1980s recalled that contractors most often did not turn down new projects although one of the promises of the independent contracting model is having time to spare. Long waits for paychecks and constant job hopping created disadvantageous conditions for both female and male professionals responsible for families.

In addition to the competitiveness in recruitment, the shifting family structure influenced women's perception of the level of riskiness. Gentry recollected that the male breadwinner model

was no longer dominant (Genty & Yost, 2008), and the divorce rate, which doubled between 1965 and 1980 (Faust & McKibben, 1999), proved this observation to be valid. In terms of medical care, full-time male employees were more likely than full-time female employees to earn benefits for both spouses in the mid-1970s (Schur & Taylor, 1991). However, the gender difference significantly decreased in the 1980s, thereby making no difference between when a wife works as an independent contractor and vice versa. Given the reality that women no longer could rely on the sole breadwinner model and stable marital relationship, the independent contracting model was perceived as risky.

In addition, Heights Inc.'s business model of home-based work did not work well in the U.S. context due to a lack of concern about working mothers and their career discontinuity. In European countries, working mothers' employment in the computing field was facilitated by government and industry in the form of flexible labor such as part-time jobs and alternative working shifts (Simons, 1981). These efforts were not shortsighted policies that were not workable in reality; rather, they were carefully planned considering various aspects of working women's lives. For instance, firms in Germany were asked to mirror school hours and operating hours of public transportation, and France experimented with Wednesdays off for women with small children (Simons, 1981). However, in the U.S., such efforts for working mothers were not coordinated. Burton Grad, co-founder of Heights Inc., explained the early 1980s situation as follows:

> We had hundreds of women who wanted to work on this part-time basis, work at home. That was the key, not at a client's location. The joke was that the clients wanted to see the dandruff fall, and for the women that was not the model. So, we failed beautifully (SI SIG, 2007a, p. 17).

Unless a contractor gains recognition, home-based work in computing is still avoided in the U.S context despite all the technological developments enabling instant communication between employers and employees. In Europe, the success of brokerage agencies such as F International was possible because the women's career continuity was facilitated across industries with the government's intervention. Producing women friendly positions in the computing industry was not a temporal and impetuous solution to labor shortages in the industry. On the contrary, hiring independent contractors was more business-centered, especially after the professionalization of independent contracting. Under the circumstances in which the working conditions of female laborers were not taken into account, it was hardly possible to continue the model of home-based work.

Section 1706 of the 1986 Tax Reform Act. In 1986, the increasingly prosperous independent contracting business faced an unforeseen barrier, Section 1706 of the 1986 Tax Reform Act. Under Section 1706, the safe harbor provision that was temporarily given to computer professionals was no longer effective, and brokerage service owners and independent contractors began to be accountable for complying with the common law in deciding one's employment status. Section 1706 reads that the following paragraph will be added to Section 530 of the Revenue Act of 1978:

> Exception. - This section shall not apply in the case of an individual who, pursuant to an arrangement between the taxpayer and another person, provides services for such other person as an engineer, designer, drafter, computer programmer, system analysts, or other similarly skilled worker engaged in a similar line of work.

Senator Daniel Patrick Moynihan introduced this section to offset the tax losses caused by the tax breaks for IBM's overseas business (Johnston, 2010). In part, this was true. On the surface,

Section 1706 seems to be a consequence of a conglomerate's power play that disadvantaged smaller business owners. However, the genesis of the section was not IBM, but the National Technical Services Association (NTSA), which tried to recruit IT professionals to some engineering businesses in an attempt to make a transition from engineering to IT (SI SIG, 2007c). For the businesses that were included in NTSA, the IBM case was a good opportunity to delegitimize the independent contracting model and to hire IT professionals into their employee-based businesses.

After the 1986 Tax Reform Act passed, all the three parties—independent contractors, independent contracting business owners, and clients—were thrown into turmoil. Some clients required their broker agencies to provide only W-2 employees, concerned about possible tax penalties (SI SIG, 2007c). For brokerage business owners, Section 1706 meant an urgent need to rework their business structure because they had to serve as employers and take care of once-independent contractors' social security and health benefits. It also brought massive changes to independent contractors as they had to decide between working as an employee and maintaining their contractor status. Soon after the news of Section 1706 was publicized, brokerage business owners collaboratively worked to clarify the legal force and evaluate the actual impact of the section (SI SIG, 2007 b). In this process, the NACCB was formed, and it contributed to stabilizing the aftermath of the legal change. Damage to independent contracting businesses varied depending on the region, main client, and individual company. However, undeniably, Section 1706 negatively affected the independent contracting model.

In terms of gender, brokerage service owners claimed that the section did a disservice to women and other minorities. The vast majority of brokerage agencies had not been minority-sensitive, but they appealed for minority encouragement since women and minority discourses

had more chances of influencing Congress than discourses on well-paid computer professionals' rights (SI SIG, 2007c). Harvey Shulman, attorney for the NACCB, described the discursive strategy as follows:

> Now Congress was saying, out of all the industries in the country, "You, Miss so and so or Mister African American, if you want to be a hairdresser or you want to be a janitor or you want to be anything else except a computer programmer, the laws will let you do that; but the laws do not want you to be a self-employed technical worker" (p. 27).

The description above applied not only to women and African Americans, but also to any populations that wanted to work as computer professionals. Nevertheless, it seems that female and African American professionals viewed the claim as valid. To repeal Section 1706, the National Association of Women Business Owners (NAWBO) and the Black Data Processing Association (BDPA) formed a coalition with the NACCB (Shulman & Yost, 2007). In 1991, the BDPA introduced a resolution that demanded the repeal of 1706, arguing that is was "harmful to minority- and female-owned small businesses" (Computerworld, 1991, p. 8) in the IT industry. Before the Tax Reform Act of 1986, a computer professional was freely able to incorporate as a one-person business, preparing the ground for a bigger business in the future. Section 1706 did not make a one-person business illegal, but clients often refused to work with those businesses for fear that the IRS would classify them as employees. For marginalized groups, the one-person corporation was a way to expand their businesses with low financial and social capital. In this sense, Section 1706 further marginalized minority populations in the computing field.

The status of independent contractors who were not incorporated is less known. The general consensus was that Section 1706 did not greatly affect contractors since the legal liabilities were mostly put on independent contracting agencies and clients. Theoretically,

independent contractors could choose between working with an agency as its employee and seeking a job from a company if they could no longer maintain an independent contractor status. Section 1706 was a more urgent issue for independent contracting agencies since they had difficulty in finding talented workers.

Although it was assumed that independent contractors were not much affected by the aftermath of the tax reform, women faced barriers in finding full-time jobs with companies. In the U.S. context, independent contractors were highly skilled and experienced workers. For these workers, suitable jobs were likely to be senior system analysts or managers. A problem was that a very small proportion of women worked at senior and managerial levels in the computing industry. This circumstance would make it difficult for women to take a career move from independent contractor back to employee.

An examination of the independent contracting model reveals that the model did not work in isolation from the employment model. The boom in independent contracting was enabled by the discontent computer professionals had with their companies. However, Section 1706 created a situation in which once-independent contractors needed to be absorbed back into those companies. The case of Microsoft's employee misclassification is a good example showing the close interactions between independent contracting and employment models. A 1989 IRS audit determined that thousands of independent contractors of Microsoft had to be classified as employees. Those once-misclassified contractors filed a lawsuit against Microsoft claiming their benefits retrospectively, which cost Microsoft $97 million in a settlement (Tennant, 2010). In that a computer professional does not necessarily remain as a contractor or an employee, it is critical to examine the working conditions of female computer professionals employed by companies to see how the interactions of independent contracting and employment models affected female

professionals.

Employment Model

The computing industry, in its infant years, was very open to hiring anyone regardless of his or her gender, race/ethnicity, and education level. The computing industry experienced a shortage of labor as in any other emerging industry, and the unforeseeable future of the field functioned as a hindrance in hiring talented workers. Hiring minority populations with the promise of a decent salary was an effective strategy to meet the increasing demand for labor. Various training programs from the government and industry revealed how urgent it was to produce a computing workforce.

In the late 1960s, some members at the General Electronic Research and Development Center designed a training program only for African Americans to fill six computing positions at General Electronics. The trainees were recruited regardless of their education levels, and even a police record did not prevent the trainees from attending the course (Bernstein, 1971). Computer trainings for minority populations continued to be designed. In 1975, the Bureau of Indian Affairs decided to fund Native Americans to receive training from the NCR Corporation, a US-based computer hardware and electronics company. The bureau and NCR Corporation planned to provide 250 Native Americans with training and to locate the trainees in the company's district marketing offices (Computerworld, 1975). Even prison inmates were given opportunities to not only receive training but also to work for government agencies, generating serious concerns about the misuse of data.

On top of special training from the government or large-scale businesses, individual companies and educational institutions encouraged gender and racial minorities to apply for positions through job advertisements. The effects of the Civil Rights Act of 1964 were

undeniable, but there were no regulations on adding remarks in job advertisements encouraging minority populations to apply. Thus, organizations' emphasis on non-discriminatory employment practices was more of a voluntary action that was created by their own needs. Women were also beneficiaries of the new field in pursuing careers; however, the promise of equal opportunities did not last long.

Ambivalent Perspectives on Female Professionals' Status. The computing industry seemed to be a promising field for women with the industry's conscious effort to attract female professionals as well as other minority populations. However, the industry was criticized for discriminatory employment practices that were similar to those in other fields. These ambivalent evaluations of the computing industry were implied in *Computerworld*. In 1975, two articles that showed contrasting views on women's status in the computing field appeared in *Computerworld*. One article titled *Lightfoot Calls Token DP Hiring Hardware to Women* (Arnst, 1975) addressed the myth of the computing industry as a women friendly area. Quoting Judith Lightfoot, a senior technical representative at Management Science America, Inc. and an officer of the National Organization for Women (NOW), the article stated that the computing industry was not as promising as it had been believed to be. The article continued, "'Women aren't active in fighting discrimination because this is an industry where women themselves have believed the propaganda [that the field is a good career choice for women]" (p. 4). The other article covered a counter-perspective based on a survey of female computer professionals. The title read *60% of Women DPers Not Encountering Sex Bias* (Arnst & Dooley, 1975). Although 60% could be a controversial number in generalizing the working conditions for women, the nuanced tone of the article was that the overall field was fair to women.

Throughout the mid- and late 1970s, the ambivalent views on gender relations in the

computing field were reiterated. On the negative side, the wage gap was a clear indication that gender-based discrimination did exist. From the 1970s, it has been possible to compare sex wage differentials among computer professionals as the occupation cluster was added to the standard occupational classification system. According to a survey conducted by the Labor Department of Dade County in Miami, female computer professionals worked more and earned less for the same job (French, 1974). While the survey was conducted in Miami, it was estimated that the wage gap would be similar across the country.

Apart from the gender wage gap, the glass ceiling emerged as another barrier to women's pursuit of computing careers. To some extent, the total percentage of female professionals in the computing industry was a disguise since women occupied the substantial majority of lower status positions. Furthermore, women's promotion to managerial positions was often barred by the industry's employment practices. A survey conducted by *Computerworld* found that the majority of the responding companies had a higher percentage of male managers (Zientara, 1982b). Considering that the industry had more male professionals than female counterparts, the larger proportion of males in managerial positions itself is not surprising and does not have to be a subject of sexism. The problem is that the responding companies saw the gender imbalance as merely women's lack of capability and experience or a coincidence, ignoring the biases they might have had in decision-making processes. A female owner of one company was frank about the reason for more female managers in firms; she explained, "'I feel we have more female management people because I [the president and owner] am female" (p. 103). A column published in *Computerworld* keenly pointed out that "the old men sitting on the promotion committees and in the managements" (Grosch, 1975, p. 11) prevented women from prospering in higher positions.

In addition to the wage gap and glass ceiling, mandating that potential employees prove their qualifications through certificates or degrees emerged as a factor discriminating against professionals who entered the field without formal education. Discussions on implementing various requisites generated concerns about experienced professionals who came from low socio-economic groups. In particular, female professionals who started careers by learning skills through on-site training or apprenticeship were put in disadvantageous positions in which they were not given opportunities for promotion or, at worst, lost their jobs.

On the positive side, careers in the computing field were highly rewarding in a financial sense. When compared to their male counterparts, female computing professionals earned significantly less. However, their situation was better than the average working woman in the U.S. One article stated that "while women in computing earned 78.2% of what men made in 1984, the median income for women in all jobs last year was only 65% of that for all women" (Raimondi, 1985, p. 6). Furthermore, computer professionals were still in demand even during the early 1980s recession, showing an increase by 15.9% between 1980 and 1981. The salary reflected the growing demand for the workforce: Compared to the previous year, there were salary increases ranging from 7.1% to 16.3% depending on the specific position (Dooly, 1981). The median salaries of computer programmers and system analysts were comparable to those of accountants and attorneys, respectively. The computing industry was certainly not favorable to women throughout the 1970s and 1980s, but the higher compensation and less blatant discrimination compared to other industries offset the disadvantages for women.

Influence of Feminist Movement. The civil rights and feminist movements in the 1960s and 1970s enabled thoughtful and lively discussions on gender issues in the industry. Evaluating notable trends in 1975, *Computerworld* carried an article with the title *Sexism in DP Is a*

Controversial Issue in '75. Briefly introducing the unusually high number of covers about sexism, the article reads, "All attempted to either prove or dispel the idea that sexism exists in the industry" (Arnst, 1975b/1976, p. 13). These heated debates over sexism seemed to be a constructive effort to address gender issues in the industry. Opposing opinions on sexism published in the magazine implied a consciousness of women's status in the computing industry.

One of the articles in 1975 covered Judith Lightfoot's speech at the Management Conference of the Association of Data Processing Service Organizations. Lightfoot, a feminist activist and computer professional, stated, "As data processing people, we are concerned with power. We speak of computing power—people power. In times like these, during a severe economic crunch, we cannot afford to waste 50% of the brains around" (French, 1975, p. 25). Such a strong call for equal opportunities and feminist language has been rarely found from the early 1980s onward. Especially now, it is unimaginable that someone would argue for equal opportunities in a very straight-faced manner at technology conferences. The 1970s was when the working conditions for women in the computing field were freely discussed thanks to the feminist movement.

Not only feminist activism but also feminist academic research contributed to the discussion of women's status in the computing industry. As discussed earlier, implicit sexism was a more serious issue than overt sexism in the early computing field. As discriminatory employment practices were embedded in the corporate culture in subtle manners, female professionals did not seem to recognize them. An article called for companies' voluntary actions to challenge "systemic discrimination" as legal enforcement could be applied only to overt discrimination. Companies were advised to "Create a positive corporate environment," "Resocialize men's attitudes," and "Train women for management" (McNurin, 1976, p. 28). This

encouragement was aligned with the Equal Employment Opportunity Commission's shifting focus to interventions in everyday employment practices. Furthermore, this article highlighted that female professionals were actually discriminated against more than they might believe themselves to be.

The article above cited a research article (Levitin, Quinn, & Stains, 1971) published in an issue of *American Behavioral Scientist* that was dedicated to gender issues in the workplace. While the introduction to the journal did not specify the role of feminist movements in academic research, the articles published in the issue mirrored the influence of feminism. Levitin et al.'s research distinguished between perceived discrimination and objective discrimination. While the former refers to individual women's perception of how they are treated in the workplace, the latter refers to the unfair evaluation and treatment of women in relation to their contribution. This research found that only 7.9% of the female respondents reported discrimination in their workplace although 95% of women were in fact exposed to objective discrimination. In this way, academic research added validity to the claim that female computer professionals were experiencing systematic discrimination although they did not recognize it.

What should be noted is that the influences of feminism grew beyond the domain of a few activists and academics and reached a wider public. In 1975, a column was published in *Computerworld* with the title *Women Don't Want Promotions* (Wolfe). The writer, a professor of information sciences at Brooklyn College, argued that the lower proportion of women in managerial positions was caused by women themselves who chose not to work overtime in favor of taking care of their families. After the release of this column, letters pointing out the column's logical fallacies arrived for weeks. Some readers questioned the validity of the writer's arguments, contending that he generalized his limited experiences without sufficient evidence

(Kolar, 1975; Mantle, 1975). Another reader rightly criticized the writer's false assumption that women voluntarily chose to resign for care work when they had no other option (Oliver, 1975).

There was no clear sign that the civil rights or feminist movements exerted significant influence on women's working conditions. The issues of the gendered wage gap and glass ceiling consistently emerged, and women's status did not seem to improve to a visible degree. However, the civil rights and feminist movements certainly facilitated discussions to improve the working conditions for women and other minority populations, helped professionals raise their awareness, and argued against discriminatory employment practices. Civil rights and feminist discourses bore fruit in that they prevented the lower status of female professionals from being normalized.

Disappearing Politics. From the mid-1980s, it became difficult to find gender-related articles in *Computerworld*. When the magazine was searched with the keywords, sex and gender, only a couple of articles exclusively covering gender issues appeared until the early 1980s. As in the previous decade, the wage gap and glass ceiling continued to be treated as the most critical issues. However, in the mid-1980s, gender issues were seldom covered; between 1986 and 1989, only one article was found regarding the working conditions for women in the computing industry. In terms of the content, it was not distinct from articles in previous years, mainly discussing the lack of women in higher positions and pointing out the biases of males at the top level. A crucial point is that the mid-1980s was when the computing industry witnessed the surge of undergraduates majoring in computer science. The inattention to gender issues might have been generated by the excessive supply of workers since the pool of college-educated workers could have satisfied the demand for labor. This explanation is plausible because concerns about female computer professionals began to mount again from the early 1990s, when the number of computer science majors markedly declined.

Another explanation for the inattention is a decline of second-wave feminism. Equal rights in education and professions was one of the most significant goals as well as achievements of second-wave feminism. Discourses and activism for equal rights remained alive even after the decline of the second wave, but the main discourses of feminism had moved to the politics of sexuality. Awareness of the unequal labor structure in the computing industry seemed to decrease; instead, symptoms of feminist backlash began to appear.

Two main symptoms of feminist backlash were found in 1980s' *Computerworld* articles. First, feminist awareness became a taboo for female professionals who wanted to climb the corporate ladder in the computing industry. An article that covered the ways to "get ahead in the computer industry" (Savage, 1991, p. 65) suggested that female professionals should not be "belligerent feminist[s]" since being vocal about women's issues would cause harm to women. Another article about general women's issues in the computing industry introduced a technical manager saying, '"Don't wear feminist colors on your sleeve'" (Larkin, 1984, p. 48). Both articles show that feminism was no longer the term used to claim fair treatment but a word that should not be mentioned if female professionals wanted to survive in the industry.

Second, individual competencies and talents began to be regarded as the factors that determine women's success in the computing industry. The two articles mentioned above clearly show this tendency. The female professional introduced in the first article stated that she had the mind-set of "he who proposes, does" (Keefe, 1983, p. 30) and became a manager one day because she pushed forward what she believed was right. In the second article, the characteristics of female IT professionals were introduced. They included, "1. More intelligent, capable of abstract thinking, bright," "2. More assertive, aggressive, competitive," and "3. More conscientious, persistent, preserving, and determined" (Larkin, 1984, p. 42). In addition, three

other characteristics—"4. More venturesome, socially bold," "5. More tough-minded and realistic," "6. More experimenting, liberal, questioning"—were included. When looking at the list of the characteristics, it appears to be very comprehensive, requiring women to have all these superior qualities.

