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“Judith” Shakespeare in Computer Programming : An Oral History Study of American Women Programmers in the Late Twentieth Century

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The abstract and thesis of Laura Zeigen for the Master of Arts in History were presented August 2, 2005, and accepted by the thesis committee and the department.

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ABSTRACT

An abstract of the thesis of Laura Zeigen for the Master of Arts in History presented August 2, 2005.

Title: "Judith" Shakespeare in Computer Programming: An Oral History Study of American Women Programmers in the Late Twentieth Century.

The question "Why are there not more women in computer science?" is one that has been asked by both scholarly and business communities since women entered the workforce in large numbers starting in the 1970s. Although there exists a vast literature covering how to involve more girls and women in computer science today, as well as a smaller body of literature outlining the few female pioneers in the field, little has been written about the women who, despite historical exclusion, actually participated in the computing industry as programmers and software engineers beginning in the 1960s. Who were the women going into this part of the labor force during this time? What was the path of women who were successful in the field? What motivated them? What deterrents did they face, and how did the women in the field overcome them? Did the women's movement of the 1960s and 1970s have an impact on women who went into the field? Did late twentieth century feminism affect their experience in the workplace?

To answer these questions, I conducted oral history interviews with twenty-six women who had worked in computer programming between 1960 to 1990 then

cohorts emerge in the analysis: one cohort of subjects (8 interviewees) born before 1950 who came of age largely before the second-wave feminist movement of the 1960s and 1970s, and a second cohort of subjects (18 interviewees), those born after 1950 who came of age at the height of the late twentieth century women's movement. The analysis presented here helps answer the question of why there are not more women in computer programming, what characteristics were held in common by the women who did go into this field, any particular barriers these women faced to pursuing such careers, and how a particular social and historical context affected the consciousness and decision-making processes of individuals in their education and careers.

"JUDITH" SHAKESPEARE IN COMPUTER PROGRAMMING:

AN ORAL HISTORY STUDY OF AMERICAN WOMEN PROGRAMMERS IN THE LATE TWENTIETH CENTURY

by

LAURA ZEIGEN

A thesis submitted in partial fulfillment of the
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DEDICATION

To my grandmother, Fannie Goradetsky Zeigen (born in a shtetl near Pinsk, Belarussia, 1906; immigrated to America, 1913), who pursued her love of knowledge in spite of the barriers presented by her particular social and historical context, and who instilled in me an appreciation for the opportunities I have had to pursue as much education as I desire living in the time and place that I do.

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There are a number without whom the completion of this thesis would not have been possible.

Thanks to my thesis committee for their willingess to meet during the summer so I could complete this. Thanks most particularly to David Johnson, my advisor, for his scrupulous editing and determination to help me graduate in time.

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Last, but not least, many, many thanks to my dear, sweet husband, Allen Bernstein, who has been so patient for so long. I'm back!

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INTRODUCTION TO THE INTERVIEWS

In *A Room of One's Own* (1929), Virginia Woolf pointedly criticized those who argued that women could not possibly rise to the level of achievement of someone like Shakespeare. Woolf, instead of assuming that because there had not yet been a female Shakespeare there could never be one, asked instead, "why *have* there not been more women Shakespeares?" She went on to identify the forces mitigating against any woman writing plays in Shakespeare's time. As Woolf outlines it, an imaginary sister of Shakespeare (whom Woolf names "Judith") would not have had access to, or parental encouragement for, an education beyond reading. This sister's attempts to sneak into her brother William's school to learn something for herself would have been met with harsh criticism, if not a severe beating, from her concerned and loving parents, who only wanted the best for her, which for that time would likely have been an arranged marriage at a young age. Had "Judith" gone to London to learn theater, as her "brother" William did, Woolf postulates that she would have at best been stopped at the theater door with ridicule, and at worst fallen in with some odd lot in the theater crowd, produced a bastard child and killed herself, a life frustrated and unlived, thwarted by the circumstances of her social and historical context.[1]

Woolf's stark answer to "Why have there not been more women Shakespeares?" points to social and historical context as crucial to evaluating an

[1] Virginia Woolf. *A Room of One's Own*. (New York: Harcourt Brace Jovanovich), 1929.

individual's or group's contributions to culture or politics in a given historical period. Both the period *about* which Woolf wrote--the early modern era--and the post World War I period *in* which she wrote must be understood in order to have a framework in which to understand women's entrance into the field of computer programming in the later twentieth century and the struggles these women faced in pursuing a career at this particular time in U.S. history.

