A Call to IS Educators to Respond to the Voices of Women in Information Security

Amy B. Woszczynski
Sherri Shade
Computer Science and Information Systems Department
Kennesaw State University
Kennesaw, GA 30144 USA
awoszczy@kennesaw.edu   sshade@kennesaw.edu

ABSTRACT

Much prior research has examined the dearth of women in the IT industry. The purpose of this study is to examine the perceptions of women in IT within the context of information security and assurance. This paper describes results from a study of a relatively new career path to see if there are female-friendly opportunities that have not existed in previous IT career paths. Research methodology focuses on a qualitative analysis of in-depth interviews with women who are self-described information security professionals. A primary goal of the study is to understand the perceptions of women in information security and determine what IS educators can do to help educate a new generation of students who are diverse, confident, and excited about the real-world aspects of an information security degree. Suggestions for improving the representation of women in information security and their ultimate perception of the field include better recruiting and retention strategies, development of mentors, and changes in presentation of the information security field.

Keywords: Diversity, Women, Information Security, Information Technology

1. INTRODUCTION

In February 2000, in response to a major Internet security breach, President Clinton invited a group of industry and academic information security experts to the White House. Of the 29 invited guests, with titles ranging from Chief Information Security Officer to Chairman and CEO, only one was a woman (Spafford, 2000). Where were all the women information security experts? This meeting seems to indicate that women information security professionals may face similar hurdles as their more general information technology (IT) counterparts.

However, there are some bright spots for women in information security. Diana Burke is Chief Information Security Officer (CISO) for Royal Bank of Canada Financial Group. Suzanne Gorman is Managing Director of Corporate Information Security with SIAC Corp. (Women Luminaries, 2004). Similarly, Renee Guttmann, who received the 2008 Compass Award from CSO Magazine and in 2007 was named a "Woman of Influence" by the Executive Women's Forum, serves as Vice President of Information Security and Privacy at Time Warner (Bhimani et al., 2008). Becky Bace serves as CEO of Infidel, Inc., a network security firm, and was selected as one of the top five most influential women in information security by Information Security Magazine in 2003 (Qualys, 2003). Jane Scott Norris was appointed as the

first information security officer of the U.S. Department of State (New Board Members, 2009). Sarah Gordon, senior researcher for Symantec Security Response, was honored with the 2005 Private Solutions Provider Woman of Influence award for information security at the annual Executive Women's Forum. Gordon is well-known for her groundbreaking work on the underlying psychology of virus writers (Symantec Researcher, 2005). Symantec must be doing something right for its women in information security, as this was the third year in a row a woman from Symantec won the award. What do these people have in common? They are part of a small group of visionaries and leaders in the emerging area of information security. They are also women.

As opposed to the numerous studies on women in IT in general, little is known about the status of women in information security, a subfield of information technology. Although there are few if any published studies on this specific topic, one study does examine the dark side of security by considering interactions between ethics and gender in the world of hacking and cracking (Adam, 2004). Perhaps the information security area in fact presents new opportunities that may be particularly interesting to women and other underrepresented groups. Or are the previously mentioned women in leadership roles in information security simply anomalies? What are the challenges facing women in

the new IT sub-discipline of information security, and what can IS educators do to begin to improve the number of women who choose and remain in information security?

This paper is organized as follows: First, a literature review on the general area of women in IT is provided, leading to research questions that are explained within the context of what is already known in the area of women working in IT. Second, a qualitative methodology is described, along with the specific characteristics of this study. A description of the themes emerging from the interviews follows the methodology section. A discussions section highlights the results of the qualitative analysis, focusing on the perceptions of women in information security and how the academic community can help women overcome challenges in pursuing a career in information security. The final section presents some conclusions, along with the limitations of this study and plans for future research.

2. BACKGROUND

2.1 Women in Information Technology

In the United States and globally, it is well-established that women comprise a small and decreasing percentage of the IT workforce. Multiple reports show that the percentage of women in IT is low and continues to decline (Hill, 2005; Stross, 2008) and that women are not making inroads into the managerial ranks of IT (Roberts, 2007). In fact, between 2000 and 2005, the number of women computer science majors plummeted 70% (Bowers, 2008). In a field that is experiencing unemployment lower than the national average (Light, 2001), women are a key underutilized resource in IT. Like its IT counterpart, the information security field is experiencing significant growth (Oltsik, 2007), particularly in the wake of the September 11 attacks and greater needs for Homeland Security employees. There is clearly a critical need for women skilled not only in IT, but in security-related aspects of managing information systems. This joining of IT and security expertise naturally leads to the specialized field of information security. Since little research has specifically looked at women in the subfield of information security, we instead focus our review on women in information technology and technical-related fields, along with criminal justice and security-related fields. First, we turn to an analysis of women in IT and technical-related fields.