Given the decline of feminist politics, it is not surprising that the early 1990s discourses about gender issues centered on the number of women in executive positions. From 1990, when the concern about the smaller percentage of female professionals reappeared, gender-related articles in *Computerworld* most often covered the topic of women executives (e.g., Leighton, 1992; Maglitta, 1990; Wilder, 1992). Although the importance of role models is undeniable, the mere existence of token women does not lead to changes in the fundamental gender issues. Kanter (1977), who introduced the notion of the token woman, found that the existence of token women served to dramatize masculine qualities and heighten boundaries between the two genders. Since a token woman is accepted in a male-dominated group because of her gender, the woman inevitably functions to help male qualities stand out even if she tries to appear gender-neutral or manlike. In this sense, the focus on the gender ratio in higher positions since the late 1990s has failed to improve conditions of female professionals in the computing field.

Conclusion: Construction of the Computing Field as Masculine

The historical context in which the computing field became masculine is similar to that of electrical engineering. Carolyn Marvin (1988) found that the field of electrical engineering, whose status had been low before the 20th century, became a masculine field with "an industrial shift from steam to electricity" (p. 9). Like the computing field, there had been uncertainties and anxieties regarding the status of the field. However, as the field gained importance with

industrial development, electrical engineering came to be regarded as a prominent field for white males and clear distinctions between insiders and outsiders—"rural, female, nonwhite" (p. 17)—came to exist.

The free software movement, the root of today's FOSS communities, was initiated when the number of women in the computing field started to decline due to educational and corporate structures. While it is often assumed that involvement in FOSS takes place in online settings, this assumption is false. As I will further discuss in chapter 5, offline networking is an important means of learning about FOSS and staying in the communities. The declining number of women would have limited their network, thereby reducing their social capital to be introduced to FOSS development. While women would not necessarily create a network in the same gender group, my interviewees' stories reveal that it is not easy to penetrate a network of males and develop close affinity with them as peers.

More critical than the numerical gender imbalance is the shift in discourses about the accountability for gender-based discrimination from social structures to individual qualities. This discursive shift was resonant with meritocracy, the long-held governing system of FOSS communities. The belief that women's entrance into and success in their careers are a matter of individual choice and talent has long existed in FOSS communities. The most notable criticism against sexism within FOSS communities was first seen in 2002; this shows how oblivious most of the contributors had been to the structural barriers that prevent women from participating in FOSS. This does not mean that FOSS developers are particularly insensitive to gender inequality, but that the discourse making individuals responsible for what they do was well penetrated in FOSS communities interlocking with meritocracy.

In the previous chapter, I argued that the Ada Initiative uses individual volunteerism and

corporate benevolence to solve gender issues in FOSS communities. The root of these types of solutions to gender issues can be found in the discursive shift in the late 1980s onwards. As an individual is considered to be an agent who leads his or her own life, the individual must solve any given problem. Corporate benevolence is not a recognition that corporate structures are accountable for gender issues, but a reconfirmation that the accountability still falls on individuals and corporations help individuals help themselves.

CHAPTER 4.

GENDER IN THE MAKING OF FOSS IDENTITIES

As demonstrated in the previous chapter, educational institutions and business practices contributed to framing the computing field as masculine. However, these practices alone are not sufficient to form the persistent popular belief that the field has always been a man's world. This belief is often generated and reinforced by a culture that decontextualizes institutional power. To unpack the roles of culture in establishing gender relations in FOSS communities, this chapter looks at how FOSS culture is defined and rationalized by developers. By culture, I do not mean popular culture that creates stereotypical images of computer enthusiasts as rebellious hackers, that constructs and maintains identities of computer enthusiasts with regard to gender relations. It should be noted that the term geek that I will often use in the remainder of the chapter is intended not to degrade computer enthusiasts who are most often males. While the term might be interpreted negatively by non-experts, it refers to an individual who continues to learn and tinker with passion within the computing field and other specialized areas.

Distinctive geek characteristics—eminently logical, highly creative, and socially inept—were not defined by the geeks themselves from the outset, but by the computing industry. Nathan Ensmenger (2010) explained the historical contexts in which geek qualities became established through employment practices. In the 1950s when programming was an arcane and idiosyncratic art, programmers needed to creatively solve problems in overcoming the limitations of underdeveloped machines. Programs at this time were customized for a particular purpose and machine; thus, programmers had to work in isolation, relying on "local knowledge and individual ability" (p. 125). According to Ensmenger, these preferred qualities for programmers continued to be maintained by the industry in the form of aptitude tests and personality profiles.

The criteria that were used to define good programmers are now ingrained in geek communities as if they are innate characteristics of geeks. It is debatable whether certain natures are inherent among those who are good at programming. However, what can be agreed on is that programming skills are not the sole indicator of good programmers in working environments. When computer science departments started producing a labor force at a higher level, recruiters of programmers lamented that computer science majors often lacked knowledge of the real world and management (Nelson & Lowrey, 1982). Some recruiters preferred to hire graduates who had earned computer science degrees from business schools rather than those equipped only with technical skills.

Above all, the artificial criteria determining who is a talented programmer have done a great disservice to women. The image of the isolated, lone thinker is more associated with masculinity than femininity. Here, masculinity should not be equated to virility, one of the most traditional masculine qualities. Masculinity refers to the quality that is considered distinctive to or appropriate for men, generating power over women and those men lacking masculinity. In general, social ineptness is not welcomed by society, and it is undeniable that geeks are stigmatized as social misfits. However, when the ineptness is justified by genius and talent, it is often condoned. The belief that women are good at communicating and interacting with people has made them appear less suited for the computing field. Whether women's sensitivity to human relations is inherent or nurtured, or whether there is a gender difference in people's skills at all, is uncertain. However, the traditional women's role as caregivers imposes a greater stigma on women who are less social.

FOSS developers have constructed their culture in association with and in comparison to other computer geeks. Whereas they separate themselves from other geeks by emphasizing their

philosophies and the ethics of FOSS contribution, they share other geek characteristics, including a passion for continuous learning, an emphasis on logical thinking, and a lack of social skills. FOSS contributors' culture is most often manifested in the discussions on online forums, in mailing lists, and at conferences and local meetings. This chapter examines FOSS culture in relation to gender by analyzing FOSS-related entries and users' discussions on Slashdot, one of the popular tech-news websites. This website does not represent the diverse FOSS communities; rather, it provides a general idea of FOSS culture that is not limited to a particular project or programing language.

This chapter consists of three sections. First, it looks at how FOSS contributors construct their identities by examining what motivates them to contribute to FOSS development. In particular, I aim to reveal how FOSS developers differentiate themselves from other computer geeks by drawing a boundary between coding for work and coding for self-directed reasons. The second section unpacks how FOSS contributors' identities and culture affect their views on gender issues in the communities. I emphasize their values of logic and freedom, which serve to depoliticize gender relations. In the last section, I look at what roles the new economy plays in constructing FOSS developers' culture. In particular, I examine how FOSS developers' identity construction as self-directed agents resonates with the ideal image of laborers projected by the neoliberal market.

Constructing the Identity of FOSS Contributors

Intrinsic Motivation for FOSS Development

In June 2012, I attended Open Source Bridge, a volunteer-run open source conference based in Portland, Oregon. On the last day of the conference, Paul Fenwick, managing director

of Perl Training Australia, gave the keynote speech on how to use psychological knowledge to encourage people to participate in open source development.[10] In particular, he focused on intrinsic motivation as a driver for contributing to open source. In the very last section, he threw out the question, "Will X make me happy?" He then rephrased it to, "Will I regret later on [doing or not doing X]?" To answer this question, Fenwick introduced a study that surveyed "720 gifted individuals" regarding what they regretted in their lives. What he found most telling in the results was that none of the participants regretted spending time pursuing their hobbies. Another item he stressed was the participants' regret over education, including missed education and bad educational choices.

Fenwick did not make a direct analogy between the study and open source development. However, considering the context in which the presentation was given, his intention was obvious; developing open source as a hobby, as enjoyment, and as a learning tool is something that people will not ever regret. One notable moment in his presentation was when he highlighted that the study's topic was about "[t]hings smart people regret!," with the word "smart" accentuated in his tone and italicized on the slide. By doing this, he implied that talented people would join open source development, driven by their intrinsic motivation. Fenwick's keynote speech conveyed the gist of the motivation behind FOSS developers' participation. This view on FOSS contributors' motivation as intrinsically generated has been long held within FOSS communities.

When asked about the reasons for open source development on Slashdot (CowboyNeal, 2003), one of the recurring themes was fun. One user stated, "We write Open Source software because THIS IS FUN" (Jacek Poplawski, 2003), and comments similar to this appeared often. In that fun, enjoyment, or pleasure is the motivating factor, FOSS development was seen as a

[10] The video can be accessed at http://www.youtube.com/watch?v=0Cl4ImQpV94

hobby by some contributors. One Slashdot user stated:

> The fact is that almost everyone with any sort of free time has a hobby. ("Hobby" being defined as an activity that one does in their spare time which does not achieve remuneration for the action.) That hobby might be tending a garden, or watching television, or playing the cello, or having sex, or cataloging astronomical objects in the sky. This also means that there could be people who dedicate their spare time to writing computer programs and helping others to write programs or use their computers better (iacrwaf, 2001).

By situating FOSS development in the realm of hobby, the commenter differentiated FOSS contribution from work and disregarded the role monetary value plays in the development. Sometimes, monetary compensation is even considered to be an undesirable motivation in any type of work; as one user stated, "Money is almost always the wrong motivation for doing anything. Do something you like, and treat the money as a nice side effect" (blancolioni, 2000). While FOSS developers' disinterest in monetary compensation met with adverse reactions—as summarized in the remark "vanity don't pay the rent or groceries" (Esion Modnar, 2003)—their voluntary contribution is not necessarily attributed to vanity or naiveté. Instead, what FOSS developers are against is external power that confines one's autonomy. A survey (timothy, 2002a) linked to a Slashdot forum in 2002 revealed that most FOSS developers were not young, inexperienced college students, but professionals who held daily jobs outside the FOSS world. That is, a significant proportion of FOSS developers was not, and very likely still is not, idealists who do not recognize material necessities. Rather, they would be among those who pursue self-driven life away from routinized work. One commenter's remark was insightful in this regard:

> I think that a lot of professional software developers end up getting involved in open

> source projects because they don't get much professional satisfaction from their day jobs. When you have to worry about idiotic management, getting laid off, projects getting cancelled in beta, etc, [*sic*] an open source project starts looking pretty good (anonymous_wombat, 2002).

One of the promises knowledge labor offers is that the workers will be less alienated from the work since the workers' creativity and personality are integrated into the products. Unlike manual labor for mass production where the workers do not have control over the finished products, software developers exercise some degree of power over the design and use of products. In addition, as the hackers' protests over the prosecution against Jon Johansen[11] demonstrated, expression through programming is considered free speech (Coleman, 2005). In this regard, software programs are not merely commodities but an extension of the self. However, long working hours, managerial involvement, and employment uncertainty make self-expression through programming a less significant element of the job. Involvement in open source development brings the promise of knowledge labor as self-expression back to the contributors even if it means a lack of spare time. By emphasizing coding for the sake of fun and self-expression, FOSS contributors construct their identities as autonomous agents who act out of intrinsic motivation instead of in reaction to external factors.

Pragmatist vs. Idealist, or Pragmatic Idealist

Pragmatism, idealism, and the seemingly incommensurable mix of two words appeared to convey another characteristic of FOSS contributors. "Scratch your own itch" is a well-known phrase to FOSS contributors, especially after Eric Raymond used it in his popular essay *The*

[11] Jon Johansen is a Norwegian-born hacker who was prosecuted for releasing DeCSS, a software program that enables users to decrypt the content of commercial DVDs. After the prosecution, a series of protests was organized by fellow hackers.

Cathedral and the Bazaar (1999a). As mentioned earlier, many FOSS contributors are not college students living in their parents' basement as assumed and derided by some people, but professionals who work for clients and companies. Some commenters thought that FOSS developers often initiate and contribute to FOSS projects for their own needs to "get their work done!" (pb, 1999). One commenter summarized this motivation well:

> It works much better if *you* have a need for something. You need an IDE for development? Grab an OS one and add the features that *you* need, fix the bugs that it contains. You need a share dealing system? Grab one, add the features you need, fix the bug (Moderation Abuser, 2000).

Beyond completing work, one of the biggest merits of developing and using FOSS was that "[s]ince a lot of other people would be able to use the same software to accomplish the same task, they are more than willing to help if it gets them closer to their goal" (Kenneth, 2000). This pragmatic approach to software development distinguishes FOSS development from proprietary development. Although not explicitly stated, some commenters criticized the inefficient practices of software development in the IT industry, which often involves "reinventing the wheel, over and over and over again" (radja, 2001). A discussion forum (Soulskill, 2011) regarding the relationship between FOSS and workforce reduction accurately captured FOSS contributors' emphasis on efficiency. The discussion forum was linked to an article (Spencer, 2011) that addressed the issue of IT staff cuts in British educational institutions with the widespread use of free technological services enabled by FOSS. Responding to this article, a thread about the government subsidies to create jobs, especially spending on building and rebuilding infrastructure, was started. Some commenters simply tried to show off their knowledge about the national economy and government affairs, but many of the commenters denounced the waste and

inefficiency of the government. One commenter precisely pinpointed the sentiment among commenters with a bitter irony: "Efficiency is evil" ("Translation," 2011).

The moral ideals of FOSS were mentioned as another motivation in contrast to pragmatism. One commenter succinctly conveyed the most intrinsic value of FOSS by saying, "Humans like freedom" (haxor.dk, 2003). Freedom was not necessarily interpreted in accordance with the four types of freedoms[12] explained by Richard Stallman to define free software. Instead, the commenters provided their own version of freedom. Being cautious about ideological censorship, one commenter contended that FOSS embodies Marxist ideals by eliminating the hierarchy between producers and consumers and making both a part of the product. This commenter stated:

> I prefer Open Source because it is the only form of software licensing and design which truly conforms to Marx's ideals: there is no special class of "developers" who weild [*sic*] power over users. Rather, everyone involved in the end product, programmers, users, documentation writers, even lawyers, can have a say ("Preposterous," 2000).

Very often, the commenters took altruistic and communal approaches. Some believed that they can "make the world better," "improve the lives of millions of people" (PeterM from Berkeley, 2000), and "empower previously disenfranchised people" (smack.addict, 2001) by contributing to FOSS development. In fact, "make the world better" is a phrase one can frequently hear from not only leaders of FOSS projects but also from contributors at all levels. However, the phrase is

[12] "You have the freedom to run the program for any purpose. You have the freedom to modify the program to suit your needs. (To make this freedom effective in practice, you must have access to the source code, since making changes in a program without having the source code is exceedingly difficult.) You have the freedom to redistribute copies, either gratis or for a fee. You have the freedom to distribute modified versions of the program, so that the community can benefit from your improvements" (Stallman, 2002, p. 20).

often empty of meaning because it is used in an abstract manner and not put into practice. The role of this moralistic stance differentiates FOSS development from the proprietary development whose exemplar is Microsoft, which is "Restrictive. Oppressive. User Hostile. Unreliable" (haxor.dk, 2003).

These two different motivations—pragmatism and idealism—reflect the driving forces that initiated FOSS development. While pragmatism resembles Eric Raymond's stance on FOSS as a method of efficiently developing software, idealism is rooted in Richard Stallman's Free Software movement, which had a moralist vision. Pragmatist and idealist approaches certainly conflict on some points as Richard Stallman and Eric Raymond had debates (e.g., Raymond, 1999b, 2001) at the dawn of the Open Source Initiative; whereas Richard Stallman saw freedom as the vital value in Free Software, Eric Raymond departed from the moralistic approach and rebranded the collaborative software development as open source, a business-friendly term. Although the distinction between the two stances still remains, it is not a source of conflict but understood as the co-existing values of FOSS by contributors, defining their identities in comparison to proprietary software developers.

Self-Development

Extrinsic motivation was thought to be another reason for FOSS development, which has importance comparable to intrinsic motivation. In particular, FOSS development was regarded as a means of self-development such as building a career or establishing a reputation among the contributors. As FOSS development often appears to be a hobby as well as work among enthusiasts who code for the sake of coding and fun, some commenters carefully or indirectly stated their motivation for participation. One commenter said, "Maybe I'm a cynic, but has anyone else considered contributing to an open source project as a way of building up their

resume?" (Valdrax, 2000). In fact, some commenters chided the somewhat materialistic approach to FOSS development, as demonstrated in the comment below:

> I don't want to discourage OS programming, but do not do it with the expectation of having it help you get a better job. Do it because you either believe if in [*sic*] or because you really enjoy it. The last thing the OS community really needs are people who are just looking for resume builders. . . (lkaos, 2002).

Involvement in FOSS development as a way to build career opportunities was not proudly mentioned by the commenters; however, this did not mean that career development through FOSS was a marginal reason for participation. The importance of FOSS development has grown to a level of necessity, and experience in FOSS development does help IT professionals advance their careers. In 2009, an article titled *How to List FOSS Experience on Your Resume* (kdawson, 2009) was linked to a Slashdot forum, implying that the industry demanded a workforce with knowledge in FOSS. Many of the commenters provided various strategies of making experiences in FOSS development look better, thus illustrating the shifting perception of participation in FOSS development.

Establishing reputation was another extrinsic motivation that drove people to contribute to FOSS. On the one hand, reputation was related to career building since reputation often accompanies better job opportunities. On the other hand, some contributors sought reputation for the purposes of self-satisfaction and recognition from others. This type of behavior was at times called ego boosting within FOSS communities with derogatory connotations. Interestingly, there were almost no commenters who said that they themselves contribute to FOSS to establish their reputation; it was referred to by others, reflecting a critical view of the self-centered mind-set in FOSS communities.

It is notable that involvement in FOSS to develop career and earn reputation was not well received, but it did not encounter harsh criticism either. Some commenters attempted to put the extrinsic motivation in a positive light. Responding to a debate over FOSS development as a resume building opportunity, one commenter stated:

> Even the "selfish" reasons that can motivate OSS developers don't involve a monetary transaction. The resume-building aspect can, in economic terms, be considered an investment in human capital, an investment made with time and effort, not dollars. For many would-be IS professionals, they may not have the financial resources to take a certified class in $hotnewtech [*sic*], but jumping in on an OSS project can provide similar benefits. It's a nice alternative means of building a skilled workforce (TopShelf, 2003).

Other commenters put more weight on the consequences rather than the means. Even if the FOSS contributors work for their own individual development and reputation in a self-centered manner, it is condoned as far as it is "the selfishness practiced by healthy, self-actualized people" and "their selfishness doesn't step on other people." Furthermore, even if "[w]riting open source software is a selfish act" (Master of Kode Fu, 2000), it was deemed an act that eventually benefits more people than oneself. It should be pointed out that this somewhat selfish motivation was embraced to the extent that it does not blur the boundary between FOSS and proprietary software development. Positive interpretations of extrinsically motivated FOSS developers should be understood as a part of making the boundary clear.

Motivations behind FOSS developers' contribution reveal that they define their identities by contrasting themselves to developers working for proprietary software businesses. It is not important if proprietary software developers are actually inefficient, immoral, and money-driven. In fact, it would hardly be the case that proprietary software developers are driven only by

extrinsic motivation. What matters is that FOSS developers should be distinct from proprietary software developers by creating and bolstering certain images of themselves.