The story of the first generation of women in the field of computer programming in the United States, described in the oral history interviews that follow, is a testament to how far some women in the world have come since "Judith" Shakespeare's time. It is a history that also demonstrates how prejudice in the present continues to create barriers for women. The personal narratives below are representative of the struggles that women trying to enter the white collar world continue to face in the opening decade of the twenty-first century. These stories begin to answer "Why are there still not more women in computer programming?" by examining which women actually did go into the field.[2]

The meaning of the oral history transcripts that follow cannot be complete, however, without at first examining the roots of what we consider to be "science," as well as the barriers to education and career advancement and various social constructs about what women are "supposed" to be doing because they were female. The access that women gained to education by the twentieth century was the product of several centuries of evolution, advocacy, and struggle, as outlined by Margaret Rossiter in her

[2] A question asked by Ellen Spertus in her 1991 essay "Why Are There So Few Female Computer Scientists?" (Technical Report: AITR-1315; Cambridge, Massachusetts, MIT) and by many others prior and since. See http://www.spectrum.ieee.org/WEBONLY/resource/may02/care.html as an example.

two-volume work on women in the history of science.[3] Rossiter describes the growth in the nineteenth century of women's academies, then colleges and universities in the United States, as central to the growth of women in science. Women's access to higher education began in the 1820s with the idea of creating "better mothers and wives" for the new American Republic.[4] As women in this early generation gained formal educations, they went on to start women's academies and universities from the 1840s through 1870s. From 1870 onward a flood of women from a burgeoning middle class, sought degrees at these private institutions of higher education and the state universities opened by the Morrill Land Grant Act of 1862.[5] Thus, by the turn of the twentieth century, the question of whether or not women should have access to higher education was not a question, but a given. Women increasingly gained college degrees in all academic disciplines, including the sciences, although the sciences presented unique barriers against women.[6]

Although the women programmers interviewed here show that, by the end of the twentieth century, most white, middle class women had ready access to higher education, the social constructs around gender, about what women were or were not "supposed to do" with their mind, body, and time, persisted.[7] The women who successfully pursued a career in computer programming overcame these "shoulds" and

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[3] Margaret M. Rossiter, *Women Scientists in America, Volume I: Struggles and Strategies to 1940* (Baltimore: Johns Hopkins University Press, 1982) and Women *Scientists in America, Volume II: Before Affirmative Action 1940-1972* (Baltimore, Johns Hopkins University Press, 1995).
[4] Rossiter, *Women Scientists in America,* I: p. 1.
[5] 12 Stat.503,7 U.S.C.301.
[6] Ibid, p. 25. Women's colleges and universities were central to employment of early women scientists in the United States, often providing the only venue through which women could find available positions since science and other departments at most co-educational universities practiced gender discrimination in hiring practices well into the twentieth century.
[7] Ibid, p. 101.

"should nots," both those coming from other people and from internalizations of these social constructs they may have made. As Alice Rossi observed generally about women and science, and as others have described since, "No one forces girls out of the study of math and science, yet a process of self-selection occurs as a result of the differing career aspirations of boys and girls as well as the differing expectations of their parents, peers, and teachers."[8]

The barriers to women entering science--barriers evident in the interview transcripts despite the advances of women in the twentieth century--are rooted deeply in the early modern and modern history of so-called Western civilization.[9] "Judith" Shakespeare's era saw the rise of what historians now consider the beginnings of modern science. Evelyn Fox Keller, feminist scientist and scholar, describes this as "Baconian" science.[10] According to Keller, competing conceptions of science at that time wavered between being defined as "man *over* nature," conquering "irrational" nature through *his* reasoning and logic or "man *with* nature," in which nature coexisted in balanced harmony between mind and things of the body. The "man over nature" approach, and with it, the metaphor of masculine reason triumphing over

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[8] Londa Schiebinger, "The History and Philosophy of Women in Science: A Review Essay," in *Sex and Scientific Inquiry*, Sandra Harding and Jean F. O'Barr, eds. (Chicago: University of Chicago Press, 1987), p. 22-23.

[9] Civil Rights Act 1964; Title IX 1972; For the purposes of this paper, I am defining "gender constructs" as the gender roles that develop out of socialization. I am defining "gender roles" as culturally-defined social roles assigned to individuals on the basis of their sex; "socialization" as the process of social interaction through which an individual learns and internalizes the culture of their society; "role" as a position within a social structure that is shaped by precise behavioral expectations or norms. The Online Dictionary of the Social Sciences (http://bitbucket.icaap.org) further adds that "radical departure from expected role behaviour will usually result in social sanctions."

[10] Evelyn Fox Keller, *Reflections on Gender and Science*, (New Haven: Yale University Press, 1995), p. 54.

feminine intuition (which lacked logic) prevailed.[11] During the early scientific revolution, women were considered not to have the mental capacity to pursue science, even though they had for centuries worked as healers, physicians, and pharmacists and continued to do so. Science itself was defined as masculine.