Women tend to leave engineering and IT-related fields in part because of the isolation they experience as compared to their male peers (Lazowska, 2002). IT continues to be a field that is perceived to be dominated by white men in the US (Kvasny, 2006; Payton, 2004; Roach, 2003), and for now, that perception matches reality. While some may suggest that women simply are not that interested in IT, others are bolder and suggest that men may actually work to keep women out of the IT field, even if the exclusion is unintentional (Tapia, 2006). Multiple studies and initiatives have described methods to encourage more women to enter technical-related fields through the use of mentors, more inclusive classroom strategies, and changing the perception of the IT classroom and workplace (Gallivan, Adya, Ahuja, Hoonakker, & Woszczynski, 2006; Kellogg, 2001; Lazowska, 2002; Moore, Yager, Sumner, & Crow, 2001; Payton, 2003; Payton, 2004; Treu, & Skinner, 2002; Woszczynski, Myers, Moody, & Beise, 2002). One group

has even targeted women in information security specifically; the Women in Defense group, which has about 47,000 members nationally (Henderson, 2007). However, with few women in leadership roles in IT, women find it difficult to link with a mentor or role model. With few women teaching in the classroom, teachers may find it difficult to model gender-inclusive classroom strategies. Finally, it is difficult to change the reality of IT as a male-dominated field, one in which women are not well-represented. This cycle of underrepresentation of women in IT continues almost unabated, in spite of the multitude of initiatives, programs, grants, and research studies attempting to recruit more women into IT.

Looking at the field of security in general – criminal justice, law enforcement, and related areas – women fare little better. There are traditionally more men than women in security, with few women role models or women in leadership positions to serve as mentors (Logsdin, 2005). At a time when businesses are encouraged to make security a strategic initiative to the business (Bhimani et al., 2007), developing a diverse workforce that is skilled in protecting organizational assets is essential for company success. Women are a large part of this potential workforce. We now turn to the research questions developed.

2.2 Research Questions

Information security is a relatively new career path. There are few current reports that describe the numbers of women working in the field of information security, and the types of jobs that they hold. While we know – or suspect – a great deal about women in IT, we do not know much about their counterparts who choose to move into the information security field Information security may present an opportunity for a new career path, one that has not existed within the current IT workforce. When developing research questions, we relied heavily upon prior literature in the field, particularly our colleagues who have completed substantial and relevant research on women in the general IT workforce, including the groundbreaking work by Camp (1997) and Trauth (2002). In addition, we developed research questions based in part upon a recently validated quantitative instrument, the Diversity Perceptions Inventory (DPI) (Woszczynski, Myers, Moody, & Beise, 2007). Data collected with the DPI clusters around four main themes:

1. Motivating factors in choosing an IT career;
2. The role of prior experiences in choosing an IT career;
3. The perceived usefulness of diversity in the IT workplace;
4. The role of teamwork in the IT workplace.

These themes naturally lead us to develop research questions to better understand women working in the information security field, answering the following questions:

• What motivates women to pursue careers in information security? How did they come to choose the field of information security? Are women more likely to choose information security rather than the more general field of IT?

• Do mentors or other prior experiences affect women's choices in the information security field? What role do education and certifications play for women in the information security field?

• Do women in information security value diversity and teamwork? Do they perceive that there is a glass ceiling for women in information security? How are women treated in the information security workforce?

• We apply all of these themes, which were developed with the more general IT workforce in mind, to the information security workforce discussed in this study. We plan to use these themes and the research questions developed to characterize women's perceptions of the information security field. Based on these clusters and analysis of the responses to the research questions posed, we will develop generalized themes that apply to the women in our study.

3. METHODOLOGY

For this study, we conducted telephone interviews with five women who are practicing professionals in the information security field. We developed a semi-structured interview script based on the research questions identified. The final interview script is shown in Appendix 1.

Each interview lasted about 45 minutes and was recorded with the use of an audio recording device, with permission of the participant. Three researchers participated in the interview via a speaker phone. One researcher conducted the interview, asking each of the questions noted in Appendix 1, and sometimes related follow-up questions. A second researcher recorded the interviews in a word processor. A third researcher observed and made reflective notes. The recorded conversations, as well as reflective notes, were used to properly capture the comments of the respondents in a word processor.

For purposes of this study, information security includes a broad array of job titles and tasks. Since we were interested in the views of women in information security, all participants were female. Participants were selected based on networking contacts with academics and practicing professionals in the information security field. Specifically, we solicited participation from women attending the Information Security Curriculum and Development conference held in Kennesaw, GA each year. We also networked with participants at the conference to add to our list of possible participants. Participants from throughout the country attend this conference, which focuses on industry and academic professionals in information security.