FOSS has been under suspicion because of its moralistic and political stances and there was doubt about its potential as a business model. Although FOSS is now a critical part of the IT industry, its value and likelihood of success as a way of software development had to be rationalized by FOSS leaders and individual developers. Thus, what led the discourses of motivation to be circulated and upheld was the need to firmly establish FOSS. In this sense, it does not come as a surprise that what motivates FOSS contributors and what defines them are still popular topics at FOSS-related conferences and on/offline forums.

Freedom as the fundamental value of FOSS development is a significant factor that helps these motivations with different values co-exist. Intrinsic motivations and extrinsic motivations, or pragmatism and idealism, are not elements that can be easily co-existent. However, freedom offers the rationale that enables FOSS contributors to argue their own motives for contribution. Here, freedom is not synonymous with freedom of speech, but instead with freedom of choice. Whereas this value of freedom functions to endow FOSS developers with different motivations, it is used to justify women's low participation in FOSS development.

Making the Gender Boundary

It Is about Freedom, It Is Their Choice

One of the most prevalent assumptions among FOSS contributors was that involvement in FOSS is a matter of choice. When individuals are considered to be autonomous agents who can make their own decisions without being affected by external factors, the scarcity of women is situated out of the historical and social contexts that led to gender relations in FOSS

communities. When gender issues in FOSS communities surfaced on Slashdot, a noticeable proportion of commenters attributed the reason to the wants of women differing from those of men. That is, "[i]f women don't want to play," it was regarded as "their choice" ("Choice," 1999). Thus, the right question to ask regarding gender issues in FOSS was not "'How do we attract more women to these development projects?'" but "'Are these projects something which a woman would want to work on?'" (Wohali, 1999). For these commenters, acting on an individual's own decision was one way to realize the value of freedom. A commenter encapsulated this assumption: "Open source is about letting people do whatever they want with the source code. It's about freedom. If hardly any women want to use it, that's their choice. Doing nothing, absolutely nothing, with open source is also allowed" ("Who cares?," 1999).

Even if disadvantages for women were deemed to exist, the degree of the disadvantages was underestimated. Responding to the difficulties female FOSS developers face, one commenter contended that the disadvantages related to gender are trivial when the person is talented enough. Moreover, disadvantages for women were compared to those for other underrepresented populations and further belittled. In the US IT industry, unfair treatment of women was assumed to be less serious than discriminatory treatment toward "a 14 year old computer tech." This commenter continued, "And lets [*sic*] face it, are you black? Handicapped? Hideously scared? Mute? Deaf? Blind?" In addition, the commenter believed that women had more advantages for the reason they are women since encouragement was "poured on women" when there was "no encouragement to become 'geeky'" for him ("Re: A woman's," 1999). This statement was certainly not true, especially considering the gendered socialization processes that encouraged males to be math- and science-oriented. The commenter's claim revealed that privileges granted to a certain gender are too embedded to be recognized.

The view of FOSS involvement as a matter of choice reflected some FOSS developers' mistrust of so-called gender or race politics. One commenter complained that "it's amazing how some people can politicize just about anything," and made a decontextualized equation "[o]pen source = free = sharing = non-political" (R. Anthony, 1999). Another commenter insisted that FOSS cannot be political since regardless of the developer, programming languages do not change. The commenter was cognizant that many of the programming languages are in English. For this commenter, dominance of English in programming languages was not an issue because there is no reason that "anyone who is a good programmer, hinting at at least slightly above average linguistic abilities, can't learn English" (fwr, 1999). However, the commenter did not question who would benefit from normalizing the use of a particular language in programming.

There Is No Such Thing as Sexism

No Gender Difference. To make the argument—involvement in FOSS is a matter of choice—convincing, there should be the premise that sexism or other types of discriminations cannot exist in FOSS development. One of the most frequently provided justifications was that a contributor's identity is unknown because FOSS is online-based. The popular idiom "on the internet nobody knows you're a dog" (jandrese, 2009) was suggested as a reason for the impossibility of sexism in the FOSS world. Since the FOSS world is not a "meat-space," an individual has "no idea the sex of the person in the first place" (brunes69, 2009). In these suppositions, there was no realization that gender is not necessarily manifested through bodies, but is performed symbolically in the form of language.

This gender-neutral approach was not exclusively used by male contributors who attempted to normalize the current gender politics in FOSS communities, but was appropriated by female contributors or so-called male allies as well. On the one hand, self-identified female

contributors claimed that their gender does not affect their experiences as FOSS contributors. Whether they are women or not "makes absolutely no difference" to them (hellbunnie, 1999). On the other hand, some women criticized the tendency to make gender stand out whenever women make achievements in FOSS communities. When Robyn Bergeron was appointed the Fedora project's first woman leader, the title of the discussion forum—Red Hat Appoints Robyn Bergerson First Female Fedora Project Reader— emphasized Bergeron's gender. In response to this, one commenter felt discomfort:

> Is it big news that the first female is appointed to any function at all? Emancipation has come a great way and nowadays female lead is business as usual. . . . In fact, using this tone is rather patronizing and I wonder whether Ms. Bergeron really appreciates the attention on the sole base that she's a lady, doing lady's things (SpaghettiPattern, 2012).

Another commenter also problematized the tone of the post, contending that other physical characters such as being albino would not have been pointed out (Bogtha, 2012). This line of argument certainly intended to support female FOSS developers by emphasizing that there is no difference between female and male developers' capabilities. However, the ultimate effect of this argument was to sustain the claim that there is no such thing as gender discrimination or sexism in FOSS communities. By making gendered practices in FOSS communities invisible, this gender-neutral approach contributes to discriminatory treatment.

Essentialist Views on Gender Differences. On the other end of the spectrum, some argued that there are differences between the two genders and these differences inevitably result in a disproportionate gender ratio among FOSS developers. These differences were decontextualized and treated as something fundamental, thereby leaving no room to intervene in the discourse. Two strategies were adopted to prove gendered differences in capabilities, styles,

and aims of coding. First, some commenters relied on scientific "facts," having their argument appear logical. Although the purpose of using scientific research as evidence was to make an argument credible, popularized science news or TV shows were very often provided as sources. The comment below is an example:

> I saw on the discovery channel once that some women while in the womb get a large "hit" of testosterone, and those women grew up to be quite the tomboy (like myself), they didn't /look/ masculine, but they acted and thought more like men. . . . I think these types of women are the kinds that get into computer. . . (Pyr, 1999).

Furthermore, the widespread scientific claims that female brains and male brains work differently was often mentioned. Along with scientific research, some commenters rationalized gender differences based on their own experiences. For instance, some argued that women tend to focus on the functions and applications of software while men are more likely to develop software for the sake of coding. Also, some said that women do not see coding as something to conquer, while men have those assertive and aggressive attitudes toward coding (Margolis & Fisher, 2002).

The gender differences listed above are not entirely fictitious or inherently sexist. Experiential and empirical findings show that there are gender differences in terms of approaches to coding. It is the decontextualization that makes arguments for gender differences problematic. Two different levels of decontextualization exist in the commenters' narrations of gender differences and their implications in computing. First, whether scientific research or an experiential finding, there is no contemplation of why a research project was designed in a certain way or how a different approach to computing is adopted by gender. Second, there is no explanation as to why these differences favor males when it comes to computing. If someone is

to argue that a certain approach to computing or brain development is more appropriate for computing, computing should have intrinsic characteristics. However, as described in the previous chapter, the way that we perceive computer science today is an outcome of constant debate.

The problem with attributing the scarcity of women in FOSS communities to gender differences is that the discourses on differences create discriminatory actions. Furthermore, when the distinctive gender characteristics are deemed to be intrinsic, it becomes difficult to deconstruct the discourses. One can see that members in FOSS communities tend to critically evaluate claims of scientific research and try to think against popular beliefs. Therefore, it is not the lack of critical reflection that accounts for the prevalent decontextualized discourses of gender differences. I showed earlier that FOSS developers feel antipathy toward the politicization of everything, subscribing to the value of freedom as in freedom of choice. The reason that FOSS developers are critical of other issues is that being logical and scientifically rigorous is considered an apolitical action based on facts. However, gender, one of the most politically laden constructs, is depoliticized on the basis of innate differences.

Women Are Materialists. The idea of intrinsic gender differences as the rationale behind the scarcity of women at times loses its persuasive power because there is a greater percentage of women in proprietary software development than in FOSS development. As a response to this, some commenters emphasized gender differences in terms of a value system, arguing that women pursue more materialist values and that is why women participate less in FOSS development. Under this assumption, the culture of FOSS communities is exempt from accountability for the unbalanced gender ratio; instead, women themselves are regarded as the cause of the problem. One commenter pointed out the value women place on monetary rewards

in a refined manner by stating, “Perhaps women just don’t like spending hours and hours of their free time on a project for little monetary gain. In other words, perhaps they aren’t as likely to be chumps compared to men :)” (quanticle, 2009). While modest words were used, it was clear that the commenter made a somewhat partial judgment of women. Another commenter more poignantly criticized women’s pursuit of monetary gains:

> [B]ecause the sex that we’re being told is biologically predisposed towards nurturing, consensus-building, sharing, caring behavior. . . . All they care about is getting paid for everything they do. And the men, who are biologically predisposed towards aggression, competition, and dominance… all they care about is sharing their code and delighting other people with the free software they’ve helped create (Americano, 2012).

This commenter saw the ethical stances of FOSS development as being closer to the ethics of care, which has been considered to be women’s ethics. This argument is inaccurate in that the boundary between self and other is blurry in the ethics of care. In FOSS development, individuality is critical since coding is a way of expressing the self. In this sense, the claim that FOSS development embodies the ethics of caring or nurturing is misleading.

What is more problematic than this inadequate explanation is the view on excluding women from FOSS development. Historically, female-dominated occupations are financially less rewarded than male-dominated occupations. Even if a job was once male-dominated, it becomes devalued when the workforce is replaced by women. Although proprietary software businesses tend to offer more stable jobs and have a better gender ratio, they do have issues concerning the recruitment and retention of female professionals. Thus, it is implausible to assume that monetary reward is what primarily attracts women. When the view on women as valuing material well-being is normalized, women cannot be regarded as suitable FOSS contributors. As

I demonstrated in the previous section, FOSS developers define their identities in opposition to the identity of proprietary software developers. Women are deemed to share commonalities with proprietary software developers since, from some FOSS developers' perspective, both are driven by money. Being regarded as materialists like proprietary software developers, women as a group are identified as non-FOSS developers.

Prove It. When the default assumption is that there is no gender-based discrimination in FOSS communities, the responsibility for proving its existence falls on those who argue for its solution. The main purpose of requesting evidence was to strongly stress the belief that there is no sexism in FOSS communities. In part, however, it was also a sign that the commenters want to appear logical. An article (ScuttleMonkey, 2009) posted to Slashdot covered the issue of ire and denial when FOSS communities respond to sexism. One commenter argued that sexism does not exist in FOSS communities because, according to the commenter's self-directed research, only 0.1% of the comments are sexist in a FOSS mailing list when women in FOSS development account for 1.5%. In addition, the commenter asked, "what is the real 'problem' that exists?" (khasim, 2009). Some commenters took the argument as valid, and others counter-argued that the quantitative analysis was not sufficient to contextualize the condition of sexism in FOSS development. Many of other comments were critical of the methods and statistical validity of the research.

In fact, the 0.1% argument was grounded in a very sloppy study; thus, it was hardly worth discussing. However, dozens of comments were pertinent to the logic of the study and the counterarguments, veering away from the issue at stake. Surveys have been conducted to examine the status of women in FOSS communities ("FLOSS," n.d.), and they contributed to helping FOSS developers become aware of the sexism in their culture. Denying the existence of

sexism through scientific and data-driven methods is a good strategy in that FOSS developers often like to act on logic and appear logical. However, this logic-focused reaction to sexism leads to degradation of the experiences and tacit knowledge of women. One commenter's statement is worth quoting:

> None of the evidence he has provided cites scientifically measured data. Key phrases like "In my experience," "another thing I noticed," and the continual referencing to personal exposure is a clear indicator of anecdotal – and therefore assumed biased – data. This indiscreet assemblage of data adds nothing valid to a rational argument for the pervasive existence of sexism in FOSS (quitewalker, 2012).

As FOSS communities are highly male-dominated, female contributors often experience gender-based discrimination in isolated contexts, handling the aftermath at an individual level. Thus, one of the Ada Initiative's goals is to approach the issue of sexism in FOSS communities at a systemic level so that individual contributors are not marginalized by denials of sexist incidents and do not experience further attacks against victims. Considering that the organizational efforts to improve women's status had not been readily available, the insistence on scientific proof and quantification of experiences might have contributed to female contributors' silence or their conformity to the male norms in FOSS communities.

There Is Sexism, But…

Not all commenters denied the existence of sexism in FOSS communities. Given that there have been serious levels of sexist behaviour such as death threats against female contributors that were backed up by concrete evidence, sexism in FOSS communities could not be easily dismissed. While some commenters called for self-reflection among FOSS contributors themselves and feasible solutions to sexism, a considerable number of commenters trivialized the

degree of sexism or treated it as an inevitable attitude resulting from distinctive traits of geeks.

No Sympathy. Geeks are often portrayed as anti-social and self-centered—or shy and introverted in some cases—in the media. Some commenters contended that geeks in general and FOSS developers in particular embody these characteristics, and this is why many FOSS developers fail to read others' minds and comply with social norms. These anti-social behaviors are not considered something that needs modification, but deemed the sign of a real geek. One commenter alleged, "F/L/OSS developers ARE amongst the brightest and the best, but they also have extraordinarily high levels of autistic behaviors, anti-social disorders, emotional disability and alienation" (jd, 2009). Unlike the FOSS world, the commenter said, "the 'real world' is mostly comprised of idiots who lack the mental capacity to understand anything new." This argument indicates that intellectual talent and social ineptness are inseparable qualities.

In the real world, FOSS developers are not as anti-social or introverted as they are believed to be. My personal encounters with male FOSS developers and my interviewees' accounts altogether refute the idea that FOSS developers, as a group, are different from any other occupational group. As it is critical to form networks to survive in the FOSS job market and to help the self to be known to other members of FOSS, the developers cannot remain anti-social. Ironically, FOSS leaders who should be the brightest of the bright have strong leadership and social skills. Thus, the view that they are outstandingly talented and thereby socially maladjusted is a discursive construct to help FOSS developers appear exceptional. In this sense, whether this view is proven to be true or not in the real world does not matter insofar as the discourse can maintain the peculiar image of FOSS developers.

Even if a FOSS developer is anti-social and introverted, it does not necessarily mean that he or she failed to conform to cultural norms. Rather, it indicates that the developer has

constituted his or her characteristics to fit the images and expectations that are projected onto geeks. The description of computer professionals as anti-social and eccentric is as old as the history of the job, and many computer professionals have grown up being exposed to these images. It is not to argue that a computer professional intentionally embodies those stereotypical representations; however, the influence of socialization through those images cannot be ignored. When an incident of sexual discrimination occurs, the characteristics of geeks become a very strong rationale. Since geeks have always been "that way," at the expense of their talents, they cannot or do not need to change themselves.

Get Over It. When geek traits that are unfavorable to women are seen as inevitable and unfixable, those who want to enter into the geek environments should condone and overcome the discriminatory treatment. That is, if one "want[s] to be part of the crowd," he or she should abandon "the victim mentality" and adjust to the geek environment (PitaBred, 2009). In this remark, there is the assumption that FOSS has always been a male geek's world. This assumption not only "Others" female contributors but also renders their existence invisible. Furthermore, the insistence that women should change themselves to fit into the community is against the FOSS value of individuality in that it suggests that women should suppress their own individuality to be accepted in FOSS communities.

The contention that women should overcome sexism in FOSS communities by themselves is also bolstered through a comparison of FOSS communities to other fields. One commenter stated, "[T]here's no reason to believe that the FOSS community is any less sexist than the rest of the world. You're going to find a lot of sexist individuals just because that's the status quo in society today" (roscivs, 2009). From this commenter's view, the culture of FOSS is not the cause of sexism since the same or a more serious level of sexism exists outside FOSS

communities. Thus, FOSS communities do not necessarily need to improve the status of women to increase the number of female contributors as sexism is not internal to FOSS but rooted in the bigger society. In a similar sense, another commenter claimed that FOSS communities are better than other audaciously sexist areas such as the military. Again, the conclusion is that sexism is not the cause of women's low involvement since other more sexist fields perform better in their gender ratio.

The underlying assumption of the argument above is that the level of sexism can be stratified. I agree with the idea that there are different degrees of sexist behaviors, and there are fields where women face greater obstacles than they do in FOSS communities. However, when it comes to how an individual perceives discrimination, the degree of sexism cannot be easily determined. Feminists' endeavor to define sexual violence as a continuum reflects their belief that directing our intention to what is more or the most serious violence dismisses victims' embodied experience of violence. Needless to say, it has never been the victims who decide the degree of violence. In this regard, the commenters' comparison without contextualization denigrates what female contributors have faced in FOSS environments and makes them feel that they are unheard.

As I mentioned earlier, women are considered stricken with a victim mentality and are supposed to abandon it to be included in FOSS communities. Ironically, some male commenters showed their own victim mentality as well by claiming their defensive and exclusive behaviors were learned through victimized experiences. In other words, because geek males have been disregarded by women, they activate a defense mechanism to protect geeks themselves. One commenter said, "[A]ren't you discouraged as geekboy, too? Isn't that girls turn away from you when they hear that you are a geek? Isn't that what makes geeky boys cry 'OH MY GAWD

THERE IS A GIRL HERE!!!'" (forthy, 1999). Another commenter used the word "despised" (Chemisor, 2012) to explain the mental harm that was inflicted on young male geeks. Since it is women who denigrate geeks and their values, the commenter argued that female unfriendly FOSS environments are logical consequences.

Reverse Sexism. Even if some commenters did not deny sexism in FOSS communities, they expressed antipathy toward any intentional effort to increase the number of female contributors. On the one hand, those efforts were considered to be against women's freedom; on the other, they were framed as reverse sexism. One commenter stated, "[W]hat I am against is pushing someone towards a field strictly because it is and going as far as to mount an entire campaign around it" (Jordy, 1999). For this commenter, the efforts to encourage women to contribute to FOSS were against one's free will since it is not one's own decision. It was not that the commenter condoned the practices of discouraging a certain population becoming involved in FOSS development, but the commenter did not recognize that male contributors are also implicitly and explicitly encouraged by their network and the discourse of valuing males over females in terms of their scientific knowledge and talents.

A few examples were given to prove that interventions in the gender ratio are a type of reverse sexism or positive discrimination. Among those, nursing careers repeatedly emerged. A stereotypical argument went as follows:

> Trust me, female-dominated professions are just as bad when it comes to sexism. The nurse profession, for example. As a male, it's ok to be a paramedic, or a doctor. But if you even start studying to become a nurse, you're told from the get go that your only purpose as a male is to do the heavy lifts, you get marked down on exams, essays etc. merely for being male (Shinobi, 2012).