As Lynette Hunter and Sarah Hutton point out in *Women, Science and Medicine: 1500-1700: Mothers and Sisters of the Royal Society* (1997), the seventeenth century Scientific Revolution emphasized experimental methodology. In 1661, the Royal Society was founded to promote experimental science and to distance science from those that did not conduct formal experiments, in particular, female healers, midwives, and others. For the most part women then did not know how to read, much less pursue such experimental explorations. Even leisured, educated, wealthy women with the skills, knowledge, and time to engage in the new science were not afforded any credit for their contributions, finding their writings relegated to the realm of "literature" as opposed to "natural philosophy"--the realm of "legitimate" science.[12] Science, as Paul Edwards describes, was defined in terms of "hard" cognition, which translated to that which is generally associated with the masculine or male.[13]

Although most women in this study did not consciously think "I am going into computer programming because it is 'cognitively hard,'" computer programming as it developed out of wartime military needs in the mid twentieth century placed it within

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[11] Ibid, p. 45; Lynette Hunter and Sarah Hutton, eds., *Women, Science and Medicine: 1500-1700: Mothers and Sisters of the Royal Society* (Thrupp, United Kingdom: Sutton Publishing, 1997), p. 8.
[12] Ibid, p. 188, 191.
[13] Paul Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, Massachusetts: The MIT Press, 1996), p. 167, 171.

the male scientific tradition. Computer science, in fact, became one of the most "male" scientific endeavors.[14]

While the scientific tradition was ossifying between "Judith" Shakespeare's time and Woolf's, becoming fixed in ever more structured ways, women's access to education expanded greatly. As outlined by Margaret Rossiter and others, the early nineteenth century saw explosive growth in the education of girls and young women in the United States. Nineteenth century arguments in favor of educating girls and women fit into the social constructs of the time: In 1819 when Emma Willard lobbied the New York legislature to fund her all-female academy, she argued that it was for the purpose of creating better mothers and wives. As the century progressed, however, arguments for women's education slowly shifted from this domestic perspective to education for women as valuable in its own right.[15]

By the turn of the twentieth century, women increasingly sought education in all fields of study--including the male domain of science. Women's growing pursuit of education did not, of course, grant them entrance into the halls of science, industry, or business overnight. When women did find employment in universities as lab technicians or assistants, it turned generally on arguments along the lines of "women are so well suited to tedious and meticulous work."[16] Although praised for their capacity for "tedious and meticulous" work, it was not considered as important as the "real" work of the astronomer or scientist in the lab, and unsurprisingly, women were

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[14] ENIAC ("electronic numerical integrator and computer"), the first analog computer, was developed during World War II out of the military's need to automate the process of calculating ballistics for firing tables. Paul E. Ceruzzi, *A History of Modern Computing* (Cambridge, Mass.: MIT Press, 1998).
[15] Rossiter, *Women Scientists in America*, I: p. 5.
[16] Ibid, p. 53-54.

paid substantially less than men for the same work.[17] Although a few women voiced frustrations at these limitations, most were satisfied with the opportunity to participate in science and utilize their education.[18] Even women who had earned Ph.D.s in scientific fields gladly, it seemed, took jobs with a lower status than their education warranted. Women were expected to be satisfied with a place at the table of science. Disparities between women and men in science, in terms of opportunities and wages (something Woolf was attempting to point out in her own time at the crossroads between the rise of women in modern science as a result of greater access to education) was the rule throughout the twentieth century and in fact is reflected strongly in the transcripts that follow. That the system still directly conflicts with what it often means to be female, which for some women involves having and rearing children, shows that the residue of historical barriers remains.[19]

The history of how computer science evolved, as a profession and as an academic discipline, likewise reveals structures that added to these historical barriers to women. As Paul E. Ceruzzi and and Paul N. Edwards both describe in their histories of the development of computing in the United States, computer science began out of military wartime needs to develop ballistic firing tables more quickly.[20] Initially, in World War I, such computations were made by roomfuls of people, largely

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[17] Ibid, p. 51, 54.
[18] Rossiter, *Women Scientists in America, I:* p. 57.
[19] Joan Williams, *Unbending Gender: Why Family and Work Conflict and What to Do About It* (New York: Oxford University Press, 2000); Ann Crittenden, *The Price of Motherhood: Why the Most Important Job in the World is Still the Least Valued* (New York: Metropolitan Books, 2001); Henry Etzkowitz, Carol Kemelgor and Brian Uzzi, *Athena Unbound: The Advancement of Women in Science and Technology* (Cambridge, United Kingdom: Cambridge University Press, 2000).
[20] Ceruzzi, *A History of Modern Computing*; Edwards, *The Closed World.*

women, doing these calculations by hand: women were literally the first "computers."[21] During World War II, the military heavily funded research efforts to develop electronic machines, in addition to Vannevar Bush's existing mechanical differential analyzer, that could make these calculations more quickly. One such effort was that of the ENIAC (Electronic Numerical Integrator And Computer), headed by John W. Mauchly and J.P. Eckert at the University of Pennsylvania's Moore School of Engineering. Although the team developing this largely consisted of men, six women--Kay Mauchley Antonelli, Jean Bartik, Betty Holberton , Marlyn Meltzer, Frances Spence, and Ruth Teitelbaum--also worked on developing the programming for this new device.[22] However, they were considered "sub-professionals" and neither paid or recognized equitably for their considerable contributions.