After soliciting volunteers to participate in our interviews, we carefully analyzed the potential respondents. We selected five women who we believe represent women information security professionals at various stages of their careers. The participants are self-described professionals in information security with a wide variety of industry experience, including travel, banking, telecommunications, education, insurance, hospitality, and financial services. Their experience levels in IT range from less than a year to several decades. The respondents range from the new graduate, working as a Business Development Manager and having less than one year of IT experience, to the VP Information Privacy and Protection, who has been working in IT for over 30 years. We believe that a range of experience levels in IT is important to our study, since women with mature experience in the IT field may have different perspectives than those who have newly entered the field. The participants were from a variety of US states, and all of the respondents were white.

The least experienced participants had degrees specifically in the IT field. Others had disparate and often unrelated formal educational experiences. Information security job titles included: 1) Chief Security Officer (CSO); 2) Business Development Manager; 3) Network Security Systems Engineer; 4) Director of IT; and 5) VP Information Privacy and Protection. Job responsibilities included training and education, antivirus activities, loss prevention, network maintenance, and management of engineers and other technical professionals, as well as development of security and privacy standards. Some participants classified themselves as being primarily technically inclined, while others stated that they were more comfortable with the business side of IT. We specifically desired a mix of more and less technically inclined respondents to represent different aspects of information security. Table 1 summarizes the job titles, educational background, and years of experience in IT for the interviewees.

Title	Degree/Education	Experience in IT/ISA
Chief Security Officer (CSO)	Pre-med, Associate's Degree CISSP and other professional certifications	About 15 years
Business Development Manager	Bachelor's in IS Certificate in Information Security	Less than 1 year
Director of IT	Bachelor's in Marketing Master's in IS	About 5-10 years
Network Security Systems Engineer	Bachelor's in IS Master's in Engineering Management Graduate Certificate in Information Security CISSP	About 10 years
Vice President (VP), Information Privacy and Protection	BS in Education Technical training on the job	Over 30 years

Table 1. Interviewee Backgrounds

4. RESULTS

Based on qualitative research methodologies, transcripts from the interviews were analyzed. Researchers chose an interpretivist approach as described by Gephart (1999). In contrast with positivist and postmodernism approaches, the interpretivist approach allows researchers to search for meanings within a specific context, in this case, work in the field of information security. Here we examined the working experiences of information security professionals allowing for complexity and personal reflection. This approach is different from a more positivist approach where the research protocol mimics reality and reflects some objective, though fairly simplistic, views of the world. "The strength of this type of research is its ability to represent reality" (Padayachee, 2002).

After collecting all the data, the researchers analyzed the transcripts, reading the responses to each question and

making notes on commonalities that emerged from the interviews. We specifically sought to better understand the data in light of the four main themes identified in previous diversity research in IT (Woszczynski et al., 2007):
• Motivating factors in choosing an IT career;
• The role of prior experiences in choosing an IT career;
• The perceived usefulness of diversity in the IT workplace;
• The role of teamwork in the IT workplace.

We found supporting data for each of these themes in the field of information security, adding breadth and understanding to a new category of IT worker. However, we also discovered additional themes, and these are supported with prior literature and studies on IT. Over a series of meetings, we were able to categorize the additional responses into the areas of stereotypes and isolation, building on the body of knowledge concerning women working in IT-related fields.

This paper describes the qualitative analysis of the study and the themes that emerged from the telephone interviews. We seek to describe information security work through the eyes of practitioners rather than rigorously analyzing hypotheses. The goal is to identify themes across and within each participant's narrative, providing rich, qualitative data to analyze the experiences of women in the information security field. The following themes emerged from our analysis:
• Women share similar motivations for pursuing information security careers.
• Prior experiences and education influence the choice of information security as a career, but a degree in an IT-related field is not required.
• Women share similar views of diversity and teamwork in information security and desire more diversity in the workplace.
• Women are often viewed in stereotypical fashion in the information security field.
• Women experience isolation in the information security field due in part to the lack of mentors available to them.

4,1 Motivations for Pursuing Information Security Careers
Part of our study sought to understand if women pursue information security careers more than other IT-related careers, and if so, why. We found a common theme among our respondents regarding their motivations to pursue careers in information security. They were uniformly enthusiastic about the information security field and felt that there are many interesting and varied opportunities for women in information security, when they are made aware of this emerging subfield. Four of the women noted that they pursued information security careers because of the social/human issues associated with it. For example, the CSO stated that she felt a career in information security was "worthwhile":

"I thought it was exciting…loved tracking down people who were not doing the right thing. I just think it is a lot of fun to think what you do is worthwhile and help someone else."

She went on to describe her early experiences and how they affected her choice of information security as a career:

"When I was 19, I had a boss forging my signature on documents and stealing money from the bank."