The extent of what the commenter described as a norm is debatable, including whether the employment practices in nursing careers are sexist. Nursing careers have been degraded as care work that does not require professional skills as high as those of physicians, and with the shortage in the nursing workforce, males who pursue careers as nurses earn more than their female counterparts (Casselman, 2013). Apart from the misrepresentation of gender relations in nursing careers, the commenter implied that FOSS communities do not need to change since there is no intervention in a balanced gender ratio in nursing careers either. If women are encouraged to contribute to FOSS development through deliberate tools, it becomes reverse sexism or positive discrimination that benefits only women.

To some extent, the negative reactions to changes in FOSS communities are induced by anti-feminism sentiment. While worries over the scarcity of women in FOSS development are not necessarily expressed in the name of feminism, feminism becomes targeted for attack. A self-identified female commenter expressed her anger saying, "I absolutely hate when women wave the flag of feminism when they're just being sexist asshats trying to get ahead of men" (Jane_Dozey, 2009). She continued to state that her male colleagues are "suspicious of [her] motives and being careful not to offend" due to their fear of backlash. Another commenter also blamed feminism for the decreasing number of degrees earned by male students and financial benefits "mysteriously" (hedwards, 2009) given to women in response to a call for action to alter the FOSS environment.

FOSS Identities and the New Economy

As discussed in the previous section, women are seen as non-FOSS developers because they pursue materialist values. Therefore, female computer professionals are equated to

proprietary software developers who work for money rather than for fun and passion. However, as FOSS has become integral to software development and as the number of paid FOSS developers increases, the justification of passion and the moralist stance do not distinguish FOSS developers. Furthermore, the economic reality that a job as a developer is not stable makes it difficult for FOSS developers to act on FOSS principles.

FOSS Developer as Paid Labor

Since FOSS development consisted mostly of unpaid and free labor, one of the biggest interests in the development was the motivation behind the voluntary contribution. FOSS developers themselves often see the motivation as intrinsic and distance themselves from monetary value. Slashdot commenters' responses to paid FOSS jobs reflect a general belief that FOSS cannot be a paid job in most cases. When a discussion forum was opened with the title *How to Get Hired as an Open Source Developer* (timothy, 2002b), one commenter made the joke below:

> Payment: I'll buy beer for you and won't tell your parents. You get to look at my personal collection of nudie magazines. You can code at my office, and tell your parents that you're at a sleepover. I'm an adult. They'll believe me. I can pick you up from school, posing as your parents. I have a PS2 and Grand Theft Auto: Vice City! (NineNine, 2002).

In the joke, there was a touch of sarcasm about the naiveté of FOSS contributors as well as a suggestion that it is not tenable to be hired as an open source developer. Contribution to FOSS was encouraged as a way to hold a competitive edge in the job market, but the vast majority of the commenters gave negative answers to the possibility of paid FOSS jobs. At least, this was a common sentiment about FOSS labor in the early 2000s. However, some commenters argued that "[t]here are plenty of legitimate and highly stable ways to make money writing free

software" (Ogerman, 2002) when the companies move away from the old-fashioned software business model, which is selling the copy. Indeed, large-scale computer companies such as IBM have started using Linux as the platform for their systems (Moody, 2002).

By the mid-2000s, the sentiment about FOSS jobs had changed. A discussion forum titled *Myth of Linux Hobby Coders Exposed* (Zonk, 2005) linked an article reading that, unlike "the myth of renegade programmers," the most talented Linux developers normally were not only fully employed but also working for the largest technology companies all over the world. One commenter expressed a concern that "To the exact same extent that the values of Linux hackers became more professional, they also become less able to claim altruism or objectivity" (Salamander, 2005). Another commenter raised doubt over "large faceless, morally and ethically bankrupt corporations" (yagu, 2005). This doubt sparked a debate over the ownership of code that was written by employed developers. Employment of Linux developers was not merely a matter of FOSS transitioning from hobby to job, but also a matter of the source code remaining free.

Despite some worries, there was sentiment among contributors that full-time employment of Linux developers was a logical consequence of the increasing importance and constant development of Linux. Those paid positions seemed to prove that "[Linux] ain't some system thrown together by some idiots who still live with their parents" (rice_burners_suck, 2005). Another commenter emphasized the positive effects of hiring Linux hackers for the companies; hiring these hackers was expected to bring value to the companies businesswise and help the companies "look like Good Guys" (grcumb, 2005).

When the late 2000s and early 2010s came, being employed to work on FOSS was considered normative. As IT companies became savvier in utilizing FOSS products and

developers, FOSS developers' possibility of being hired as a full-time employee increased. The scope of the position was not limited to writing code, but included other roles such as system administration, product support, and design. Having a career as a FOSS developer was rarely seen with a suspicious eye because it is great to be paid to do what one loves. Some commenters tried to make it clear that there are still differences between FOSS and proprietary software development careers although both of them are paid. One commenter emphasized that "[paid FOSS developers] are getting paid for their labor, not paid a million times over, every time a copy of the code is distributed" (noidentity, 2010).

Until the mid-2000s, the implicit suggestion about paid FOSS jobs was that some FOSS developers were actively recruited to eminent companies due to the developers' distinguished talents. However, planned career development to be hired in FOSS development became normalized after the late-2000s. In response to a discussion forum, *How to List FOSS Experience in Open Source on Your Resume* (kdawson, 2009), many of the commenters shared strategies to make FOSS experience distinctive. The view on FOSS as a career development tool was seen not only in the Slashdot community but also in other IT magazines and blogs around the same period. Thus, it seems that contributing to FOSS as an investment in a future career was a widespread practice among FOSS contributors by the late 2000s.

Economic downturn in the U.S. would have led FOSS developers to embrace the somewhat materialist approach to FOSS development, which is development for financial security, if not financial success. In 2012, a discussion forum was opened with the title *Ask Slashdot: Where Are the Open Source Jobs?* (timothy, 2012). The discussion prompt introduced the story of a FOSS developer who sought another FOSS job as the person's company was about to make a shift to the Microsoft system. Some commenters supported the person's decision to

find a FOSS development position for ethical reasons. One commenter stated, "If we really want to call ourselves professionals—and not *cheap whores who will do anything for a paycheck—then we are REQUIRED to stand up for our principles" (Arrogant_Bastard, 2012). At a moderate level, the argument was that it is important to work for enjoyment.

Surprisingly, a considerable number of commenters criticized the person for considering leaving the job because the company would no longer use FOSS as a main tool. Above all, the economic situation in recent years was the main reason for blaming the person's attitude. With a scathing tone, one commenter expressed irritation, saying, "You're a douche. In an economy where many people have been unemployed for so long that they're just dropping out of workplace altogether, you're fretting over 'FUD' because your company did a normal thing and switched products?" (bonch, 2012). Other commenters contended that making transitions for the sake of working with FOSS is not a viable option in one's career track.

The changing discourses of FOSS development as a paid job reveals that contributing to FOSS is as important to expand career options as it is to practice one's moralistic values in software development. This change might be attributed to generational differences since FOSS has existed long enough to have developers who are not aware of its roots. For younger generations, the practical aspects of FOSS as a learning tool and career development strategy would be more important than its moralistic values. In addition, experienced developers who have contributed to FOSS for a long time might see the significance of career development as they feel insecure in their jobs. In fact, at LinuxFest Ohio 2012, one of the tracks was about career development, and many of the attendees were Linux developers who saw the need to develop themselves. While increased acceptance of paid jobs would have been caused by various factors that need more investigation, it is undeniable that FOSS is no longer a realm for

enthusiasts who will work without any monetary compensation.

New Economy

The moralistic stance that FOSS developers contribute without monetary compensation cannot be strongly held any longer due to the increasing opportunities to be hired to work for or with FOSS. However, the criticism that women do not contribute to FOSS at the expense of money has continued to emerge. When the Ada Initiative was introduced to Slashdot in 2012 (Soulskill, 2012), there was bitter sarcasm that the organization would not achieve its goal of having more women in FOSS technology and culture since women chase money. However, contrary to the criticism, women have been escaping from the IT industry, leaving the lucrative salaries behind. When a discussion forum was opened with the title *Why Women Are Leaving IT* (Zonk, 2007), unanticipated responses came in supporting those women. Considering the typical reactions of the past, the most likely reason would be that women do not have the passion and talent to survive in the IT industry. These types of degradation of women still accounted for a fair proportion of the comments. However, many commenters blamed the industry for driving the IT workforce to leave its excessive work load and even expressed envy for the women who leave the industry.

One commenter mentioned "Maybe this means that women are smarter? They know when to bow out of a stupid job like this" (try_anything, 2007). Another commenter also saw women's decision to flee as a wise choice for a satisfactory life. Introducing an article about the reason why women earn less than men do, the commenter explained that "it is because women go for the quality of life while men go for the money. . . . No surprise that women are leaving IT when the jobs suck more and more" (DaveV1.0, 2007). This comment does not accurately reflect the reality since women were placed into positions where they earned less, which resulted in a

lower quality of life. It is a false assumption that women are given full freedom to choose their quality of life. Apart from this erroneous assumption, what should be noted is that IT professionals' dissatisfaction with the industry's treatment of workers generated male commenters' sympathy with women leaving the field. A self-identified male professional showed his discontent with the typical working conditions in the IT industry, saying, "I'm not a woman. And frankly, I would LOVE to flee my IT jobs, ESPECIALLY because of the whole being on call 24 hours, and all the after-hours work, etc." (Jethro, 2007). There was a series of similar responses that IT professionals are supposed to be on call 24/7, and these adverse working conditions ultimately result in a smaller potential employee pool.

One commenter rightly showed that exclusion of women in the IT industry is to some extent caused by IT companies' employment practices. The comment read, "IT jobs treat people like shit. Women don't stay in the jobs because they don't put with up being treated like shit. Men say the women don't belong because they're not willing to be treated like shit like they themselves are" (hazem, 2007). This comment implies that antipathy toward women in the IT industry reflects male professionals' frustration with the fact that they cannot easily leave the industry. It could be social pressure, family responsibilities, or lucrative salaries that subtly force male professionals to stay in the industry. Whatever the rationale, male IT professionals seem to form strong companionship by sharing the hardship together. Male commenters' sympathy with female professionals could have resulted from their realization that it is the industry that drives women to leave.

I do not intend to be apologetic for male professionals who are socially and culturally forced to endure the harsh working conditions in the IT industry; male privileges gained from the companionship are undeniable, and being apologetic cannot generate a fruitful discussion. I want

to focus on why the IT industry would perpetuate this employment practice despite the potential harm to the industry itself. One commenter gave an insightful answer to this question:

> Essentially this will come down to a management problem. At some point, people will avoid IT as a career altogether. And when that happens, demand will go up for people, more money will be offered, and people will hold their noses and come back. In the late 1990s perks for IT were tremendous—stock options, lots of vacation, huge bonuses. Now IT is treated like 3rd world labour…it's a necessary evil for most businesses, they hold their nose and pay for it (Ubergrendle, 2007).

From the business point of view, female professionals who are leaving the industry might not represent a significant loss compared to what they need to pay to have female professionals stay. It is not just taking actions for work-life balance such as offering flexible work hours, teleworking, or parental leave. The business also loses the grounds for imposing dreadful working conditions on the male counterparts. It comes as no surprise that large and successful businesses build living facilities like Google campus to retain the most talented workforce. However, newly launched or small businesses would find it a better choice to hire young, often male, professionals who are willing to devote their time to work.

Efficient FOSS Labor

While it was not difficult to find male commenters who expressed sympathy for women when the IT industry in general was discussed, this type of response was almost non-existent in FOSS-related discussions. As I mentioned earlier, what distinguishes the identities of FOSS developers from those of proprietary software developers is the motivations for developing. Among the motivations, freedom as in freedom of choice was one of the most critical elements that define FOSS developers' identities. As many FOSS developers believe that they decide what

they do—either developing software for free or having a job as a paid employee—entirely based on their free will, there is no room to sympathize with other developers who are situated in conditions unfavorable to participation in FOSS development.

What should be noted is that FOSS developers' belief in autonomous action makes them the most suitable workforce in the new economy. The worries about FOSS developers' ideological stance as communism no longer exist; rather, they act upon the tenet of neoliberalism, which attributes one's condition to a matter of individual choice and responsibility. The long discussion about the government's subsidiary for creating jobs should be understood in this context. Whereas FOSS developers value the public good in the form of coding and community, these aspects are only valuable when efficiency is ensured. Fostering diversity would be understood as reducing efficiency since developers who argue for better environments are not sufficiently self-motivated and self-determined. Under this logic, the efforts to include women cannot be welcomed by the communities.

Conclusion: FOSS Contributors in the Making of Knowledge Workers' Subjectivities

Throughout the chapter, I have unpacked how FOSS contributors define their identities in comparison to proprietary software developers and how freedom as the most appreciated value in FOSS communities leads to negative attitudes toward the inclusion of women. The characteristics of FOSS contributors can be summarized in two words: active and freedom. While the motivations for FOSS developers became diversified, fun and passion are still claimed to be the main reasons for contributing to FOSS. Fun and passion serve as the impetus for FOSS contributors to constantly develop the self and produce values for the society. This characteristic of FOSS developers as active learners and active citizens helps them to act as the ideal laborers

under the logic of neoliberalism. In the knowledge industry, which is the base of the neoliberal market, laborers who actively adjust to rapidly changing markets are among the most important assets. This quality of FOSS developers justifies distinguishing productive laborers from unproductive ones. Whereas someone who does not have a work and hobby boundary—in other words, work and life balance—becomes productive in the workforce, someone who cannot afford constant self-development due to financial or social constraints becomes unproductive in the workforce.

FOSS developers make themselves the ideal workforce for the neoliberal market by seeking freedom. Here, freedom means freedom of choice or a status of not being regulated by any external forces. By arguing that participation in FOSS or any other choice in the career path is based on freedom, FOSS developers help the industry remain immune from accountability for unfair employment practices. Moreover, they tend to condone contingent labor conditions that do not regulate them to be confined within a specific job or company. FOSS developers, by being an active labor force acting on the value of freedom, embody neoliberal worker subjectivities.

While this type of workforce is not uncommon in the current knowledge industry, FOSS developers are different in that they became ideal laborers by being hostile to female contributors. Unlike the majority of male developers, female developers are considered passive and inefficient by demanding "special" treatment that takes their individual circumstances into account. In addition, the existence of women is regarded as taking male contributors' freedom away since women's presence requires different levels of regulations to create a respectful and gender-sensitive environment. FOSS contributors' construction of their culture, which works against marginalized populations, should be understood as a part of creating neoliberal workers' subjectivities.

CHAPTER 5.

GENDER DIMENSIONS OF LABOR RELATIONS AND KNOWLEDGE PRODUCTION

Gabriella Coleman, in her influential study about hacker ethics, narrated "a '*typical*'[13] life history" of a FOSS hacker. The first half of the narrative unfolds as follows. The *typical* hacker, who is assumed to be a male,[14] traces his first hacking experience back to a very early age, demonstrating his natural talents. As he becomes older, he substantially grows as a hacker by teaching himself programming and interacting with other hackers online. He voraciously learns computing and eventually encounters free software to which he later contributes. While acknowledging that there cannot be a *typical* life history due to the unique details of each individual's life, Coleman provided this story based on her interviews with FOSS hackers.

I also have been exposed to similar variants of the narrative at conference sessions, on FOSS developers' blogs, or in FOSS-related books. For those who have observed the culture and discourse of FOSS communities, the narrative seems resonant with FOSS hackers' lives. However, when it comes to female developers, the narrative is no longer a *typical* life history. The majority of my interviewees did not follow this computer-prodigy journey of life. Some began programming during their college years, and others did not think of programming as a career option until they entered the job market. Although some interviewees were introduced to programming at earlier ages, they were aware of how rare those cases were for girls.

Although I cannot represent my interviewees or other FOSS developers who have *atypical* life histories, it is not difficult to assume that the discourse of *typical* life patterns of

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[13] I used italics for the words typical and atypical to deliver and emphasize the idea that a typical life history of hackers is constructed by further marginalizing underrepresented populations in FOSS development.

[14] In the recently published book *Coding Freedom: The Ethics and Aesthetics of Hacking* (2012), Coleman explained that she "[uses] 'he,' because most hackers are male" (p. 25).

FOSS developers intimidates those who are not given the privilege of spending their childhood and adolescence like *typical* hackers. When I attended the question-and-answer (Q&A) session *Ask Eric Raymond Anything* at Penguicon 2012, I was the only woman as well as the only Asian in the room. Although I expected the room to be full of attendees, the session was less crowded and quiet. This might have been because Eric Raymond is a frequent visitor to the conference or because his influence is no longer as considerable as before. However, Raymond is still a hero among young male computer enthusiasts. Most of the time, about 10 young men, whose ages seemed to be around late teens or early 20s, asked Raymond about programming languages. They did not seem to be uninformed about what they asked; rather, they looked as though they wanted to know the perspectives of Raymond, whom they respect. The young male attendees appeared to be those who had made the *typical* life journey of FOSS hackers. During the entire session, I was afraid to ask a question, thinking that it would unnecessarily make me stand out from the rest of the group; I could experience what it feels like to be someone who is different from the crowd.

This chapter examines the stories of female FOSS developers who do not fall into the *typical* FOSS hacker category. Although I included one male FOSS developer and three female non-FOSS computing professionals in my interviewee pool, this chapter focuses on the narratives of female FOSS developers. The chapter consists of three parts. First, I will describe Angie Byron's speech at DrupalCon Denver 2012. Byron's did not talk about her life history as a FOSS developer, although she briefly introduced her multiple backgrounds in FOSS development. Instead, she talked about Drupal Association's governance, in particular, the direction in Drupal community building. Her talk explained how the construction and circulation of a *typical* life history of FOSS hackers have affected FOSS culture and marginalized those who

did not take a similar path. After analyzing Byron's speech, this chapter discusses the experiences of female FOSS developers based on my interviews with some of them. The interviewees' stories unpack the reasons behind the scarcity of women in FOSS development and the causes of outreach programs to include more women. The last part looks at how the interviewees justify the efforts to foster diversity and how the justifications relate to their interpretation of FOSS roles.

Story of Angie Byron, an Atypical Hacker[15]

I was sitting in a session of DrupalCon Denver 2012. Angie Byron, the speaker, was the only woman who discussed governance of the Drupal Association during the three days of general programs. As she entered the room and chatted with the people around her, a person behind me whispered to his friend, "She is the second most important person after Dries [founder and president of the Drupal Association]." Drupal is a content management system (CMS) based on FOSS, which is a tool to build and manage websites by providing features such as user account registration, menu management, and layout customization. Often, Drupal's success is credited to its use by the White House for website management. Its market share ranked third after WordPress and Zoomla. I was excited to hear what Byron had to say about the Drupal community because she is one of the best-known and most influential women in FOSS development.

Byron began the session with a summary of Drupal's growth over the past few years and moved into explaining do-ocracy. Along with meritocracy, do-ocracy is one of the most widely

[15] This description of Byron's speech is based on my field notes from DrupalCon Denver 2012 and the video of the talk, which can be accessed at http://blip.tv/drupalcondenver/the-drupal-community-where-are-we-going-and-how-to-get-involved-6036678.

accepted governing structures of FOSS communities. In FOSS contexts, meritocracy refers to a system in which those who have abilities and talents lead projects while do-ocracy is based on the idea that those who want to see something done will initiate and lead projects. When Byron introduced the notion of do-ocracy focusing on its potential for empowerment, the famous *We Can Do It* poster appeared on a slide. While this poster was initially produced as wartime propaganda in the U.S., it has been appropriated by feminists to signify women's empowerment. I was somewhat surprised at Byron's use of this poster. Although the poster has become too widely used and is not necessarily associated with feminism, it still serves as a reminder of the feminist spirit. As discussed in previous chapters, FOSS contributors often challenge feminist ideas. On the one hand, the poster was a pleasant surprise for me since I read it as a well-planned strategy to emphasize participation in FOSS development as a means of women's empowerment. On the other hand, I was worried about how Byron and her presentation would be received by the session attendees.