Thus, women, while involved in the inception of computing as a moden profession, were shut out of it as it professionalized. As Martha Moore Trescott describes, "As the various scientific fields became professionalized, women technologists, theorists, and inventors were not generally welcomed or included in the sciences. Engineering was no exception to this trend."[23] Ruth Perry and Lisa Greber describe this further:

> Women often participate in the early stages of a new technical field, but once a field has stabilized and demonstrated its intellectual (and financial) potential,

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[21] Edwards, *The Closed World*, p. 45.
[22] Janelle Brown, "Women Proto-Programmers Get Just Reward, " in Netizen, May 9-11, 1997, http://webmonkey.wired.com/netizen/97/18/index4a.html, accessed August 5, 2005.
[23] Martha Moore Trescott. "Women in the Intellectual Development of Engineering: A Study in Persistence and Systems Thought," in *Women of Science: Righting the Record*, ed. G. Kass-Simon and Patricia Farnes (Bloomington, Indiana: Indiana University Press, 1990), p. 147-187.

> women are excluded. They no longer can be found in decision-making positions within the field, however invaluable their prior contributions.[24]

The ties of computer science to the military likewise created a barrier for women. The computing profession was able to develop after World War II largely due to the vast part of its research funding which came from the United States military desiring an advantage over the Soviet Union in the Cold War. Thus, although by the early 1960s, companies such as IBM and the RAND corporation had seen, and been able to apply, the military-time computing technology for business purposes, computing at its inception largely grew out of military needs and were focused on military projects. Although women had served in the U.S. military during World War II, they had not done so in as great numbers as men, and after World War II were encouraged to give up any career aspirations in lieu of exclusively childrearing at home and supporting husbands in their careers. Women thus were not present in great numbers in the military during a key time period in which the military was involved with developing computing.

In addition, the way that computer science emerged as an academic discipline created barriers. As an examination of various conference proceedings from the 1960s and early 1970s shows, what this new field was to consist of was open for debate, but largely a struggle between whether the major would initially reside in a university's

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[24] Ruth Perry and Lisa Greber. "Women and Computers: An Introduction," in *Gender and Scientific Authority*, ed. Barbara Laslett, Sally Gregory Kohlstedt, Helen Longino, and Evelynn Hammons (Chicago: University of Chicago Press, 1996), p. 155-182.

engineering department or mathematics department.[25] Engineering departments argued that, owing to the need for the computing field to evolve the physical hardware needed, that computer science should reside in engineering. Mathematics departments argued that computer science should instead reside in their department as the non-hardware aspects of computing, programming, involved logical processes and calculations that the math world had already been contributing to the rise of the field. While no conclusive decision was made about which department was most appropriate for computer science--ultimately it was left to each individual university whether the computer science major emerged under the engineering or mathematics department--faculty in both departments did concur that computer science had to have a foundation that would serve both arenas, including the calculus math classes that traditionally were required of both engineering and math students. This need to "prove" itself as a legitimate academic discipline while it suffered an identity crisis in its formation led to additional requirements being placed into the computer science curriculum. These requirements became particularly important as the mass of baby boomers coming of age in the mid 1970s flocked to the profession--seen as a guarantee of gainful employment and generous salary--and there was an increasing need to "extra" students

[25] J.A.P. Hall, ed. *Computers in education; proceedings of a conference on the computing laboratory in the technical college, held at Hatfield College of Technology* (New York: Pergamon Press, 1962); Aaron Finerman, ed. "University education in computing science; proceedings," in *Conference on Graduate Academic and Related Research Programs in Computering Science (State Univeristy of New York, Stony Brook, 1967),* (New York: Academic Press, 1968); Ron Colman and Paul Lorton, Jr., eds. *Computer science and education: the papers of the ACM SIGCSE-SIGCUE technical symposium (sponsored by the Association for Computing Machinery, Special Interest Groups on Computer Uses in Education and Computer Science Education)* (New York: Association for Computing Machinery, 1975).

need to "extra" students out of the program.[26] The engineering and mathematics departments in which computer science emerged were themselves already largely male dominated. Thus, the academic and work environments encountered by the subjects in this study were a product of several layers, from both computer programming's origins in the military and the debate over computer science as an academic field, that were largely designed as "male" endeavors.