Further, she stated that she was "…interested in the people aspect of fraud and crime when it came to banking," and thus pursued a career in information security.

In a similar manner, the Business Development Manager chose a career in information security based on her personal experience after someone tried to steal her identity. Because of that experience, she began a career in information security.

"I just wanted to know why, how they did it, and how to prevent them from doing it again."

The Director of IT was explicit in her desire to learn more about the "human nature of IT":

"I found it fascinating. It is almost like the psychology of computing…not in the real technical side but more of the policy and how it affects business and the usability factors of it, how you maintain the balance."

Clearly, the women in our study found information security to have a real-world impact. One of their main motivations for pursuing a career in information security was to make a difference, to have an impact on the human side of computing. These responses closely parallel prior research suggesting that women would show interest in IT careers, if there is some real-world problem to be solved, a way for them to help people in their work. Women in our study tend to be less interested in IT careers because of a passion for the actual technology. Some of the participants chose the information security field based on a kind of mission, an opportunity to serve their community or the greater good.

4.2 Role of Prior Experiences and Education
Prior experiences seemed to play an important role in deciding to pursue a career in information security for the women in our study. The CSO recounted a story about an encounter with a criminal at the drive-through when she was a young teller at a bank.

"She was trying to steal money by forging bad checks at the bank…This got me interested in the people aspect of fraud and crime when it came to banking."

The early experience with security and fraud led to this woman deciding to pursue a career in information security.

The educational backgrounds of our respondents differed markedly. Two respondents had undergraduate degrees in IT-related fields, while three had degrees unrelated to IT. All of the respondents noted the importance of certifications in the information security field, most notably the CISSP. Two respondents had graduate degrees, one in engineering and the other in information systems. Job title had little to do with educational background. It appears that women in information security, like their male counterparts, may change to IT careers after completing a non-IT related degree and pursuing a non-IT-related career.

4.3 Views on Diversity and Teamwork
The women in our study universally agreed that diversity and teamwork are important in the information security field, calling it "absolutely critical." However, most noted that their companies were not very diverse in terms of gender, with one noting that she was the "only female in the company out of 25 employees." Another said that her team was "really different because I have two female engineers"

on her team, out of five employees. In her experience, it was rare to have so many women participate as part of a team in information security.

Three respondents specifically talked about the unique ideas and thoughts that women bring to the workplace. They thought that women brought "another perspective into problem solving…" and that companies should work to "bring in different perspectives" and a "broad perspective." Interestingly, one of the women stated:

"From what I have seen so far, it doesn't matter whether it is security or any other IT. Women bring another perspective into problem solving and planning. [The company] will benefit from a mix [of perspectives]."

Clearly, the women understand that information security needs diversity to achieve the goal of having different perspectives when solving a problem or working on a team. Women bring something extra to the table, as do minorities or other underrepresented groups.

4.4 Stereotypes
Stereotypes are firmly in place for the women in our study and are viewed as negative influences. Women consistently noted that they were often viewed with less respect than their male counterparts. For example, the CSO noted:

"I had gone to a security conference, and there were hundreds of men, and I was the only female. They always have the meet and greet in the evening. I was approached by three different men because they thought I was a prostitute. There could be no way that a woman would be here unless she was a prostitute."

This respondent was appalled that another professional attending the meet and greet portion of the conference mistook her for a prostitute. She stressed that she was not wearing suggestive clothing and was properly identified as a conference participant by a name badge when the conversation took place. Another stereotype emerged when the same respondent described a similar situation:

"I went to a conference fairly recently and I was in the bookstore and looking at a couple of things and a guy came up to me and said, 'Are you here buying books for your boss?'"

Rather than being perceived as a fellow security professional, this woman reported perceptions ranging from being a secretary to being a prostitute. The secretary comment may be more understandable, since presumably the conference attendees were not wearing name badges at the bookstore. These negative perceptions of women in information security may discourage other women from even trying to get into the field.

4.5 Isolation
Isolation was another theme across the interviews. Participants were asked whether or not women were more likely to work in information security than other areas of IT. In general, women in information security were well aware of being in the minority, as noted by the Network Security Systems Engineer:

"There are very few women in the field. Most of the classes I have taken are male dominated. Only 10 of 100 people taking the CISSP were [women]. Many

times I was the only female taking IT Security classes."

She continued:

"From what I have seen, it seems that women do not work in IT Security. They choose other areas of IT."

The VP Information Privacy and Protection concurred:

"I did have some discomfort when I was the only woman, but eventually I got over it."

It appears that women have to adjust to the male-dominated information security field, just as they have to adjust in the traditional, male-dominated IT workforce and other technical-related fields.