Figure 4. Byron's talk slide 1

After explaining do-ocracy, Byron described how she came to join FOSS communities. Although she installed Linux in 1995 and has been an advocate of FOSS since then, it was in 2005 that she contributed for the first time. Byron implied that she was scared of contributing to FOSS and said that she does not want her case to be anybody else's story. Arguing that fun is an important value of FOSS development, Byron suggested three traits that define a contributor; to be a contributor, one should "think that's dumb," "want to see it fixed," and "do something about it." By defining a contributor this way, Byron challenged the prevalent assumption that contributing means programming.

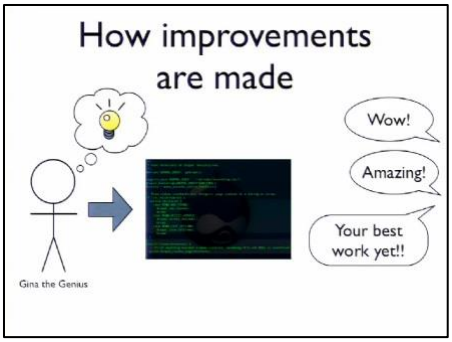

Figure 5. Byron's talk slide 2

She continued to explain the myth people hold about how improvements are made in a FOSS project. She pointed to a character drawn on the slide whose name is "Gina the Genius." The character was described as someone who uses Emacs as a text editor and writes code that amazes others. Humor as well as sarcasm were embedded in her short remark, "she uses Emacs, because she is the genius." Richard Stallman once described women inexperienced in Emacs as "Emac virgins," suggesting the masculine value attached to the text editor. He said, "In the church of Emacs we believe that taking her Emacs virginity away is a blessed act" (Byfield, 2009). Byron's choice of a female character as the programmer and Emacs as the text editor was intended to wittily criticize the belief that women are not competent enough to understand esoteric technological tools.

Byron's subtle changes of gender roles went on. When she explained the realistic processes of FOSS development, she gave female names to all the characters drawn on the slide—Edwina the end user, Paula the programmer, Tatiana the tester, and Wendy a user of XP. Moreover, introducing two hypothetical contributors with contrasting development styles, Byron called the female character Sam and the male character Pat, which are both gender-ambiguous names. Female contributors often point out that some people online act in a sexist manner by assuming or treating anyone discussing FOSS projects as males. Certainly, this is not just the case in online communication. As indicated in the Richard Stallman and Mark Shuttleworth incidents, female contributors are regarded as non-

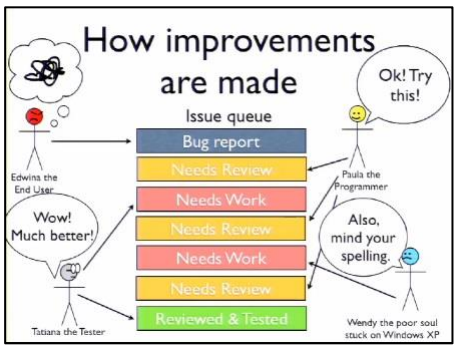

Figure 6. Byron's talk slide 3

existent even when they are physically present. Byron challenged the gender-insensitive practices in FOSS communities and created an alternative representation of female FOSS contributors.

At the end of the session, Byron emphasized that she does not simply mean programing by contribution; instead, she said that programming is only a part of what constitutes the whole of FOSS development along with other tasks such as documentation, graphic design, advocacy, bug reporting, and usability testing. In FOSS development, coding is often considered to be the most important contribution, and other tasks are less valued. People often stress the significance of documentation or bug reports/fixes when asked about the areas to which novices in FOSS development, especially women, can contribute. While these tasks are essential for FOSS development, those deemed to have the most merit are the contributors who code. Byron attempted to destabilize the internal hierarchy of FOSS development, which is often formed and reinforced by gender roles, by attaching an equal amount of value to each task.

Byron's talk constantly criticized and challenged normative beliefs within FOSS communities. These critical insights are grounded in her *non-typical* life history. Her early life is less known, but she received formal college education in computer science at a later age than traditional college students ("Summer camp," 2005). She spent her adolescence with a computer and became aware of FOSS in its early stage. However, Byron was daunted by the images of *typical* FOSS developers, which deterred her participation in FOSS for several years. Leslie Hawthorn, who managed the Google Summer of Code, once told a story of how Byron overcame her reservations and became an influential figure in FOSS development:

> To my surprise, she let all of us know that she had taken a few classes on web design at community college, but nothing that had really prepared her extensively for working on

> Drupal. She said that she'd been terrified of contributing to open source because it was just for geniuses but since she saw that Summer of Code was a program for students, she thought they'd be OK with someone who was a complete beginner. She'd been sucked in completely by Drupal and now spent morning, noon and night working on it (Hawthorn, 2010).

Without a professor's advice, Byron, the first women featured on the cover of *Linux Journal* (Frevele, 2011), would never have contributed to FOSS. Byron's story reveals that participation in FOSS development is not a matter of freedom as some FOSS contributors have argued. Both social and cultural capitals play role as significant as individual talent and enthusiasm. Furthermore, Byron suggested that coding talent does not necessarily help a developer make a better product. Byron's advocacy of do-ocracy over meritocracy is based on her belief that do-ocracy encourages people with diverse backgrounds to become involved in FOSS development. Byron's story requires us to hear other FOSS contributors who have not lived up to the *typical* images of FOSS hackers to better understand the labor relations within FOSS communities.

Gender and Participation in FOSS Development

When asked about how they were introduced to FOSS development, my interviewees gave a variety of answers. Alan, the sole male interviewee, followed a path similar to that in the *typical* life history described earlier. He grew up enthusiastically tinkering with a computer in his bedroom. Alan's first encounter with FOSS was when he saw someone use a Linux computer in a summer camp for talented youth that he attended in the late 1990s. Impressed by what his peer was doing with the Linux computer, Alan searched for information on Linux and gained a perspective that "[Linux] was a personal computer operating system that had a goal for users

being able to do whatever they wanted." For the next two to three years, Alan developed a deeper understanding of FOSS by reading Slashdot, "by the time a Linux-focused, open source-focused website" according to him. Luckily, his college years coincided with the malfunction of paperless voting machines, which created public concern in the 2000 presidential election. The machine manufacturer threatened students from Swarthmore College because they publicized the company's e-mail exchanges regarding the machine's flaw, which were unearthed by a hacker. Working in FOSS-related organizations after his graduation, Alan has stayed on an ideal path as a FOSS developer.

Among the female interviewees, Ruth was the only person who had a similar story. She was exposed to programming at an earlier age thanks to her parents' insight into future society. She recollected:

> I was basically given a computer. I didn't realize how rare the story was, but I was taught with this given computer specifically because my parents thought that feminism perhaps had fixed the society such that I would have many opportunities and I can go into the fields that women weren't in and make a lot of money.

Although Ruth had a close affinity with technology, she chose a humanities discipline as her major in college, thinking that the choice would help her suffer less from the stressful relationships she had with male geeky friends during her adolescence. Her male friends did not treat her as a peer capable of working with technology, but as a woman to date. However, it seemed that her early exposure to computers led her to stay current on the new emerging Internet culture. Although she did not have a clear memory of how she came to know about FOSS, she remembered that USENET during the 1980s and 1990s was her main tool for learning the hacker culture. Learning about Richard Stallman's ideals and reading Steven Levy's *Hackers* and hacker

ethics, she "was drawn to the philosophy that you are going to work collaboratively, you are gonna work with other people, and what you are gonna work on is gonna be a sort of the public good."

For some interviewees, intimate relationships were the channel through which to enter the FOSS world. Both Anita and Irene were introduced to Linux by their boyfriends. Encouraged by her boyfriend, Anita started going to a local Linux user group and interacting with other contributors. However, it took time for her to become actively involved in FOSS development and look at wider FOSS communities. Irene's introduction came during her college years when her boyfriend first told her about Linux. She grew more familiar with FOSS as she socialized with her peers and mentors within her school and has worked in various FOSS projects since her graduation. Other close personal relationships also served as a motivating factor for the interviewees to participate in FOSS development. Leah was influenced by her father, who has been a software engineer for four decades. She always had a computer in her house because of her father's job. Since her father was a member of the Electronic Frontier Foundation, she had opportunities to hear about the Digital Millennium Copyright Act at a young age. Moreover, it was Leah's father who brought Lawrence Lessig's book *Free Culture* to her. When she later decided to contribute to FOSS, a male friend, who had already been working on FOSS, helped her cross the threshold.

The rest of the interviewees began to contribute to FOSS as a career option. Jean made a career transition to a FOSS-based organization when her previous company, which had released its technologies under FOSS licenses, was acquired by a company that develops proprietary software. Betsy was a forward-looking person who brought the concept of FOSS into her team in a large tech company. She found it inefficient for an entire team to spend all of its working hours

fixing bugs; so Betsy learned how FOSS could make the development process more productive. For Mary, working in the IT industry itself was unplanned. As she had difficulties in pursuing a PhD in her major, she reoriented her goal toward an area that requires interdisciplinary knowledge of her major as well as programming. This led her to learn Python, a computer programming language whose releases are open source.

Luzena's story deserves separate space, although I still put her case into the career option category. Whereas the three interviewees mentioned above tended to subscribe to the idea of the Open Source Initiative—in other words, FOSS as an efficient development tool— Luzena valued the ideals of the Free Software movement. She began to learn programming in college as a non-traditional student. Although she had used FOSS software before, whether the program was FOSS-based or not did not matter to her since she "didn't know how to program at that time." When she came to college, she developed a sense of what FOSS is and how it works. As someone who has been involved in feminism and other social movements, she espoused the ethical stance of the Free Software movement, which promotes the public good. Meanwhile, as someone who had experienced harsh financial conditions working as a nanny and a restaurant server, she viewed FOSS as a career opportunity. She stated:

> You are interested in giving something free, interested in giving something good where alternatives maybe aren't as good. And you are having a lot of fun doing it, and you can do it for a job. That's when I sort of finally had a cohesive picture of what open source could be.

Even though I created distinct categories for the ways in which my interviewees were introduced to FOSS, each interviewee had a unique story. Despite their differences, many of the interviewees were to a lesser or greater extent influenced by their interpersonal relationships,

especially with romantic partners, male friends, and male family members. This situation is not limited to my interviewees, but is often reported by other female FOSS developers as well. Irene not only reconfirmed this observation but also argued that those relationships with men are somehow related to women's survival in FOSS communities:

> I found a way to succeed in that system, and then a lot of them probably had to do with very close relationships that I had with men in different projects. Some of those were dating relationships, some of them were just really close friendships. And I am finding that a lot of the women that I know who are successful have those intimate relationships in all their stories. There are some exceptions if they've got generations of engineers in their family and their fathers are really supportive of them, they would be able to kind of enter into open source without having intimate relationships.

Irene contended that these intimate relationships with men carry a backlash against the efforts to invite more women into FOSS since feminist criticisms against the culture of FOSS communities can potentially damage those relationships. I do not find Irene's argument necessarily plausible. Some women who became established without the help of close relationships with males would be likely to argue that there is no sexism in FOSS communities since their presence and success prove it to be true. Three of my interviewees who entered the FOSS world based on their independent decisions in fact told me that they had not experienced any notable sexist treatment. On the contrary, Irene herself demonstrates that her intimate relationships with males in her FOSS career did not make her insensitive to gender issues. More investigation is needed to make the claim that female FOSS contributors' close relationships with men have acted as a backlash against outreach efforts. However, it is agreed that those relationships are prevalent in female contributors' stories, and this calls attention to the roles of networking in FOSS involvement that

I will discuss in the next section.

Why There Are So Few Women in FOSS Development

To discuss the reasons for the small percentage of women in FOSS development, issues of both recruitment and retention must be addressed. While the fundamental structure that bolsters the male-dominant culture is the same, the everyday practices adopted to maintain the culture may vary. As discussed in chapter 3, the number of women who majored in computer science or worked for the computing industry declined around the time when the Free Software movement began. Although there have been rises and falls since the mid-1980s, the percentage of women in the computing field has followed a downward curve. There have been efforts to find radical solutions to the issue, and the intervention program at Carnegie Mellon University is a well-known success case (Margolis & Fisher, 2002). However, the general conditions seem not to have changed, especially considering that scholars have repeatedly pointed out similar causes and solutions for the last three decades. Thus, there is a limited pool of potential female contributors from the outset. Even if a woman from the limited pool begins to participate in FOSS, the culture inside FOSS communities, at times, drives the existing female contributors away. This section first will discuss the factors that contribute to women's difficulties in both entering FOSS communities and staying in them. Following this, I will discuss the efforts for outreach to women.

Difficulties in Recruiting Women

General Lack of Female Contributor Pool. To the question of why there is a small percentage of women in FOSS communities, the majority of the interviewees pointed out the limited pool of women in the computing field as the main reason. Those who were college

educated in computer science said that there were only a few female students in their classes. However, why the percentage of women in FOSS development is significantly lower than that of women in proprietary software development remains unresolved. Alan, based on his own experience of being introduced to FOSS development and his observation of others, drew a diagram that illustrated multiple steps to become a FOSS developer.

Alan suggested five steps. First, "Realistically, you need to learn how to program." Although Alan promptly corrected himself by saying the word "realistically" was an "exaggeration," he admitted that programming capability is "useful" for a project. When one roughly assumes that the ratio of males to females among the potential FOSS contributor pool is 75:25, the likelihood for women to become FOSS contributors is low from the beginning. The second step is gaining a basic understanding of FOSS itself. Although someone comes to know FOSS through his or her own search, "you need an access to people who tell you about it." At this step, the gender ratio would widen since peers are often the human resource that facilitates understanding FOSS. Unless a woman actively engages with her male colleagues, she loses the chance to understand the idea of FOSS. The third step is to understand different types of FOSS projects and become familiar with communication tools within those projects. Internet relay chat (IRC) channels and mailing lists are the most frequently used tools for communication. The gender gap also widens at this step with a ratio of 9 males to 1 female. Someone who has completed these three steps can be deemed to have the technological competence to contribute to FOSS. However, technological competence alone does not make someone a FOSS contributor. The realization that "you would be a good person to participate in this project," which Alan called self-actualization, should follow. When the person still remains determined to contribute to FOSS even after some failures and retries, one can say that the person has become a FOSS

contributor. At this point, the percentage of women has significantly decreased to around 2%. While Alan did not mention contributors who focus on areas other than programming, they would take a similar path.

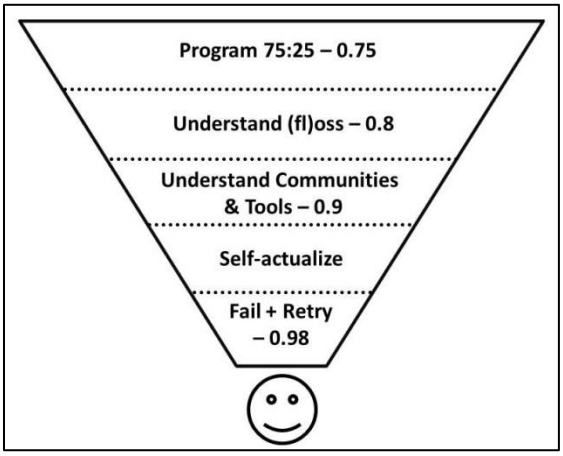

Figure 7. Steps to become a FOSS contributor

Real-life cases would have more variants, and the ratio assumed in the diagram would not be representative of all FOSS communities since it is based on one person's experiential knowledge. However, his explanation of the scarcity of women in FOSS development gives a more sophisticated view of the processes of becoming a contributor. While some contributors who feel antipathy toward outreach programs argue that FOSS contribution is entirely a matter of choice, people must acquire social capital early even to move through the first step. It should be noted that the gender gap increases with each step, which implies different types of gender-related barriers to becoming a FOSS contributor.

Barriers to Entrance. In chapter 3, I unpacked how the growth of computer science in higher education settings contributed to the decreasing number of women in the field. While I limited the scope of the analysis to college education, gender gaps in using and learning computers start much earlier. As the *typical* life history of FOSS hackers reveals, the very first moment in preparation for becoming a FOSS developer is when someone is given a computer.

Cynthia, who is a Latina woman and once worked as a software engineer, said that kids in Silicon Valley, from very early ages, are surrounded by technologies and provided opportunities to discuss and learn about them with their parents, whose jobs are very likely tech-related.

What Cynthia told me was not much different from what I observed in She's Geeky 10, Bay Area. At the unconference, I joined a session about the ways in which girls can be exposed to science fields, expecting that it would also be about gender issues in STEM education in general. A couple of women who have daughters, a teenage girl whose mother is a computing professional, and I were present at the session. The direction of the session differed from my expectation. The attendees shared information on museums, camps, and events where *the attendees* can bring *their daughters*, as well as resources that *the attendees* can use *for their daughters*. In other words, the session was about STEM education for girls living in the Bay Area, not for girls in general. I do not intend to criticize them for only focusing on their children. The attendees seemed to be anxious about their daughters' STEM education because of the Bay Area's competitive environment. Moreover, my position as a researcher who is concerned with gender issues in the STEM fields heightened my expectations.

The session at She's Geeky 10 revealed that someone's entrance into programming is likely to be decided by the environment. In 2011, DEFCON, one of the largest hacker conventions, started a DEFCON Kids program. To have a child registered in this program, parents must prove their registration in DEFCON. Figures from the computing field are invited to speak; in 2012, the speakers included "General Alexander, Director of US Cyber Command and the NSA; Chris Anderson, Editor-in-Chief of Wired Magazine; Cory Doctorow, sci-fi author; Joe Grand, famous hardware hacker; and Marcia Hoffman, an EFF [Electronic Frontier Foundation] lawyer" (defconkids.org). This is not a list of people that a normal kid could easily

meet and talk with. Without their parents' enthusiastic support, both financially and culturally, this type of learning opportunity to become a young hacker would not exist. In current years, social class seems to be a factor as important as gender in accessing resources to follow the hacker prodigy's journey of life. The equal gender ratio at the DEFCON Kid program indicates that girls are encouraged as much as boys when their parents have social and financial capital to support them. However, gender was a more determinant element that affected the allocation of resources in the past. In the early 1980s, the ratio of boys to girls in computer camps and classes was 3:1, and girls were more likely to attend cheaper programs (Hess & Miura, 1985). These are the generations that would have been involved in FOSS when it was booming with the release of Linux. Like Alan said, "it's male plus white plus upper middle class," which helped someone cross the first threshold to becoming a FOSS developer.

Networking. Once someone gains programming skills, the person must understand what FOSS is to become closer to actual FOSS participation. As demonstrated in my interviewees' stories, different sorts of interpersonal relationships (i.e., interpersonal networks) are among the most common ways of gaining exposure to FOSS. Since women's participation in FOSS development is low from the beginning, a woman is less likely to benefit from women's networks. Anita said:

> A lot of people find Linux through someone they know, and if women only hang out with other women and they have not used Linux, because they are not interested in technology, they have a less chance to be exposed to it, and less chance to be in a group, in their life, social circles that are using Linux and getting involved with open source software.