Feminist scholars today, such as Londa Schiebinger, Sandra Harding, and Sue Rosser, argue that it is time to reexamine the very basis of the Western scientific tradition and to develop a "feminist science" in which gender biases are made a conscious part of scientific work.[27] In the case of computer science, specifically, others advocate a shift in how the subject is taught, not to make it easier because women cannot do the work, but to recognize and take into account the double-whammy of the scientific tradition and computer science as "hard," "male," activity. Socially prescribed roles and gender constructs and personal desires create overwhelming time demands for women, especially those who want to have children.

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[26] "Extra" students within a program are largely determined by how large a department wants to, or can, grow. The numbers limitation of how many students are allowed into the upper-level classes is largely, in this author's opinion, an artificial construct of academia which does not allow many students to pursue their educational goals fully.

[27] Londa Shiebinger, *Has Feminism Changed Science* (Cambridge, Massachusetts: Harvard University Press, 1999), p. 11: "Because modern science is a product of hundreds of years of active shunning of women, the process of bringing women into science has required, and will continue to require, deep structural changes in the culture, methods and content of science. Women should not be expected to succeed happily in an enterprise that at its origins was structured to exclude them." Sue V. Rosser, *Women, Science and Society: The Crucial Union* (New York: Teachers College Press, 2000), p. 111.

The structure of scientific careers requires long hours and overtime, and a woman with children is expected to do both the work and the child-rearing.[28]

An additional issue emerges from this examination: the experiences of the subjects of this thesis also reflect larger economic shifts as globalization increased in the late twentieth and early twenty-first centuries.[29] Outsourcing computer and other scientific work overseas has resulted in layoffs across entire industries and reflects harsh economic realities for all workers, not just women. Stories of women in computer science therefore tells a larger story of, first, how women in the late twentieth century confronted and overcame centuries of discrimination, and, second, how changing global economics affected workers in the computer programming field.

Although women today do not generally live lives as frustrated as did the women in Shakespeare's time, women continue to grapple with the kinds of challenges that Woolf addressed. This study highlights how women, with supportive parents, a love of logic, and strong determination, did persist. It gives voice also to the frustration these women felt as they pursued their goals in careers fraught with barriers. This study likewise shows how far off an answer remains to the question "Why are there not more women in computer science?"

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[28] Jane Margolis and Allan Fisher, *Unlocking the Clubhouse: Women in Computing* (Cambridge, Massachusetts: The MIT Press, 2002).

[29] Globalization could be thought of as increasing economic dependency between countries across the world and the increase in the power of multinational corporations over individual governments accompanying this increasing economic interdependency. Related to this is a term coined by Benjamin Barber--"McWorld"--which he uses to describe a world ruled by multinational corporations in which citizen interest in the public good at times runs counter to, and is suppressed by, the marketplace. From Online Dictionary of the Social Sciences, http://bitbucket.icaap.org, accessed online 7/12/2005.

METHODOLOGIES AND DATA

Much has been written about the continuing dearth of women choosing computer science as a major in college or pursuing careers in the computing industry.[30] Likewise, there is a vast literature about how to encourage girls and women to engage in this field.[31] Jane Margolis's and Allan Fisher's 2001 study of undergraduates at Carnegie-Mellon University produced a list of recommendations for how computer science departments could improve their recruitment and retention of female students.[32] There also exists, although it is much smaller, studies of the few, unusual women who helped spearhead the computing industry, such as the initial programmers of ENIAC, many of whom were married to male researchers, and Admiral Grace Murray Hopper, who helped develop COBOL, one of the first programming languages.[33]

Little, however, has been written about the women who, despite historical exclusion, actually participated in the computing industry as programmers and software engineers beginning in the 1960s. Who were the women going into this part of the labor force during this time? What was the path of women who were successful

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[30] Important examples of the many works in this literature include: Margolis and Fisher, *Unlocking the Clubhouse* and Harriet Zuckerman, Jonathan R. Cole and John T. Bruer, eds. *The Outer Circle: Women in the Scientific Community.* (New Haven: Yale University Press, 1991).

[31] See, for example, Majorie W. Steinkapm and Martin L. Maehr. "Gender Differences in Motivational Orientations toward Achievement in School Science: A Quantitative Synthesis," *American Educational Research Journal*, 21 (Spring 1984): 39-59; Mary Thom, *Balancing the equation: where are women and girls in science, engineering and technology?* (New York: National Council for Research on Women, 2001).

[32] Margolis and Fisher, *Unlocking the Clubhouse*, p. 129.

[33] Charlene W. Billings, *Grace Hopper: Navy Admiral and Computer Pioneer* (Hillside, N.J.: Enslow Publishers, 1989); Grace *Hopper: Admiral of the Cyber Sea* (Annapolis, MD: Naval Institute Press, 2004).

in the field? What motivated them? What deterrents did they face, and how did the women in the field overcome them? Did the women's movement of the 1960s and 1970s have an impact on women who went into the field? Did late twentieth century feminism affect their experience in the workplace?