Even the women we interviewed, who would all be identified as successful information security professionals with, in some cases, high positions on the organizational chart, noticed the glass ceiling that women tend to face. The Business Development Manager commented:

"I don't think I would be able to advance in my company…[Managers] think they need to be men [in order to advance in the company]"

That same respondent did see a bright future for women, if they could get hired in the first place:

"Actually, once you have your foot in the door you are considered one of the guys…It just isn't easy to get there."

The CSO agreed, stating that "I think we have come a long way," although she noted that she sometimes encounters "someone who does not think that females have anything of value to add, that we are too emotional, and couldn't understand technology." The women in our study simply wanted to be given the opportunity to be successful in information security. The Business Development Manager said:

"Women in technology are needed and shouldn't be handed things on a silver platter but should be given an opportunity."

Even participants who described their IT experiences as being "treated very well" went on to highlight an aspect of isolation such as "social isolation." Simply stated – and unsurprisingly – there appear to be very few women in information security. Interestingly, one of the respondents noted that women were choosing other areas of IT to pursue, but that other area was never identified. Moreover, the Director of IT gave her perception of why there are so few women in IT in general, saying that it has to do with spatial skills:

"Fewer women tend to take their toys apart as children versus a male child."

According to the women in our study, women in information security experience extreme isolation in the workplace.

Mentors provide one method to minimize the effects of isolation. As mentioned previously, mentors are important to achieving success in the workplace. The Network Security Systems Engineer reported that she had "no mentors," illustrating the few women available as mentors in information security, and the difficulty in finding mentors who are men. In general, participants in this study had few or no role models. The Director of IT and the Business Development Manager participants reported having excellent role models that were male information security professionals. Several respondents noted that the choice of

male mentors is a result of the dearth of women in IT generally, as well as in the sub-field of information security. The perception of the VP Information Privacy and Protection was that men were more willing to be mentors than their female counterparts:

> "It has seemed to be men who are more willing to be mentors in my experience."

It may appear that men are more willing to be mentors, but this perception may be flawed due to the dearth of women in information security. Women were very complimentary of two different male professors that they had taken, as the Director of IT stated:

> "A passionate professor such as Professor [confidential male #1] helped. They made me like it and everything I learned about it I enjoyed. Actually when I started to really find it fascinating was when I took Professor's [confidential male #2] first security class in graduate school. I think that the more women there are out there as mentors to others, the more women we can get into the security field."

The Business Development Manager had similar experiences with professors who were men. It seems that women will find mentors wherever possible. Passionate men willing to serve as role models offer unique opportunities to foster relationships with their women colleagues.

Another participant reported her positive experience with men as mentors, particularly if the men had military or law enforcement background. In fact, the VP Information Privacy and Protection, who thought she was treated very well in information security, stated: "Men who have a military or law enforcement background seem to be more comfortable and respectful to women." It appears that women would like to have mentors and role models, and indeed, will take the role models where they find them. In information security, which is male-dominated, that means seeking men as role models and mentors.

5. DISCUSSION

After identifying the themes above, we now move to a discussion of how IS educators can work to change the perceptions of women in the information security field. The women in our study had similar motivations for pursuing a career in information security. Often, an event would occur (i.e., stolen identity, bank fraud, etc.) that would trigger an interest in information security to solve a real-world problem. Women could relate to the problems and the need to provide a solution. IS educators need to do a much better job of marketing information security to current and potential students. Stressing the real-world relevance of information security may appeal to women who want a career that will make a difference, that will solve problems, and that will make people's lives easier. Rather than promoting information security as a field of technical engineers and programmers, IS educators need to do a better job of portraying realistic employment opportunities for potential students. Internships that allow students to see what an information security professional may do in the workplace, will offer a real-world view of the industry and should be encouraged where possible. In the classroom, teaching the business and the technical sides of information security lets students see the real-world relevance of information security as a career. Similarly, professors should encourage diverse teams in the classroom, with distinct areas of valued expertise that demonstrate the importance of both the business and technical sides of information security.

We found that women in our study might or might not have a formal degree in IT or a related area. Since women often move into information security after pursuing another career, educators need to design certificate or non-degree programs so that women can obtain the credentials to move up in information security.

The women in our study all valued diversity and teamwork. They believed that women's perspectives were often missing from projects, which gave the engineers a one-dimensional view of how to solve a problem. IS educators can work to overcome the dearth of women in information security through recruiting and retention programs. By carefully and clearly marketing information security, IS educators can prime the pipeline with a more diverse group of students. Retaining those students by giving them a clear picture of the information security field should be an ongoing marketing activity in which IS educators are intimately involved. Creating classroom projects that require contributions from both the technical and business sides of an information security problem allows students – both men and women – to see the value of both sides, and the contributions that women may bring to the table.