There might be a counterargument that learning materials about FOSS are readily available on the Internet. Some FOSS developers' claim that participation in FOSS should be a matter of

individual choice based on the idea that the Internet is the main channel through which the idea of FOSS is circulated. It is true that online news websites such as Slashdot and Hacker News and numerous FOSS-related mailing lists are important learning places for a potential FOSS developer. However, someone needs prior information to visit those websites or subscribe to those mailing lists. Alan argued that when an interested individual joins a mailing list, the person is already at a "filtered point" or "biased point." He said that the mix of race, class, and gender factors increases the probability for someone to be included in networks that talk about Linux.

Initially, I assumed that once women enter a computer science program in college, they would have more chances to hear about FOSS through their professors or classes and this would offset their lack of network at earlier ages. However, this was not necessarily the case. Luzena said, "I was fortunate to have a professor who did talk about it, and really championed the idea that being able to look at someone's source code was really great skill to have going in the working place." As indicated in the word "fortunate," it was not common for educators in college settings to introduce the idea of FOSS. Like Luzena, other interviewees remembered that information on FOSS was rarely provided via formal routes in their college years. Irene did not meet any professor who discussed FOSS in her college years although she was able to meet mentors and peer groups via personal routes. A generational factor might have affected my interviewees' experiences. Leah, one of the youngest interviewees, told me that a Python class was eventually created in her school after she graduated. Irene's criticism of the teaching practices in the computer science major partly explains why a college education does not help someone learn about FOSS:

> It's unbelievable to me that educational institutions who choose to teach Oracle [Database] instead of PostgreSQL as teaching database, especially when they have to pay

> for it. In terms of teaching concept and understanding how database does work, PostgreSQL is a much better option.

To put it simply, Oracle Database and PostgreSQL are database management systems whose purpose is to help store, modify, and utilize information from a database. Apart from the debate over which application is better for an educational purpose, Irene pointed out that educational institutions do not give students' opportunities to learn the inner working of database management systems in an effective manner. Irene suggested that the close relationship between computer science education and the proprietary software business, which is built on funding and workforce supply relationships, would lead educational institutions to be reluctant to introduce and teach FOSS. When formal ways of learning about FOSS are not provided, interpersonal networks are the major avenue for someone to seek an understanding of FOSS. Given that women often do not have such networks, the gender ratio widens.

Self-Actualization. As seen in the diagram, an understanding of FOSS and self-actualization does not have a clear boundary. As someone looks at how a FOSS community is formed and maintained and how a FOSS product is developed, the person would sense whether he or she is the right person to participate in FOSS development. The biggest barrier to women's self-actualization has been their low self-esteem, a result of constant comparison to male counterparts. Anita explained how she felt when it had been only few years since her first use of Linux:

> So we [women] are starting off with fewer who are interested in early on. The ones who do get interested in that point often feel that they are really behind. You know they meet all the guys who say "you know, I have been programming since I was 12 years old," "I contributed to my first open source project at 7." It's really intimidating.

The *typical* life history of a FOSS hacker, which was introduced earlier, serves to make women feel intimidated and less confident. It seems that a strong sense of rivalry exists among male contributors. *When* they first started programming, *when* they first installed Linux, and *when* they first contributed a line to a Linux kernel are often discussed among male contributors in online forums. Furthermore, *what type* of tools one uses for programming and *what type* of projects one contributes to are also frequent discussion topics that express one's superiority over others. Given that a tangible reward other than reputation is not provided to many FOSS contributors, the desire to show one's level of competence is understandable. However, the stratification of a contributor's ability or level of involvement is likely to function as a deterrent to the participation of women and other underrepresented populations in FOSS communities.

The atmosphere, where the level of competence is more heavily emphasized than the actual contribution itself, often makes women feel less qualified. Radia, who is a non-contributor, said that she needs to have a higher level of programming skills to make a contribution to a FOSS project. It seems that this belief in contribution to FOSS was constructed by her interaction with male colleagues. Radia stated:

> I think it is really hard to contribute. I have heard about some of the male developers in my team who are very into open source, open source communities, contributed quite a bit. But for me, I haven't considered that because the level of expertise is a lot higher than mine. So at the moment, I am like more focused on just catching up to a certain level of expertise because I have a feeling, maybe wrong, but to contribute to open source communities, you need to have certain level of programming skill.

While good programming skills are an important asset, programming is not the sole talent required in FOSS development. Bug report and documentation are among the most significant

areas of contribution, but they suffer from a shortage of workers. Radia's perception of FOSS development was based on her colleague's perceptions of their contribution to FOSS communities, especially given that she is fairly new to programming and does not have a deeper understanding of FOSS. One can assume that, based on what Radia said, she hears her colleagues boast about their coding skills more often than explain the meaning of their contribution, no matter how small it is. When secondary aspects of FOSS contribution (e.g., how young when someone started contributing, how many lines someone has written, how many technological tools someone can use) are emphasized over the meaningfulness of the contribution, the likelihood of self-actualization cannot be high among potential contributors who did not have the privilege of learning programming early enough.

No Spare Time. Even if women move through the self-actualization step, their traditional role as care givers functions as a deterrent to their participation in FOSS. When I asked Irene, who is married, how she strikes a work-life balance, she answered without hesitation, "I don't have work-life balance. No, I don't at all. And it's a problem. It's a problem." Irene told me that she spends 60 hours per week on FOSS projects. On top of that, she had just accepted a part-time position as an advisor for a FOSS-related organization when we spoke. If this is a normal life for an established FOSS contributor, it would be extremely difficult for women to participate in FOSS as full-time contributors and provide care for their families at the same time. In fact, Irene was able to think of only two women who are established contributors in FOSS communities as well as mothers. Ruth, who is a long-time FOSS contributor and the mother of a child, gave a further explanation of what it is like to add more volunteer work to a woman's life:

> Women already do more than their fair share of work for the most part in terms of taking care of children, keeping the house clean, and working two maybe or three jobs to

> support the family. Expecting women to then stay up to three in the morning, and take more of their free time away to open source projects in the hopes that they might be able to get a job, that's a big barrier.

A probable counterargument to this rationalization is that not all women engage in intensive caregiving work. In particular, college students or young professionals who do not have heavy caregiving responsibilities would feel less pressure about spending their free time on FOSS projects and self-development. Interestingly, however, most of the interviewees without families answered that women's caregiving work is one of the biggest barriers to women's participation. This response might have been generated by the interviewees' perception of the free time of women as a collective, free time that is often consumed for others not for themselves. Ruth interpreted the scarcity of women's participation in FOSS as a form of resistance to society's expectation for women to provide free labor. She stated:

> As a woman, there are many demands on us to do free labor. As a part of expectation we work for free, and we devote our labor to society, or to family, or to men. It is a huge expectation on us as a part of oppression. And having some suspicion or resistance is natural. You know, there is pressure on me to join the PTA to contribute to the public school, to do quite a lot of organizational, high level organizational work, grant writing, all kinds of work. The school system in public education depends on exploiting the labor of middle class women as do a lot of things like child rearing and just basic maintenance of society.

Studies on the relationship between free time and gender strengthen Ruth's argument. In the U.S. context, both quantity and quality of free time were low for women, and this led women to feel more time pressure (Mattingly & Bianchi, 2003). One notable finding was that increased free

time did not help women feel less rushed while men felt less time pressure with an increase in free time (Mattingly & Sayer, 2006). Mattingly and Sayer explained that "women feel more pressure to combine a high level of domestic output with paid work hours, and this pressure may underlie the lack of association between free time and being rushed for women" (pp. 218-219). They contended that "persisting gender inequality in the domestic sphere" contributes to women's perceptions of free time. Gender differences in free time and time pressure were not only observed among adults, but also found in female adolescents attending middle and high schools (Winn & Heeter, 2009). Thus, my interviewees' response that the lack of free time is one of the biggest barriers to women's participation in FOSS should be interpreted considering time constraints in both physical and perceptual senses.

Less free time and a higher level of time pressure may make women more cautious about choosing what to do during their free time. One of the common responses among my interviewees was that women tend to want to spend their free time doing something meaningful. Eva, another non-developer said, "When compared to all of the possible things a woman can do during her free time, coding must be the most fun thing. Otherwise it should be a very meaningful thing even compared to other options." In the previous section, I described a tendency in which the meaningfulness of FOSS development is underplayed in comparison to the ability to code. When contribution to FOSS is seen as a competition, it is unlikely that women will spend their free time on FOSS development.

Difficulties in Retaining Women

Even if women overcome the entry barriers and start contributing to FOSS, the retention issue still remains. It is not certain what proportion of women leaves FOSS development due to the unorganized structure of FOSS communities. However, based on my interviewees'

experiences, I presume that it is not uncommon for a female contributor to leave. The interviewees suggested several factors as reasons for driving women out of FOSS communities.

Sexism Inside. Some of the interviewees pointed out that different levels of sexism affect female contributors' retention. Treating female contributors as non-existent in FOSS development was considered to be a lower level of sexism that occurs frequently. When Anita started to attend a local Linux user group suggested by her boyfriend, she often heard attendees ask her boyfriend "Does your girlfriend use Linux?" in her presence. The underlying assumption that women are not FOSS contributors results in overwhelming attention to a few women, as in Anita's case. This assumption is more likely to be made in online settings. Anita described the common reactions of men when they find female contributors' presence online:

> As I started getting online and going in [IRC] channels and all that stuff, it was kind of weird because there weren't very many women, we were always assumed we are guy. So there are some people who completely oblivious because they may haven't worked with a lot of women developers in open source.

Those who were "completely oblivious to women existing at all in open source" were seen as "trouble," but this type of reaction to FOSS women was regarded as less serous sexism that can be accepted. A group of contributors who were "actively discouraging and trolling" FOSS women was considered more problematic. One way to discourage female contributors is to denigrate women's contribution. Luzena described a situation that could occur when the hiring for an influential position is being decided. She said that some male contributors would say, "I've never heard of her," "why she deserves to do this," or "if we nominate her, then I would nominate all of my friends," whereas there would be no opposition to male contributors' nominations. Luzena saw this denigration as "rude, dismissive, and hurtful."

Ruth explained that harsher standards were applied to women by comparing FOSS women to female writers. She said that both female contributors and writers participate in the public sphere through their coding and writing. As a result, "[women] do attract a lot of backlash against women's participation," and "[women] become more of a target for almost anything." The "misogynist comments" and "hate speech" would not stop even if women proved themselves to be good at programming since what male contributors ultimately attack is not the quality of coding but women's participation in the public sphere. In contrast, "men are given the freedom to screw up and still be good, and to be seen as intrinsically good at programming."

As a great proportion of FOSS activities take place online, hostile comments are frequently observed in online settings. Often, the anonymous or pseudo-anonymous qualities of online communication makes cruel comments commonplace. Anita also has met those "who come in and say things like 'get back in the kitchen' or just come in to say cruel things like 'you are all men' or 'I want to see your pictures' or 'will you all marry me.'" Anita simply dismissed these types of comments as "just really childish malicious things" and treated the people as "just trolls." However, upon close examination of the comments, one can see that they are relevant to what Ruth said regarding the public sphere. The "trolls" did not merely devalue women's technical skills, but by asking them to go back to the traditional women's place they stood in opposition to women's existence in the public sphere.

The consequence of the hostile environment is female contributors' hesitation to become involved in the public sphere online. Irene is a well-regarded contributor in her area and she thinks of herself as aggressive. However, she said, "I haven't been really a contributor to public technical mailing lists at all in the entire of my career because it is scary, really scary to do." Online communication based on anonymity or pseudo-anonymity is not the only way in which

FOSS contributors interact with each other. However, because it is one of the most important communication channels among contributors, verbal attacks against female contributors online would narrow the space in which they can safely work.

Macho Culture. Most of the interviewees problematized sexist comments and behaviors of male contributors as they affect women's willingness to continue to contribute to FOSS. Sharing similar experiences of being disregarded and attacked indicated the prevalence of sexism in FOSS communities. However, the interviewees were cautious about criticizing the culture of FOSS communities as a whole; instead, they tended to blame individuals who are immature and disrespectful. Ruth was the only person who explicitly criticized sexism within FOSS communities at a more structural level, seeing "open source culture" as "macho." Although Ruth's view is not the majority view, I believe it is worth addressing in a separate section. I still agree with the majority of the interviewees in the sense that sexist behaviors of some male contributors cannot be generalized. However, the persistence and sufferance of sexism implies that FOSS communities somehow sustain the sexist culture.

Ruth argued that the sexist or macho culture of FOSS communities is rooted in the feminization of geeks among earlier generations. She said that "[whoever] grew up being nerdy was very feminized for being nerdy" when the field of computing was still new. Ruth, when she was young, saw a nerdy boy was called a "wimp" or a "faggot"; thus, "a lot of misogyny reflected badly on those men [who were nerdy]." Ruth interpreted the current macho culture of FOSS communities as a backlash against the feminization of geeks. She did not call the FOSS culture macho simply because some contributors do not behave properly. Rather, she expressed concern about what metaphors are used and how hackers treat each other to reveal the subtle but pervasive masculine hacker culture. In terms of the metaphor, Ruth emphasized the term rape as

a metaphor, which means "to (metaphorically) screw someone or something, violently" according to the *Original Hacker's Dictionary.* Moreover, she paid attention to FOSS developers' tendency to be harsh to each other, especially in online communication settings. Ruth stated, "You are harsh to other person, you are doing them a favor because you are criticizing them and toughening them up." In other words, FOSS developers construct their masculinity by criticizing others, in particular their codes. Most women take this culture as masculine, offensive, or intimidating since they are not socialized to be aggressive.

Ruth's argument resonates with other studies on geek identities in that they see geeks or computer enthusiasts as constructing their masculine identities by being scientific and rational (Verma, 2007). When male FOSS developers criticize and try to toughen up other developers online, it is in an attempt to appear rational to the level of aggressiveness. This way, male FOSS contributors can achieve two types of hegemonic masculinity—one being manly and one being logical. When following this argument, male FOSS contributors' harsher treatment of women can be understood as a sense of crisis in that they can no longer claim their masculinities in opposition to illogical and emotional women. I should make it clear that defining the FOSS culture as masculine differs from making a generalization about all male contributors. Instead, I intend to criticize the ways in which the aggressive FOSS culture is sustained by some developers and acquiesced to by other contributors even if the culture prevents women from participating in FOSS development.

No Accountability. A FOSS community is often considered a very loosely organized collective that consists of interested individuals worldwide. For instance, in the narrowest sense, the Drupal community could be defined as a group of people who are officially hired by the Drupal Association, but the Drupal community normally includes anyone who is involved in

developing and using Drupal. This loose organization means there is no authority responsible for unfair treatment of contributors. Luzena contended that some contributors can think of the community as being unsafe when there is no basic consensus about how to be respectful of others. When she said "unsafe," she did not necessarily mean only a type of feeling one can have in physical space, but included experience of fear in virtual space as well. Luzena stated:

> Imagine you are at home in the middle of America somewhere on your laptop, and you see something like [offensive comments]. And it's almost like someone just punched on your gut through your computer, and you are alone, alone in your house, you are just trying to get your work done.

Luzena argued for writing a code of conduct so that "[people] have to agree to a basic level of respecting each other" and "thoughtfulness." However, the attempt to write a code of conduct for a FOSS community often faces criticism. Ruth summarized the common reaction as one word: censorship. That is, a code of conduct is perceived as a tool to regulate freedom of speech, especially that of male contributors, and the basic rights of underrepresented populations to remain safe is denied. Ruth continued to list common responses to a code of conduct such as "[Women] are not like real adults," "They want to make an environment where we can't flirt, can't joke," or "[They have] no sense of humour." These responses often lead to the claim that those who cannot adjust to the existing culture are not qualified to be a member. FOSS contributors not only tend to oppose any organizational actions that regulate their behaviors but also deny their accountability for how they behave. This denial of accountability based on the claim of freedom makes it difficult for female contributors to address gender issues within the communities.

Outreach

Various outreach programs have attempted to include more women in FOSS communities. LinuxChix was the first community established to support women in FOSS communities, although the main purpose was not outreach to women. Since the launch of LinuxChix in 1999, a series of communities has been created to not only retain the existing female contributors but also to recruit new women contributors. Between 2004 and 2006, there was a notable increase in such communities, including Debian Women, GNOME Women, Ubuntu Women, and PHP Women. Groups with similar purposes continued to form; thus, many of the FOSS projects that grew to considerable size have groups for female contributors and those that support women. Approaches to outreach are as varied as the groups; however, in this section, I focus on two conflicting issues regarding outreach programs: rationalization of outreach and gender role assignment.

Rationalization of Outreach. Except for two, all of my interviewees were involved in outreach to women through various programs. Since there is a firm belief that involvement in FOSS is an individual decision and any outreach efforts are positive discrimination, it is important to have rationales that can be accepted in FOSS communities in general. It should be noted that some open source projects have grown, actively discussing gender issues in their communities. For instance, both Alan and Ruth referred to Python as a FOSS community in which diversity issues were discussed patiently and deliberately from an early stage, and the community has enjoyed a relatively better gender ratio. However, in some cases, discussing gender dynamics itself faces obstacles. Irene, based on her personal interaction, said that there are "Debian women who really reject the notion of women and the need to establish themselves as separate from Debian itself." Furthermore, she said that "Debian has a lot of very vocal

European members who are very opposed to women separatist movement." Thus, rationales for outreach differ depending on the historical and cultural context of a FOSS community. However, the rationales that my interviewees mainly discussed fall into two categories: labor shortage and women's rights.

For some FOSS communities that suffer from a labor shortage, outreach is a way to recruit new contributors. Anita, who works for a Linux distribution vendor, stated, "We really need more contributors. So pushing anyone out is really a loss for us all." According to Alan, women are the "obvious outreach pool" since women were more likely than men to be cast out in the step of becoming a programmer. He explained that his outreach efforts normally impress other male colleagues rather than arouse negative attitudes because the rationale to "save women and save the world by programming open source" is well received.

Some of my interviewees emphasized the need for gender issues to be more actively discussed. Luzena, who has been involved in feminist activism, lamented the retrogression of FOSS communities in their gender sensitivity. She stated:

> All republicans just voted down the equal pay act, including the women. How do you do that, how do you vote against equality? It's interesting because in the community that I come from, there is a backlash against feminism because of transgender issues and so on. . . . They think that they are so past feminism, and now they don't need it. And in the software community it's the opposite, like we are so pre-feminism, and we do need it.

Luzena argued that feminist thoughts should be integrated into FOSS communities to challenge the sexist practices in recruiting potential contributors. In a similar vein, Ruth also criticized outreach strategies that do not problematize gender dynamics within FOSS communities. In particular, she saw outreach to teenage girls as "old school" since it does not help to reverse the

gendered power structure in the computing field or in FOSS development. For her, merely increasing the number of women cannot fix the gender issues in FOSS development. Rather, she argued for outreach channels that can bridge the knowledge gap among adults first and bring younger generations in later so that the same harsh treatment of women is not repeated.