To answer these questions, I searched for other fields in which similar research had been done. A work closest to the study I had in mind is *Women Becoming Mathematicians: Creating a Professional Identity in Post-World War II America* (2000), by Margaret A.M. Murray. Murray conducted oral history interviews with 36 of the 200 women who earned Ph.D's in mathematics from American institutions from 1940 to 1959. Murray found that her subjects "had a natural, intrinsic *curiosity* about mathematics...*opportunity* to explore mathematics in some depth and breadth," and the support and encouragement of key mentors and role models, both male and female.[34] Murray also found that more than a few of her subjects "seemed to thrive on a moderate amount of adversity: direct challenges to their mathematical interests and aspirations, if not overwhelming or preemptive, emboldened them to persevere." Murray's interviewees showed, as she put it, "a complex interplay of internal motivation, social conditioning, encouragement, provocation, discrimination, and opportunity." [35]

Murray's work is the model for this compilation of oral history interviews with late twentieth-century women computer programmers. Oral history interviews provide qualitative data about individuals' lives and provides a detailed record of the meaning

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[34] Margaret A.M. Murray, *Women Becoming Mathematicians: Creating a Professional Identity in Post-World War II America* (Cambridge, Massachusetts: The MIT Press, 2000), p. 71.
[35] Ibid, p. 72.

that individuals perceive of and attribute to their experiences.[36] My approach also is inductive, allowing for hypothesis-building from details in the interviews.[37] In this case, my objective has been to use information from the subjects' life stories to build a picture of what kind of women in the United States went into the computing industry in the late twentieth century and why they chose this field of work. The issues I hope to illuminate include, among other things, whether there were unusual factors in these women's lives that led them to pursue a career in computer science and persist in their studies and careers when, for example, four times as many female as opposed to male computer science undergraduates drop out of the major in college.[38]

Sample

The interviewees in this study were chosen in a non-randomized way. I recruited for subjects by placing advertisements in several alumni newsletters (the University of Oregon and Reed College; Oregon State University would not allow an ad). Limited funds was the primary reason for not advertising in more venues. Notices were also sent out via several listservs related to women in computer science.[39]

Potential subjects who replied to these advertisements were screened on the basis of several criteria: (1) The subject needed to have obtained either a bachelor's or master's degree in computer science or mathematics between 1960 and 1990.

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[36] Sherna Berger Gluck and Daphne Patai, eds. *Women's Words: The Feminist Practice of Oral History* (New York: Routledge, 1991), p. 23, 31.
[37] John W. Crewell, *Research Design: Qaulitative & Quantitative Approaches* (Thousand Oaks, California: SAGE Publications, Inc., 1994), p. 145;
[38] H. Dryburgh, " Underrepresentation of girls and women in Computer Science: Classification of 1990s research." *Journal of Educational Computing Research*, 23 (2000): 181-202.
[39] SYSTERS, a women-only forum designed for professional women in computer science, http://www.systers.org/, accessed online 7/12/2005; WISENET, list for women in science, mathematics, and engineering, http://listserv.uic.edu/archives/wisenet.html, accessed online 7/12/2005.

Mathematics was included as a valid major because computer science as a separate academic major did not emerge fully until the 1970s. (2) The subject needed to be easily reachable for an interview. This reduced the geographic sphere to women in Oregon and Washington state. (3) The subject agreed to participate in the oral history interview and to the parameters of the study, as outlined in the Informed Consent form. (4) The subject needed to be female. The fact that all subjects came from Oregon or Washington state gives this study a regional character, but it is not possible to say what this regional character is in the absence of other regional data. This points to the need for additional data from other areas across the country.

As my research proceeded, I realized that the subjects also needed to have worked as a computer programmer in some capacity between 1960 and 1990. Several individuals I initially interviewed had mathematics degrees but went into teaching mathematics and had not actively worked as computer programmers. In addition to three already interviewed subjects who fell into this category, one subject did not show up for her interview. There were technical difficulties in the interview of another, so no recording of this interview was done. Another subject, interviewed because of interest in his experiences with the then highest-level computing center at Los Alamos in the 1960s, was later excluded from the pool of subjects because he was not female.

In the end, twenty-six subjects fit the criteria and had worked as a computer programmer between 1960 and 1990, for the most part in various business realms. One worked in the defense industry and one in academia. I have divided the subjects into

two cohorts: interviewees in the first cohort (8 people out of the 26 subjects total, or 31%) were born before 1950 and went to college in the 1950s or early 1960s, that is, before the 1960s and 1970s women's movement. The second cohort (18 people out of the 26 subjects total, or 69%) were born after 1950 and went to college and into the workforce in the 1970s or later--after the women's movement began. This division into cohorts is significant to my findings because the social context in which these two groups developed their interest in science, chose a college major, and pursued a career differed substantially.