All of the women in our study had mentoring issues. They either had no mentors, or they found their own men mentors. Although we hope to populate the pipeline with more women for the future information security workforce and for academia, it will take time. Meanwhile, we need to encourage and reward men who are willing to mentor male and female students in information security. We need to provide professional development opportunities for them, training programs that illustrate mentoring strategies for success. We found that several women were even motivated to pursue a career in information security because of the mentors they found in the educational setting, so there is no doubt that mentors can make a difference. Devising formal and informal mentoring opportunities for students and faculty, monitoring mentoring relationships, and rewarding faculty members who actively participate in the mentoring process, are all options for IS educators. These mentoring activities will help women overcome the isolation they face because of their underrepresentation in information security. Other mentoring options include networking opportunities with women alumni from information security degree programs, and industry volunteers to serve as mentors for qualified and at-risk students.

In the classroom, IS educators should model gender-inclusive strategies to encourage participation from both men and women. Classes should teach legal and ethical issues regarding promotion of employees, stressing that the best employee should be selected, regardless of their demographic background. As educators, we should encourage more women to participate in projects that will enhance their marketability, such as study abroad, research projects, graduate research and teaching assistantships, and scholarships. These professional development opportunities should be awarded to the most qualified individuals, using care to get a diverse group where possible. In the long run, if IS educators are unable to recruit diverse students for the

information security pipeline – at high schools, during their freshman year, etc. – and retain them with intensive mentoring efforts, there is little industry can do to break the cycle of underrepresentation of women in information security. IS educators must act on this initiative so that women are included in the information security workforce of the future.

6. CONCLUSIONS AND LIMITATIONS

The purpose of this study is to learn what initially motivated information security professionals, as well as what sustains them in the career path, through in-depth interviews with women who are currently working and succeeding in the information security field. We reported results from interviews of women in the field and made recommendations for IS educators to improve the representation and status of women in the information security workforce. Future studies should include the addition of men working in the information security field for comparison purposes. Moreover, studies that analyze the effect of career sequencing and childbirth on choice of careers for women, may shed additional light on women's motivations to pursue or not pursue specific careers. Specifically, researchers can compare fast-changing careers in which women are well-represented, such as law, medicine, and advertising, to fast-changing careers in which women are not so well-represented, such as IT. Future research should also carefully consider and refute or support some of the more provocative and controversial views of women in IT, such as those espoused by then-Harvard president Laurence Summers, who suggested that women may have innate differences that cause them not to choose math or science-related careers (Bombardieri, 2005). While research on innate differences is beyond the scope of this paper, it is a topic that future researchers should continue to study.

One of the clear limitations of this the study is that data has been collected only from women. It is not clear that the responses from men will be very different from those recorded for women in the IT security field. Also the participants are those who have chosen the information security field. It would be useful to be able to identify participants who deliberately chose not to pursue such a career, and examine possible negative influences. Moreover, our study looked at the perceptions of women in information security, but failed to consider the interactions that gender may have with other individual variables, such as ethnicity and culture, and even with variables as specific as geographical location (Kim, Jung, & Ball-Rokeach, 2007). Previous researchers have encouraged studies into the effect of these interactions on perceptions (Faulkner, 2000), and future research should include additional variables for consideration. Finally the small number of participants in the current study restricts its generalizability, but does provide rich qualitative observations. Future steps should not only include interviews with men, but should expand the sample to include more women. For a larger number of participants, it will be important to consider a quantitative approach to research, including a survey instrument, in addition to qualitative data analysis, similar to the results reported in this study. Development of a survey instrument based on existing work that is related, as well as emphasizing the identified themes emerging from this study, may provide more data to determine perceptions of women working in the information security field. Based on this future research, we may be able to offer more targeted interventions that IS educators can take to encourage women to enter and succeed in the information security field.

With the lingering effects of the September 11, 2001 attacks on the United States and the world, the growth of the information security field is projected to continue. This growth and the understanding of the strategic importance of the security of data are of keen interest to IT and other professionals around the world. It is not only important from the perspective of national and international security, but also from the perspective of growth in jobs and opportunities to serve a greater good. Prior research concerning women in IT has suggested that women are more interested in fields with social impact and that they are more likely to be interested in computers when they are seen as tools, rather than entertainment. Thus, the emerging information security field represents a significant opportunity to open the IT field to women in greater numbers. Indeed women are leaders in the information security industry today, although they are still in the minority. Despite their small numbers, these women are establishing networks and critical mass through initiatives such as Alta Associates' Executive Women's Forum, a conference begun in 2003 to focus on best practices in information security (Executive Women's Forum, 2009). These women should be role models for a new generation of women in information security. It is important that educators, parents, and employers learn about opportunities in information security so that these opportunities may be communicated to potential IT professionals at all stages in preparation, from middle school through post-graduate study and professional development in a productive career.