Gender Role Assignment. Another conflicting issue in outreach programs is what type of tasks the potential female contributors should be encouraged to undertake. Contributors' status is often stratified depending on their skill, with coding being the highest level of skill and the other tasks being lower levels of skills. When I asked what Alan thought about women being encouraged to perform tasks other than coding, he asked himself "if there is any kind of explicit or implicit role pushing where you push people who are women into non-core roles" to further contextualize my question. He continued, "Calling them non-core is kind of unfair."

Alan did not give an answer to the question he posed to himself, but the question deserves more contemplation. One can assume that women are pushed to think the right roles for them are non-coding tasks. The cultural construction of coding as always being a man's domain makes it difficult for women to envision themselves coding. Time constraints are another factor preventing women from coding. When asked about how to help women remain in FOSS development despite their lack of time, Irene said that they can be assigned tasks to do during "half an hour or fifteen minutes spare time." Coding is not a task that someone can do in a short amount of time. Ruth once said she needs a chunk of uninterrupted time to code, which is not easy for women to find.

In regard to Alan's following comment—"Calling them non-core is kind of unfair."— I agree that calling any of the tasks in FOSS development non-core is unfair since it takes multiple skills for a FOSS product to be developed, circulated, and used. However, saying that tasks other

than coding are considered non-core is fair. As shown in Alan's diagram, coding is the first task that occurs to people's minds when discussing FOSS development. This is because FOSS development most often prioritizes functions over any other features such as design or usability. This tendency is in part a result of the condition of FOSS development in which an individual initiates a project. Therefore, making the program work is the top priority until the project grows and people start contributing. Most importantly, FOSS is about code from the outset.

In response to the small number of female contributors, there have been attempts to recruit women regardless of their role. Byron's talk is an example that attempts to include women in any type of role in the Drupal community. Anita also said that she encourages women even to perform non-technical tasks in the hope that they will become interested in coding by looking closely at the work. Leah once heard that a session at the Perl conference had a discussion on "how can get women involved in free software" and "documentation, QA system, testing, and design" were suggested as areas for women. While she said these roles should be emphasized, Leah wanted the gender boundary to be redrawn.

Ruth was the only person who strongly criticized the strategy to increase the number of women by assigning them to non-coding tasks. Certainly, it was not that she degraded the value of those tasks. Taking WordPress as an example, Ruth argued that FOSS outreach programs should aim to recruit women to participate in the highest status work since that is what eventually helps women to secure jobs. She heavily subscribed to the ideals of hacker ethics and free software, but at the same time saw participation in FOSS as a good career opportunity for women. Although women would use more free time and exert more effort to code, Ruth saw the need to encourage women to do so. Otherwise, the possible consequence is repetition of the gender hierarchy.

Future of FOSS and the Role of Diversity

The scarcity of women in FOSS and the outreach effort deserve attention due to FOSS's roles in the knowledge society. Liberal feminists' idea of gender equality still holds great significance; in fact, concerns about gender imbalance in FOSS communities are, to a great extent, generated by liberal feminists' claim that women should be given the same opportunities as men. Some of my interviewees also seem to act on the belief that women and men should be equal when they are involved in outreach. A problem of the liberal feminist ideal is its focus on the balance in a numerical sense. That is, the quantitative balance of gender is often set as the main aim to be achieved, and the quality of opportunity is considered to automatically follow. However, as Ruth argued, it is problematic to put women into secondary roles in the hierarchy of FOSS development because not only do coding experiences increase future employability but also coders' values are very likely to influence the products developed. Considering the influence of FOSS, which permeates various aspects of our lives, the people involved in FOSS development and what they envision with FOSS have critical importance. Thus, in this section, I will discuss how my interviewees envisioned the roles of FOSS and why they are concerned about diversity in their envisioning.

Importance of FOSS

FOSS for Financial Benefits. Interviewees emphasized the role of FOSS as an alternative to high-priced proprietary software. Mary and Luzena addressed the need for cheaper FOSS alternatives not just because the pricing in proprietary software development is illogical but because the unnecessary high price is disadvantageous for people who need to access the software but do not have the financial resources to do so. Both Mary and Luzena are latecomers to FOSS development and had careers in other fields. Their experiences as users helped them see

how the price of a software program restricts one's access to information, widens the knowledge gaps between the haves and have-nots, and prevents the use of software for the public good.

Mary has a background in finance and has seen corporations spend a considerable amount of money on Bloomberg Terminal, a financial data analysis system, which is the most widely used system in the field. The price for the services is not publicly available, but it seems to be around $1,800 to $2,000 per month based on Mary's description and other resources online (Simons, 2012). Furthermore, the users are locked into a two-year contract when they confirm their subscription. Mary began with pointing out the unintuitive user interface of the terminal saying, "It's like MS-DOS. You have to key in everything rather than go by mouse, not very user-friendly." Then, she talked about her ultimate goal in the field of FOSS, which is to develop "open source sort of Bloomberg application" that will be "freely available." She said that making financial information open is desirable not only for the industry's experts to access transparent information but also for non-experts to understand the moves of financial resources, which affect their lives in both direct and indirect ways.

Luzena has been involved in social activism and worked for non-profit organizations. While she was working, Luzena found that "[the organizations] are tied down to paid software and the mercy of companies" and have to purchase "the latest version of software like Adobe Creative Suite." She viewed this proprietary software as unsuitable for the small budget as well as for the needs of non-profit organizations. She stressed the necessity of FOSS tools that are customizable to fit different user conditions and saw this as an opportunity for FOSS contributors to expand their career options.

Better Interactions with User. Jean, who is involved in open web technology, emphasized the close and open communications between developers and users. She stated:

> I think that as development process [open source is] much better than proprietary software because you are so close to your users, you can have an open dialogue with them about the software you are building, and it makes a better product. Because instead of sort of being walled off from people who are going to use the products, you are always in contact with them throughout the process.

The relationship between FOSS developers and users is a contested topic; thus, what Jean said needs more contextualization. The FOSS project she has been working on is large enough to have a support team. As a member of the support team, she observes users' responses, collects their reviews, and reports them to the engineering team every week so that the feedback can be updated into the product. Comparison between Microsoft Office and Apache OpenOffice will give a better picture. For ordinary Microsoft Office users, the ways in which they can report bugs or give suggestions are limited. As of March 2013, Microsoft does not accept bug reports or suggestions for the Office product. Although users can still provide their feedback by posting public questions on the community website and sending closed messages to the support team, it is unlikely that one will be able to see the processes in which the feedback is handled. Furthermore, the users would be oblivious to the changes made since laypeople would update Microsoft Office through the automatic Windows update system. Apache OpenOffice users would be able to see the processes in a more transparent manner by subscribing to mailing lists that are categorized based on topics and target audiences. It takes time, effort, and a certain amount of knowledge to digest information on OpenOffice; thus, I would not contend that every user can access the information easily. However, there is certainly less secrecy in the Apache OpenOffice case.

However, the open interactions between FOSS developers and users are not applied to all

projects. In particular, when a project is small, the communications are not smooth as in bigger projects due to labor shortage. Furthermore, how a developer defines an end user—from a user with no knowledge of development to another developer using the program—can affect the quality of communication. However, as Jean's experiences demonstrate, FOSS projects with a wider user base can effectively and efficiently respond to users' needs through open communication tools.

Power of Code. Several interviewees addressed the issue of technological power over people's lives, expressing concern about what roles software will play in the operation of society as well as the everyday lives of individuals. Living through the important phases of technological development and observing the increased status of programmers in the 1990s and the 2000s, Alan came to the realization that "programmers of the next 20 years are going to dramatically change the society and everyone else is going to have no say over it. . . . That's why this whole thing matters to me." He further explained that FOSS is a part of bigger political questions regarding the power of technology such as "who controls the technology on daily basis, who chooses what gets made, to what extent can you say no to technology you don't wanna use either practically or politically."

As an example of technological power, Alan introduced the Skype privacy case in China. In 2008, the world learned that TOM Online, Skype's partner company in China, had not only filtered but also stored conversations containing certain words such as "'Communist Party', 'Tibet', or 'democracy'" ("Skype admits," 2008). Alan said "because of the structure of software and organization that created it, your person-to-person communication is mediated through the party who you do not truly trust." The power of software Alan referenced is related to Winner's and Lessig's ideas of "technology is political" and "code is law," respectively. That is, the ways

in which a software product is built affects how the product is maintained, who is involved in its maintenance, and how individual users' thoughts and behaviors are regulated.

Betsy also expressed great concern about society's reliance on software. She stated, "We use software to automate a lot of critical things, you know, how water gets filtered, and there is software that controls pipes and filtration systems, things like that. . . . And we rely on really without thinking about it." For Betsy, FOSS makes the decision processes regarding critical infrastructure transparent and helps people understand how those critical systems work and how to modify them if necessary.

For younger generations, it seems that the e-voting machine incident in the 2000 presidential election had a notable impact. Both Alan and Leah, who spent their college years around the election, saw the whole process of the election as an example demonstrating the power of technology as well as the need for transparency and reliability in software development. This historical incident helped them to see the power involved in the production of software.

Access to Information. Access to information, the most fundamental principle of the Free Software movement, is another role interviewees envisioned for FOSS. In particular, Irene made it clear that she "strongly agree[s] with a lot of [Stallman's] theories" in that she thinks of FOSS as "a social justice issue." She argued against the current education system that reinforces "closed source mentality" as it prevents young generations from realizing how people's rights and freedom are taken away. For her, changes in education are an urgent matter in which FOSS must play its role.

The meaning of access to information was not limited to developers' rights to look at and modify source code but extended to users' control over the maintenance and circulation of their

own information. As individuals started managing and sharing their information on the web, the role of FOSS in granting users the power to control their information became more critical. This is not the type of right discussed in the Free Software movement since FSF launched before people became concerned about their personal data on the web. Anita explained the importance of users' rights to their information online through the example of Gmail. She stated, "If their service goes down, I am gonna be out of luck. Or, if they do something nasty I am on the hook for that."

Considering the current context where individuals increasingly share their personal information and manage their data online, Anita underscored FOSS's role in supporting data portability. Simply put, data portability refers to the ability to move data from one application program to another. For instance, I can move all the published posts on my WordPress blog to my new Joomla! blog since both WordPress and Joomla! as FOSS applications allow users to move data. This data moving process is often called migrating, and migrating can be accomplished without a high level of technological knowledge. It is obvious that data portability is enhanced when developers for one application can see the inner workings of other applications.

Importance of Diversity

While gender balance within FOSS communities is critical in the sense of equal opportunities, it is also important in that knowledge production reflects the knowledge producer. This does not necessarily mean that knowledge laborers with diverse backgrounds will produce knowledge as diverse as their backgrounds; rather, it means that the diverse culture would more likely contribute to dynamic interactions within a group. My interviewees tended to agree that a diverse contributor pool influences both FOSS products and development processes. However,

they had different views of the levels and types of influence created by a pool of diverse knowledge producers.

User Preference/Need. Some of the interviewees contended that an increase in the number of female FOSS developers results in an increasing number of programs that women prefer to use. To further explain, Mary gave the Pinterest example. She said that Pinterest evolved as a women friendly website with the influence of Cynthia Maxwell, one of the first hires at Pinterest, whereas it had been a bookmarking website. As of March 2013, 83% of the Pinterest users were women (Wagstaff, 2012). It is hard to determine the relationship between the diversity of Pinterest's employee pool and its popularity among women, but Pinterest is deemed to fit women's lifestyle well. When I attended Wikimania 2012, there was a discussion about why Pinterest attracts women when Wikipedia fails to do so. One of the opinions was that Pinterest does not require as much spare time as Wikipedia does; a woman can play on Pinterest during a short amount of disposable time between chores.

Firefox's Personas was cited as an example in a similar sense as Pinterest. Personas is a Firefox feature that allows users to choose their own theme for the browser's background. The themes can be created and submitted by any users so that they can be shared with other users. At times, the themes feature scantily clad women with titles such as "sexy babe" or "woman on summerbeach." In regard to this, Jean said that there is "an overwhelming number of more masculine-focused personas than for women." She further explained that the product made would reflect the producer, and the types of themes on Personas indicate the gender balance in the creator pool.

The narrow cultural backgrounds can also lead to the lack of programs needed by underrepresented populations. Giving a hypothetical example of video editors, Alan said there

was "a lack of high quality video editors. . . . They are missing because people who are used to using high quality video editors didn't make all the way to the pipeline [to become FOSS developers]." He put the gender issue in the same context; that is, Alan assumed that the lack of women would result in the lack of programs that women need.

Problem Solving in the Development Process. Interviewees used the term problem solving in two ways. In the development process, problem solving means the ways in which the developer makes the program perform the intended function. For instance, when a developer makes a weather forecast application, there would be different ways to retrieve data from the National Weather Service, display weather, and update the users' locations, among other services. The process in which the developer finds the most suitable way in the given context is called problem solving. Some of the interviewees mentioned the importance of diversity in problem solving.

Anita said, "Problems are looked at and solved in different ways. Teams can be more effective when they have a diverse set of people looking at them." She clarified this statement to avoid misunderstanding. Anita refused the simplest and essentialist idea that women would solve the problem in a woman's way. Rather, she emphasized the synergetic power created by collaboration among diverse developers and the innovative solution that is not biased toward a certain population.

Siri, a mobile application for the iPhone, is a good example to support what Anita said. When I asked Luzena for examples related to diversity of developers, she narrated the case of Siri. Siri was once criticized as "sexist" for not having enough information regarding women, especially data on women's reproductive rights, such as abortion, women's clinics, and birth control. In contrast, the program has ample data on men's sexual life, such as "blow job" and

"Viagra" (Hill, 2011). There are no men's or women's approaches to solving the gender bias in Siri's database, but a diverse developer pool would have found a less biased way to retrieve data or found better data sets.

Problem Solving for Society. Interviewees also used the term problem solving in the sense that software can address social problems in society. Civic hacking, a notion Leah introduced, shows how software developers try to solve social issues. She defined civic hacking as "looking at government and also functions traditionally held by government and trying to figure out the ways that modern technology can make better." These attempts to make society better through technologies are attributed to people's view on the government's services as "antiquated, bureaucratic, and horribly inefficient." In fact, it has become common for software developers at hackathons to create products that will help solve social issues such as poverty, environmental pollution, and disease prevention. In that this type of problem solving can greatly affect people's everyday lives, who has the power over the technological development becomes critical.

Describing her experiences of participating in a hackathon for social change, Leah expressed her frustration with teams that had only abstract ideas about social issues based on what they had seen in the media. She said that most of the teams did not pay attention to the people whose basic rights are not protected. Leah believed that the developers' privileged status generated the inattention to marginalized populations. She said, "I don't think that a single other group in the room started from the place 'Let's build something that is for poor people.' Cause no one in the room was poor."

While Leah talked about the lack of diversity resulting in the lack of technological development for the marginalized, other interviewees assumed that some cases where technology

intended to help a certain group of people took the wrong direction due to the developers' limited perspectives. Luzena looked askance at companies' growing interest in the mobile phone market in Africa. She said that companies provide African populations with mobile phones as if they work toward the public good. Luzena supposed that although African populations use their mobile phones for transactions as we would debit cards, companies from the West will eventually end up "letting them use credit card and then having everybody all caught up in a debt cycle like we are here because we only know our way of doing it." For her, the lack of diversity among developers was problematic because it can lead to repeating the disservice that the privileged has done to the marginalized in the name of benevolence.

Conclusion: Reclaiming the Voice in the Coded Public Sphere

In the last section of this chapter, I showed that most of my interviewees were aware of the political implications of FOSS development. Political is a term that FOSS contributors often refuse to use (Coleman, 2004), and my interviewees also displayed this tendency. Only one interviewee explicitly used the word in explaining the nature of FOSS development. Nevertheless, I see their views as political in the sense that my interviewees related FOSS development to the lives of users as members of a civic society rather than consumers. These views on FOSS development have great significance since software programs are increasingly developed to solve social issues that once were handled by the public sector.

Observing Google play a role in providing services that were performed by the public sector, Vaidhyanathan (2011) called it "public failure" (p. 6). He contended that "when Google does something adequately and relatively cheaply in the service of the public, public institutions are relived of pressure to perform their tasks well." The traditional tasks of public institutions are

fulfilled by non-profit FOSS development more than by for-profit proprietary software development. As proprietary software development companies have their specific target audiences and the labor force of business is dedicated to developing products for them, they are unlikely to devote themselves to solving social issues. At the end of 2012, both Google and Microsoft publicized their plans to provide financial resources to organizations that work toward the public good (France-Presse, 2012). Thus, one might say that for-profit tech companies prefer to serve as charities rather than develop products to solve social issues by themselves.

FOSS developers and organizations are often those that develop software programs for society. To achieve the goal of helping society, solutions should be accessible, replicable, and sustainable. In this sense, software development for the public is more probable and desirable through FOSS organizations than through proprietary software businesses. The attempt to tackle social issues through software is well demonstrated by the National Day of Civic Hacking, a national event organized by the White House and sponsored by various tech companies and government agencies. At the event, "many government agencies will liberate data for citizens across the U.S. to use to build tech that helps their communities" (Constine, 2013). The event calls for involvement of "citizens, software developers, and entrepreneurs from all over the nation" (hackforchange.org) to create solutions to problems in society. The website of the event makes it clear that the hacking projects of this event will be released under an open source license. Government Big Data Forum is another example in which the government tries to utilize technologies to bring more efficiency to government affairs.

Given that technologies, especially software programs, will be increasingly used to monitor and govern the lives of people to resolve crucial issues in society, who gets involved in the processes of technological development is critical. As my interviewees revealed, technologies

are not developed in a neutral way, but reflect the dynamics among contributors. Considering the growing influence of FOSS development on civic society, contribution to FOSS can be regarded as participating in the public sphere. In this sense, I see code as voice. Coleman (2005), in her study of FOSS hackers' ethics, contended that coding is considered a means of self-expression. Although I agree with Coleman in that one can express her or his individuality through coding, I oppose use of the term self-expression. My opposition is attributed to the ways in which the word has been used as if the means for self-expression are granted to anyone. On the contrary, voice is something to be acquired rather than given, especially in the neoliberal society where the voice of people as mere consumers is often emphasized (Couldry, 2010). Thus, removing barriers to women's involvement in FOSS development should be understood as helping them achieve a voice in the decision-making process of society.

CHAPTER 6.

CONCLUSION

I started this research with a concern about the low percentage of women in FOSS development. The concern was not caused by a liberal feminist assumption that women should achieve equal status as men in a numerical sense; that is, I did not see the same percentage of women—or a higher percentage of women than now, at least—as a goal that FOSS communities should attain. Rather, I aimed to unpack what has caused the gender imbalance in the contribution to FOSS and tried to find the answer by looking at the historical and cultural contexts for the initiation and maintenance of FOSS communities. In this conclusion, I will discuss implications of this study as well as the limitations with suggestions for future studies.

Implications

There are four main implications, which correspond to the four keywords of this study: information industry, labor, knowledge, and gender. The examination of FOSS communities reveals the ways in which labor is mobilized and knowledge is produced along the gender line in the information industry. The reason why I departed from a liberal feminist approach is because I viewed gender relations as both the cause and effect of the labor relations in the information industry rather than as a mere consequence. That is, the information industry would not function in the way it does without stratification of knowledge labor based on gender as well as race and geographical location. As I discussed in chapter 4, there was a realization among male IT workers that they are well compensated monetarily at the cost of extended work hours and unstable employment status. Giving privileges to a certain population, the industry can use the labor to the fullest extent. If the information industry had benefited from stratification of

laborers, the equal opportunity claim would not be heard. Labor relations is more critical in the information industry than in others since the knowledge produced in the industry reflects who the laborers are.