As historian Sara Evans and others have pointed out, the women's movement of the late 1960s and early 1970s actually consisted of a number of distinctive, simultaneous movements, not necessarily working together, but each individually working towards similar goals of raising society's consciousness about women's legal, personal, economic, and political position in society and working to end gender discrimination in the law and economy.[40] For instance, until the 1970s women could not obtain credit in their own name and were legally paid less than men for the same work.[41] The diverse threads of the women's movement arose out of a growing awareness that women of all backgrounds experienced discrimination as a result of their sex.[42] The publication of Betty Freidan's 1963 work *The Feminine Mystique* is

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[40] According to Alice Echols, radical feminists wanted "to persuade women that gender united them more than class or race divided them," and sought to restructure private and public life, but that liberal feminism initially focused more on trying to open opportunities for women that had previously been open only to men, but still within the existing social structure." Alice Echols, *Daring to be Bad: Radical Feminism in America 1967-1975* (Minneapolis: University of Minnesota Press, 1989), p. 10.

[41] Sara M. Evans. *Tidal Wave: How Women Changed America at Century's End* (New York: Free Press, 2003), p. 1.

[42] Jane De Hart Mathews posits that the second-wave feminist movement of the 1960s and 1970s arose partially out of "issues left unresolved by an earlier generation of feminists." Jane De Hart Mathews,

often pointed to as giving voice to "the problem with no name," the predicament of intelligent, educated women being confined to the domestic sphere of . Seeking work outside the home, while not prohibited, was strongly frowned upon in the 1950s. Passage in 1964 of the Civil Rights Act, especially Title VII, which prohibited discrimination in employment due to sex, further raised awareness of these issues. Subsequent frustration over nonenforcement of this law and rulings by the Equal Employment Opportunity Commission (EEOC) led to the creation of the National Organization for Women and other groups dedicated to gender equity, women's reproductive rights, access to child care, and equality in domestic relations.[43] As Steven Mintz and Susan Kellogg point out, "What Americans have witnessed since 1960 are fundamental challenges to the forms, ideals, and role expectations that have defined the family for the last century and a half."[44] The feminist movement essentially rejected the societal expectation that women defer their own goals to those of their spouses and children. Mintz and Kellogg go on: "The larger mainstream of the women's movement articulated a powerful critique of the idea that child care and housework was the apex of a woman's accomplishments or her sole means of fulfillment...women were urged to raise their consciousness of their own needs and abilities."[45]

"The New Feminism and the Dynamics of Social Change," in *Women's America: Refocusing the Past*, edited by Linda K. Kerber and Jane DeHart Mathews. (New York: Oxford University Press, 1982): p. 397.

[43] Ruth Rosen. *The World Split Open: How the Modern Women's Movement Changed America.* (New York: Viking Press, 2000), p. xviii-xix.

[44] Steven Mintz and Susan Kellogg. *Domestic Revolutions: A Social History of American Family Life.* (New York: The Free Press, 1988), p. 204.

[45] Ibid, p. 207.

As will be revealed in the transcripts, women in the second cohort as a group made different choices in terms of career and child-bearing and marriage than did those in the first cohort, who also struggled to carve out a career for themselves. Part of what informed these different decisions were societal expectations for white, middle-class women prior to and after the women's movement.

Data collection

Data was collected between October 2001 and April 2002 through interviews with each subject. Some interviews took place in the subject's home, but most were held in coffee shops. Following the model set out by Murray, interviews were kept to 2 hours; most ran for about 1½ hours. The interviews were framed around questions designed to elicit answers regarding family and educational background, experiences in college, the subject's decision-making processes in high school and college, how they chose a college major, and after college how they found their first job. In addition, I sought to elicit subjects' general observations about their experiences as women in the computing industry.

Interviews were tape-recorded and transcribed. Each 1½ hour of interview equated to 4 to 6 hours spent in transcribing the tape, for a total of approximately 39 hours interviewing and 160 hours in transcribing. A transcriber was hired to transcribe five of the longer interviews.

Data analysis

Although qualitative analysis software, such as NUD*IST NVivo, exists, using such software to analyze all the transcripts was found to be problematic. This was

partially because subjects often discussed similar concepts using different terms and partially because, while the software can create links between different sets of data, it does not analyze the data. I therefore determined that it was more efficient and richer for the purposes of interpretation to analyze the data by reviewing each transcript and gathering the key concepts in each interviewee document. The most significant results, therefore, emerged from categories based on specific themes emphasized by subjects, including parental support, encouraging school environments, a love of logic, and the process by which an individual consciously chose to pursue computer programming at some point. A result of this qualitative analysis, however, is that the numbers presented here are "impressionistic" at best and should not be regarded as strict statistical figures.