7. REFERENCES

Adam, A.E. (2004) "Hacking into Hacking: Gender and the Hacker Phenomenon." ACM SIGCAS Computers and Society, 32(7).

Bhimani, Anish, Boni, Bill, Cullinane, Dave, Cloutier, Roland, Dorey, Paul, Guttmann, Renee, Kent, David, Natanson, Claudia, Shumard, Craig, & Wuchner, Andrew (2008, December 8) "The Time is Now: Making Information Security Strategic to Business Innovation: Recommendations from Global 1000 Executives." RSA, The Security Division of EMC. Retrieved 7/2/2009 from http://research.bizreport.com/detail/RES/1228724370_967.html.

Bombardieri, Macella (2005, January 17) "Summers' Remarks on Women Draw Fire." The Boston Globe [online edition]. Retrieved 8/15/2008 from http://www.boston.com/news/local/articles/2005/01/17/summers_remarks_on_women_draw_fire/.

Bowers, Toni (2008, July 31) "Number of Women Entering IT Field Drops." TechRepublic. Retrieved 9/15/2009 from http://blogs.techrepublic.com.com/career/?p=368.

Camp, T. (1997) "The Incredible Shrinking Pipeline." Communications of the ACM, 40(10), 103-110.

Executive Women's Forum (2009) 7th Annual Executive Women's Forum. Retrieved 7/3/2009 from http://www.infosecuritywomen.com.

Faulkner, Wendy (2000, Winter) "The Power and the Pleasure? A Research Agenda for 'Making Gender Stick' to Engineers." Science, Technology, & Human Values, 25(1), 87-119.

Gallivan, Mike, Adya, Monica, Ahuja, Manju, Hoonakker, Peter, & Woszczynski, Amy (2006, April 13-15) "Workforce Diversity in the IT Profession: Recognizing and Resolving the Shortage of Women and Minority Employees" [Panel presentation]. SIGMIS-CPR, Claremont, CA, 44-45.

Gephart, R. (1999) "Paradigms and Research Methods." Academy of Management Research Methods Forum, 4.

Henderson, Tom (2007, December 10) "Women in Defense Businesses Form Networking Group." Crain's Detroit Business, 23(50), 14.

Hill, Kimberly (2005, March 9) "Why Women Leave IT." NewsFactor.com. Retrieved 10/15/2009 from http://www.newsfactor.com/story.xhtml?story_id=31000&full_skip=1.

Kellogg, Alex P. (2001, July 18) "Report Urges Educators to Improve the Representation of Women in the Sciences." The Chronicle of Higher Education. Retrieved 7/18/2001: http://chronicle.com/daily/2001/07/2001071802n.htm.

Kim, Yong-Chan, Jung, Joo-Young, & Ball-Rokeach, Sandra J. (2007) "Ethnicity, Place, and Communication Technology: Effects of Ethnicity on Multi-dimensional Internet Connectedness." Information Technology & People, 20(3), 282-303.

Kvasny, Lynette (2006, Fall) "Let the Sisters Speak: Understanding Information Technology from the Standpoint of the 'Other.'" The DATA BASE for Advances in Information Systems, 37(4), 13-25.

Lazowska, Ed (2002, June) "Pale and Male: 19th Century Design in a 21st Century World." Inroads, SIGCSE Bulletin, 34(2), 11-12.

Light, Jennifer S. (2001) "Separate but Equal? Reasonable Accommodation in the Information Age." American Planning Association. Journal of the American Planning Association, 67(3), 263-278. Retrieved July 9, 2009, from ABI/INFORM Global. (Document ID: 75375920).

Logsdin, Holly (2005, May) "Great Expectations for Women in Security." SDM, 130.

Market Wire (2005, November) "Symantec Researcher Named a Woman of Influence for Information Security." Market Wire. Retrieved 7/2/2009 from http://findarticles.com/p/articles/mi_pwwi/is_200511/ai_n15749704/?tag=content;col1.

Moore, Jo Ellen, Yager, Susan E., Sumner, Mary, & Crow, Galen B. (2001, July) "Facilitating Career Changes into IT." Communications of the ACM, 44(7), 71-73.

New Board Members (2009, March 3) "(ISC)2 Announces New Board Members and Elects 2009 Board Officers." PR.com. Retrieved 7/2/2009 from http://pdf.pr.com/press-release/pr-136074.pdf.

Oltsik, Jon (2007, September 24) "Chief Information Security Officers: Good News and Bad News." CNET News. Retrieved 7/2/2009 from http://news.cnet.com/8301-10784_3-9783562-7.html.