FOSS Communities as Social Factory

While FOSS is often framed as a hobby or an act of altruism by FOSS contributors, this framing prevents us from perceiving FOSS as labor and situating it within the information industry. As I have reiterated throughout this study, FOSS development is a critical part of the information industry. The importance of FOSS development can be understood in two aspects. First, the products made through FOSS development have increasingly penetrated into individual users' everyday lives as well as business sectors. WordPress is a useful example. While WordPress is used by a large number of individuals as a personal blogging platform, businesses also make extensive use of WordPress, so much so that numerous commercial websites support the launch and maintenance of WordPress accounts for business purposes. That is, FOSS development is crucial in that it produces goods that offer an alternative to or supplement to proprietary software.

Second, the networks among FOSS contributors serve as an invaluable resource for the industry. The industry can use the labor force without financial investments to maintain it. The notion of social factory is used to describe such shift in which the society, instead of the factory, becomes the space for work processes. While industrial goods have been produced in specific locations, the networks among individuals serve as the space for production of immaterial goods in the information industry. Proprietary software businesses such as Microsoft and Oracle rely on the collaboration and networks among their employees to develop their products. However, the power of collaboration is limited because those businesses prevent the flow of communication

with their rigid conceptualization of information as property. In contrast, the networks among FOSS contributors can be spread out without limit because of the openness of the information produced by FOSS development. Microsoft has attempted to adopt FOSS-like approaches to software development to employ the power of networks. Currently, Microsoft has two licenses that give a certain degree of freedom to users to learn and modify for their own purposes. Furthermore, Microsoft launched its openness initiative in 2008 to promote collaborative relationships between Microsoft products and open source platforms.

Initially, sharing code was considered to be an antithesis to proprietary software development or, to put it differently, capitalist appropriation of information. However, sharing code is a crucial way to use the collective knowledge labor force with minimum expense. Hardt and Negri stated, "The cooperative aspect of immaterial labor is not imposed or organized from the outside, as it was in previous forms of labor, but rather, *cooperation is completely immanent to the labouring itself*" (p. 294). FOSS communities were voluntarily organized in response to the current intellectual property regime that prevents the free movement of information. Given the voluntary nature of FOSS at the beginning, it should not be seen as mere appropriation of free labor. However, it is certain the cooperation among contributors based on loose networks is the most desired form of labor force in the information industry.

Making Knowledge Laborers' Subjectivity

The discourse of self-development or self-cultivation is strong motivation that enables FOSS contributors to become invested in various FOSS projects. In recent years, the experiences in FOSS development have functioned as proof that someone is a knowledge laborer desired by the information industry in which constant training and retraining are required to survive. This discourse is a good means of stratifying knowledge laborers based on gender, race, and location.

The discourse of self-development appears to be neutral since one's growth through self-directed learning is believed to be a matter of individual choice and willingness. However, investment in self-development is constrained by the social and cultural capital that one possesses. As discussed by my interviewees, who can be a qualified software developer is often determined at earlier ages. In particular, interpersonal networks are one of the major resources that help people to become familiar with computing as both skill and culture.

When acquiring appropriate skills to be a knowledge laborer is regarded as individualized choice or effort, the information industry's responsibility for ensuring equal opportunities is minimized. I should note again that only one interviewee criticized the FOSS culture as a whole, and the rest tended to blame individuals who discriminate against women. Two of the interviewees—Betsy, FOSS contributor, and Radia, non-FOSS contributor—clearly stated that the organization and the company they belong to have environments friendly to diverse developer populations, and they would not condone any discriminatory employment practices. It is true that the information industry does not explicitly give disadvantages to women as it did in the past. Wage differentials based on the male breadwinner model or gendered division of labor are rarely observed in high-end information businesses. This does not mean there is no wage gap between the genders or that women are given equal chances to be involved in any type of technological work. Rather, I contend that the industry implicitly marginalizes women and other underrepresented populations because of a lack of experience or a lack of skills. On the surface level, this justification seems legitimate since technological skills and knowledge are the most crucial qualifications for computing professionals. However, this justification is likely to give advantages to the already privileged since they are the people who have resources for self-development.

FOSS communities are where the discourse of self-development is strongly supported by contributors. The history of feminist movement and the processes in which women have gained equal opportunities are at the opposite end of freedom and meritocracy. In this sense, arguments for the inclusion of women, outreach programs, and codes of conduct cannot help but elicit negative attitudes from some contributors. By identifying themselves in opposition to female contributors, male contributors can appear as autonomous agents driven by their own will and decisions.

Knowledge Production for the Public Good

In chapter 5, I discussed the use of technologies as a means of solving social issues. Public failure has resulted in the shift of responsibilities for public services from the public sector to the private sector. The merits of openness, low cost, and fast development through collaboration made FOSS a suitable platform for developing technologies for the public. However, there are problems in the attempt to recover from the public failure through technologies.

The idea of technological determinism is embedded in integrating technologies into solutions to social issues. That is, there is an underlying assumption that technologies will automatically bring positive outcomes to people's lives insofar as the producers intend to do so. In this assumption, the reciprocal relationships between technologies and social relations are not taken into consideration. Critics of technological determinism (MacKenzie & Wajcman, 1985) have argued that social relations and technological development are mutually constitutive. How technologies are developed and what effects are brought about by the development vary depending on the social relations within which both the producers and beneficiaries of the technologies are situated. The simplistic assumption that technologies with a good intention will

lead to positive outcomes is generated by a lack of understanding about the roles of social relations.

Also, the belief that social issues can be solved without deliberate discussion is problematic. The government's effort to use FOSS in resolving social problems is partly initiated by FOSS's efficiency. For instance, the National Day of Civic Hacking encourages the attendees to generate workable solutions within a short amount of time. Hackathon, an event where computer programmers and interested individuals intensively work on a programming project for two to three days, is the model of the National Day of Civic Hacking. One can easily assume that the developers cannot take all the issues at stake into account within such a short amount of time. Developing a workable program in an artificial context differs from creating a product that works in a real-life context. The government's use of Hackathon-like tools to address social issues can be seen as a reaction to the public's mistrust in the efficiency of the public sector. The public sector's emphasis on efficiency is likely to lead to a lack of deliberation. Thus, a constant attention should be given to how knowledge produced by FOSS development is construed by FOSS contributors and how the technologically deterministic assumption can be challenged by diversity of the contributor pool.

Revival of Feminist Labor Movement

While the percentages of women in FOSS development for the last three decades have been disappointing, the FOSS communities' recent efforts to foster diversity, especially those of the Ada Initiative, are encouraging. Since World War II, union membership rates have been declining by and large. In 2012, only 11.3% of wage and salary workers were represented by trade unions, and the rate was much lower for private sector wage and salary workers, recording 6.6% (Sherk, 2013). Mosco and McKercher (2009) suggested that the shift from industrial to

information society contributed to the decreasing union membership rates by facilitating decentralization of workforce. The presence of the Ada Initiative is noteworthy because it functions as a labor organization in the field where the workforce is most decentralized. Factory was considered to be the place where laborers are unionized, and the basis for collective action seemed to have been weakened with the decreasing number of factory jobs. However, the Ada Initiative succeeded in utilizing the collaborative space of FOSS communities despite the suspicious views on establishment of labor movement in the knowledge industry.

The launch and success of the Ada Initiative can be read as a symptom of resurgence of radical feminism. Observing the historical trajectory of feminist politics over the last four decades, Nancy Fraser (2013) contended that the global economic crisis enabled radical feminist politics to revive and grow as a force to challenge the neoliberal politics. Since the Ada Initiative is still a young organization, it is difficult to predict how its politics will unfold in the following years. However, the fact that the co-founders are invested in the tenets of radical feminism, especially its view on gendered labor relations, demonstrates the potential of radical feminism in addressing the current issues of knowledge labor.

As I have argued throughout the study, knowledge as well as labor should be taken into account when looking at the knowledge industry. The Ada Initiative's work is significant in that it takes interventions in the employment practices of knowledge labor whose role is increasingly crucial. However, more importantly, the Ada Initiative draws particular attention since its activities will affect who will be given the opportunities to make rearrangement of knowledge and power in the future society. The Ada Initiative has been keen to the privileges given to a certain population in participating in the public sphere in the form of technological knowledge production. The Ada Initiative's sensitivity to the imbalanced distribution of privileges was

informed by feminist politics. The future activities of the Ada Initiative require close examinations to see how the resurgence of radical feminism will affect both gendered labor relations and knowledge production in the information industry.

Limitations and Future Opportunities

There has been less scholarly attention to gender relations in FOSS development despite its long-lasting gender imbalance of the developer pool. In particular, the historical and economic contexts that have maintained the imbalance were rarely examined. Since this research is one of the few efforts to unpack the gender aspects of FOSS, this study has limitations that should be highlighted and addressed in future studies.

Oral History Collections

While this study attempted to reveal the historical contexts of the computing field in the 1980s by looking at historical documents, those documents do not offer a deeper understanding of women's experiences in regard to the field. CHM and CBI have collected oral histories of computing professionals in the earlier years and tried to address gender issues by interviewing women. However, their approach to uncovering gender relations in the computing field is somewhat problematic. In most cases, gender-related questions were only given to female interviewees while leaving the perspectives of male professionals unheard. As I discussed in the introductory chapter, looking at gender relations requires examinations on the experiences of both genders and the ways in which the experiences of each gender constitute the lives of the other. Furthermore, the experiences of women who were cast out from the computing industry are as important as those of influential female professionals. However, the stories of women who failed to reach a higher position are very often unasked. The lack of empirical data from male

professionals and female professionals with various levels of experiences contributes to an incomplete explanation of the historical context. Thus, future studies need to expand the scope of historical data so as to learn what has been often omitted in writing the history of computing.

Practices of FOSS Development

One of the assumptions of this study was that the experiences of female FOSS developers as a marginalized group would affect the ways in which FOSS products are developed. While I explained how gender would influence the end products based on my interviewees' views on the role of FOSS and the effects of diversity on software development, the answers were often vague. In fact, some of the interviewees had difficulties in giving specific examples of how developers' different assumptions can lead to different ways of problem-solving. An examination of the processes in which a particular product is envisioned and developed would give a better understanding of FOSS products as reflection of the developers and the development processes. To do so, an ethnographic work that involves participation in the development practices will be needed.

Users' Interaction with FOSS Products

At the beginning, I supposed that a particular way of developing technological products will affect the interaction between users and the technologies. In Open Source Bridge 2012, Jeff Eaton cautiously addressed the issue of FOSS developers' disinterest in users. Whereas there are FOSS projects that endeavour to enhance usability, some of the projects are developer-centred. The disinterest in users are sometimes caused by the shortage of workforce since better usability requires the developer pool to work on human computer interaction from the very beginning of a project. At times, inattention to users stems from FOSS developers' belief in self-education. That is, they would expect the users to learn about the products by themselves if the users are to enjoy

the freedom given by FOSS development. How FOSS developers envision the users is a way of examining the developers' philosophies in producing knowledge. Along with exploration of FOSS development practices, looking at users' interaction with FOSS products can give insights into how knowledge is understood by FOSS developers.

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APPENDIX A. HSRB APPROVAL LETTER

BGSU
BOWLING GREEN STATE UNIVERSITY
Office of Research Compliance

DATE:	April 12, 2012
TO:	Yeon Ju Oh, MA
FROM:	Bowling Green State University Human Subjects Review Board
PROJECT TITLE:	[298917-2] The ethics and politics of knowledge production among female software programmers in FOSS movement
SUBMISSION TYPE:	Revision
ACTION:	APPROVED
APPROVAL DATE:	April 11, 2012
EXPIRATION DATE:	February 18, 2013
REVIEW TYPE:	Expedited Review
REVIEW CATEGORY:	Expedited review category # 7

Thank you for your submission of Revision materials for this project. The Bowling Green State University Human Subjects Review Board has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

The final approved version of the consent document(s) is available as a published Board Document in the Review Details page. You must use the approved version of the consent document when obtaining consent from participants. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require that each participant receives a copy of the consent document.

Please note that you are responsible to conduct the study as approved by the HSRB. If you seek to make any changes in your project activities or procedures, those modifications must be approved by this committee prior to initiation. Please use the modification request form for this procedure.

You have been approved to enroll *25* participants. If you wish to enroll additional participants you must seek approval from the HSRB.

All UNANTICIPATED PROBLEMS involving risks to subjects or others and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office. All NON-COMPLIANCE issues or COMPLAINTS regarding this project must also be reported promptly to this office.

This approval expires on February 18, 2013. You will receive a continuing review notice before your project expires. If you wish to continue your work after the expiration date, your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date.

Good luck with your work. If you have any questions, please contact the Office of Research Compliance at 419-372-7716 or hsrb@bgsu.edu. Please include your project title and reference number in all correspondence regarding this project.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Bowling Green State University Human Subjects Review Board's records.

BGSU.
BOWLING GREEN STATE UNIVERSITY
Office of Research Compliance

DATE:	February 12, 2013
TO:	Yeon Ju Oh, MA
FROM:	Bowling Green State University Human Subjects Review Board
PROJECT TITLE:	[298917-3] The ethics and politics of knowledge production among female software programmers in FOSS movement
SUBMISSION TYPE:	Continuing Review/Progress Report
ACTION:	APPROVED
APPROVAL DATE:	February 19, 2013
EXPIRATION DATE:	February 18, 2014
REVIEW TYPE:	Expedited Review
REVIEW CATEGORY:	Expedited review category # 7

Thank you for your submission of Continuing Review/Progress Report materials for this project. The Bowling Green State University Human Subjects Review Board has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

Please note that you are responsible to conduct the study as approved by the HSRB. If you seek to make any changes in your project activities or procedures, those modifications must be approved by this committee prior to initiation. Please use the modification request form for this procedure.

All UNANTICIPATED PROBLEMS involving risks to subjects or others and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office. All NON-COMPLIANCE issues or COMPLAINTS regarding this project must also be reported promptly to this office.

This approval expires on February 18, 2014. You will receive a continuing review notice before your project expires. If you wish to continue your work after the expiration date, your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date.

Good luck with your work. If you have any questions, please contact the Office of Research Compliance at 419-372-7716 or hsrb@bgsu.edu. Please include your project title and reference number in all correspondence regarding this project.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Bowling Green State University Human Subjects Review Board's records.

APPENDIX B. INFORMED CONSENT FORM

BGSU
BOWLING GREEN STATE UNIVERSITY
School of Media and Communication
West Hall 302
Bowling Green, OH 43402
Phone: 419-372-8349 / Fax: 419-372-0202

Informed Consent

My name is Yeon Ju Oh, a PhD student in the School of Media and Communication at Bowling Green State University. I am conducting research on the ethics and philosophies of female software programmers in designing programs with a special emphasis on women in FOSS (Free and Open Source Software) development. This study is advised by Dr. Radhika Gajjala, faculty member in the School of Media and Communication at Bowling Green State University. You are invited to participate in this study since you, as one of the few women participating in FOSS development as programmers, managers, researchers, and advocates, can offer valuable insights into a better understanding of women's experiences in FOSS development.

Purpose: I have two main purposes in conducting this study. First, I aim to offer a better understanding of why only a small number of women participate in FOSS development or why they are excluded from the development. Second, I examine what ethics and philosophies FOSS women employ in designing projects. Participation in FOSS development from diverse groups may contributes to promoting diversities in projects created. Thus, I will examine how your ethics and philosophies influence the projects you are involved in. Your thoughts will be invaluable assets for educational institutions or related organizations that strive to foster women's involvement in FOSS development. Upon the completion of interview, you will receive a $25 Barns & Noble gift card as an acknowledgement of your contribution.

Procedure: To participate in this study, you must be at least 18 years old. If you decide to participate, you will be scheduled for a face-to-face, in-depth interview. I will ask open-ended questions rather than questions that can be answered by yes or no. Since each interviewee has a different depth of experiences and thoughts, the time that will take for an in-depth interview varies by individuals. As I interact with you, I may or may not find some parts that I need to further discuss, and this will also affect the time spent for an interview. Despite these factors, an in-depth interview normally takes 1 to 2 hours, and your interview will not exceed 2 hours. During the interview, you

will be given questions about your motivation and experiences in participating in FOSS development, and the past or current projects you are or were involved in. Depending on the completion level of this interview, you may or may not need to schedule for an additional interview. Although I will try to interview you only once for your convenience, the time and place, or the presence of interference may require an additional interview. All the interviews will be audio-recorded in order to accurately reflect your experiences and thoughts on the analysis. After interviews are completed, you may receive follow-up questions via email or phone if clarifications are needed. Your involvement in this study will take minimum one hour to maximum three hours.

Voluntary participation: Your participation is completely voluntary. You may decide to skip questions and you are free to withdraw at any time. If you decide to participate and change your mind later, you may withdraw your consent and stop your participation without penalty or explanation. Deciding to participate in this research or not will not impact any relationship that you may have with Bowling Green State University.

Confidentiality Protection: My priority in interviewing you is to protect your confidentiality and privacy. I will ensure your confidentiality throughout the processes of recording and transcribing interviews and writing manuscripts unless you agree to disclose your affiliation, employment position, and other personal information. Your interview data will be stored in devices in the possession of me with protection tools such as a password, and any raw interview data will not be transmitted by using wired communication tools such as email or file-sharing program to minimize the possibility of having your data be exposed to third parties. Only the research advisor and I will have access to the raw interview data. The raw interview data will be kept for one year upon the completion of research publication. Before this study is published, I will ask you to review the parts pertinent to your interview(s) so that you can ensure your information you do not want to disclose has been properly removed or replaced with pseudonyms.

Risks: Although the FOSS community has pursued gender equality, insensitivity to gender issues and unfair treatment of women still exist within the community. There could be risks that you experience embarrassment and criticisms within your working place. Female developers who explicitly addressed women's issues listed responses they received as follow: some co-workers' belittlement of efforts toward fair treatment, some co-workers' defensive reactions to the issues

raised, denial of discriminatory treatment, and labeling the outspoken as a "feminist." These may cause you stress within your working environment, and lead to biased perceptions of you by co-workers. To prevent these risks, I will put my priority on keeping your identity confidential through various procedures mentioned above.

Your rights as a participant: As a participant, you have the right to have all questions concerned with the study answered by me, and you may request a summary or copy of the results of the study after its completion.

If you have any questions or comments about this study, you can contact the principal investigator, Yeon Ju Oh at (419) 806-2061 or oyeonj@bgsu.edu, or the research advisor, Dr. Radhika Gajjala at (419)372-7537 or radhik@bgsu.edu. You may also contact the Chair, Human Subjects Review Board, Bowling Green State University, (419) 372-7716 (hsrb@bgsu.edu), if any problems or concerns arise during the course of the study.

Thank you for your interest in participating this study.

I have been informed of the purposes, procedures, risks and benefits of this study. I have had the opportunity to have all my questions answered and I have been informed that my participation is completely voluntary. I agree to participate in this research.

Participant Signature Date

BGSU HSRB - APPROVED FOR USE
IRBNet ID # 298917
EFFECTIVE 04/11/2012
EXPIRES 02/18/2013