Padayachee, K. (2002) "An Interpretive Study of Software Risk Management Perspectives." ACM International Conference Proceeding Series; Vol. 30. Proceedings of the 2002 Annual Research Conference of the South African

Institute of Computer Scientists and Information Technologists on Enablement through Technology, 118-127.

Payton, Fay Cobb (2003, June) "Rethinking the Digital Divide." Communications of the ACM, 46(6), 89-91.

Payton, Fay Cobb (2004, March 11) "Making STEM Careers More Accessible." Black Issues in Higher Education, 21(2), 4.

Qualys, Inc. (2003, September 10) "Qualys Advisory Board Member Becky Bace Honored as One of the Five Most Influential Women in Information Security." Qualys USA News Releases. Retrieved 7/2/2009 from http://www.qualys.com/company/newsroom/newsreleases/usa/view/2003-09-10-2/.

Roach, Ronald (2003, June 19) "Minority Women See Advancement Through Information Technology." Black Issues in Higher Education, 20(9), 37.

Roberts, Mary Lou (2007, January 15) "Why the Number of Women in IT is Decreasing." IT Jungle. Retrieved 10/8/09 from http://www.itjungle.com/tfh/tfh011507-story02.html.

Spafford, Gene (2000, February 23) "Infosecurity at the White House." Neohapsis Archives. Retrieved 7/2/2009 from http://archives.neohapsis.com/archives/ntbugtraq/2000-q1/0156.html.

Stross, Randall (2008, November 15) "What Has Driven Women Out of Computer Science?" The New York Times [online]. Retrieved 9/21/2009 from http://www.nytimes.com/2008/11/16/business/16digi.html

Tapia, Andrew Hoplight (2006, Fall) "Hostile Work Environment.Com: Increasing Participation of Underrepresented Groups, Lessons Learned from the Dot-Com Era." The DATA BASE for Advances in Information Systems, 37(4), 79-98.

Trauth, E.M. (2002) "Odd Girl Out: The Individual Differences Perspective on Women in the IT Profession." Information Technology & People, 15(2), 99-117.

Treu, Kevin, & Skinner, Alisha (2002, June) "Ten Suggestions for a Gender-Equitable CS Classroom." Inroads, SIGCSE Bulletin, 34(2), 165-167.

Woszczynski, Amy, Myers, Martha, & Moody, Janette (2007) "Student Perceptions of Diversity Issues in IT." Journal of Information Systems Education, 17(4), 449-458.

Woszczynski, A., Myers, M., Moody, J., & Beise, C. (2002) "IT Workforce Issues: Stereotypes and IT Careers." 5th Annual Conference of the Southern Association for Information Systems (SAIS), Savannah, GA, March 1-2, 1-2.

AUTHOR BIOGRAPHIES

Amy B. Woszczynski is Associate Professor of Information Systems and Director of the Master of Science in Information Systems degree program at Kennesaw State University. She received a Bachelor's from Georgia Tech, an MBA from Kennesaw State University, and a PhD from Clemson University. Dr. Woszczynski's research interests include diversity in the IT workforce and global issues for the IT workforce. She has published on these and other

topics in *Journal of Information Systems Education*, *Journal of Computer Information Systems*, *Industrial Management & Data Systems*, *Communications of Global Information Technology*, *Computers in Human Behavior*, and at national and regional conferences.

Sherri L. Shade is an Assistant Professor of Information Systems at Kennesaw State University. She received a Bachelor's and a Master's of Science in Information Systems from Kennesaw State University. Professor Shade's research interests include diversity in the IT workforce and ethical issues in the IT workforce. She has published on these in *Journal of Information Systems Education*, *Communications of Global Information Technology*, and at regional conferences.

APPENDIX 1. Women in Information Security Interview Script

INTRODUCTION:

The purpose of this research is to examine careers in Information Security and Assurance within the context of women in IT. We are interested in exploring this relatively new career path to see if there are opportunities for women that have not existed in previous IT career paths.

QUESTIONS

1. What is your current job title? Please describe your general duties as they pertain to IT security.
2. Please describe your career path and how you came to choose IT security.
3. What is your educational background? Training?
4. Why did you pursue a career in information security?
5. What prior experiences (mentors, early classes) have impacted you in choosing a career in information security?
6. Is diversity useful or desirable in the information security field?
7. Is teamwork an important aspect of information security?
8. Do you believe that there is a glass ceiling in information security? That is, is the security area as male-dominated as other areas of IT?
9. How are women treated and perceived in the information security field?
10. Are women more likely to work in information security than other areas of IT? Why? Why not?

Information Systems & Computing
Academic Professionals

STATEMENT OF PEER REVIEW INTEGRITY

All papers published in the Journal of Information Systems Education have undergone rigorous peer review. This includes an initial editor screening and double-blind refereeing by three or more expert referees.