Several features about the backgrounds of the subjects of this study deserve mention because they highlight the ways in which the social and historical context of the interviewees' lives overtly or subtly affected their decisions about college and careers. The data points to a shift in social expectations for women before and after the women's movement of the 1960s and 1970s. These statistics also reflect how people in general are today responding to a changing global economy.

About a third of the total (9 out of 26 subjects, or 35%) came to computer programming as a second career later in life, reflecting the fact that women's career patterns in computer programming do not necessarily follow the traditional standard of moving directly from a 4-year computer science degree into the field. While over half of the subjects (14 out of 26, 53%) still work as computer programmers, an almost

equal number (12 out of twenty-six, 46%) do not. Of the latter, seven are consultants (usability, technical) or independent contractors (graphic design); two work in academia (one in computer science, still in the field); and three are retired. Not counting the three retirees and the academic in computer science, eight out of twenty-six (31%) are no longer working as programmers. One other factor is that careers in any field often lead to different occupations. Although additional data on the general workforce population would be needed to make valid comparisons here, this shift of 30% of the total moving into other areas suggests, based on the reasons stated in the interviews, how increasing outsourcing and layoffs because of the globalization of the high technology industry is affecting whether or not individuals continue in the profession.

Although all but one subjects had married, only eight of the twenty-six (31%) had had children at the time of the interviews, and only two of the eight with children were in the second cohort. While the second cohort made up 69% of the interviewees, they made up only 25% of the interviewees with children. In other words, these women computer programmers display generally a lower rate for having children than the general populace, and it was more common for women in the first cohort to have children than for women in the second. This is a not-surprising reflection of changing societal expectations for gender roles. The 1950s and 1960s, before the women's movement became a social force, and when the first cohort became adults, was an era marked by a modern cult of domesticity. As Jane De Hart Mathews has pointed out, in 1960, when approximately 40% of American women held part-time or full-time

jobs, the rhetoric about what women "should" be doing "still conformed to the old domestic ideology" that women should not be in the workforce.[46]

Beginning in the late 1960s, however, the women's movement shook up these assumptions. As a result, women becoming adults in the 1970s and beyond, whether or not they considered themselves feminists or supporters of the women's movement, operated in a social context where expectations about women's lives had changed and did not automatically include marrying and having children. As historian Sara Evans has pointed out, "The contagion of feminism lay in its ability to touch women at a deeply personal level, politicizing matters that were previously taken for granted as 'the way things were'."[47] Of the eight subjects in the study who did have children, five took significant time out of the workforce beyond maternity leave to raise children. Younger subjects tended not to have children or took only maternity leave: 12 out of the 18 subjects in the second cohort, or 66%, did not have children. The 6 who did have children (33%), took brief maternity leaves, rather than stepping out of the work force until their children were in school. One person in the second cohort, however, is now working part-time to spend more time raising her child. This increasing trend in younger women to take maternity leave, or to forgo child-bearing altogether, coincides with more general patterns in women's lives in the contemporary United States for this particular demographic of middle class, white women.[48]

Eight subjects out of the twenty-six (31%) obtained graduate degrees (computer or non-computer related) beyond their original bachelor's degree. Three of

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[46] De Hart Mathews, p. 404.
[47] Evans. *Tidal Wave,* p. 41.
[48] Crittenden, *The Price of Motherhood,* p. 22-23.

these eight did not have children, and the other five (all with children) obtained their degrees after their children were at least in grade school. These numbers reflect the tension women continue to face between child-rearing and pursuing educational and career airms and points to the indirect, "meandering" paths that the women in this study took in their careers, regardless of the cohort they were in.

DISJUNCTURE: How I saw the subjects versus how they saw themselves

One aspect of this study that needs comment is the disjuncture between how I perceived the subjects' experiences and how they perceived those experiences. For instance, I started this project with the hypothesis that women born earlier in the twentieth century (those who were part of the first cohort) would have experienced greater barriers and discrimination in attaining career goals, and that they persevered largely because they felt they must take a stand for women in general. This was far from the case, however. Women in the first cohort, while still operating within a social context in which gender roles were more narrowly proscribed, ventured into computer programming not as a cause for women, but as a career of interest to them. Some situations, which I thought demonstrated discrimination toward women (such as the subject who always made the two-hour bus trip to visit her boyfriend on weekends, while he never made a like effort), were mentioned by subjects without hint of feeling they had been put out.[49] In other situations, such as when a subject was encouraged to become a drafting technician instead of a full engineer, my interviewees did feel

[49] Subject 7 (b. 1945), p. 9.

discriminated against as a woman.[50] Overall, however, women in the first cohort felt that, if a woman could not achieve something she wanted to, it was because she had not made decisions as an individual rather than because she was the victim of societal expectations.

Subjects in the second cohort expressed a similar attitude about their career choice. They pursued a career they loved and had little interest in making a political point. However, in contrast to first cohort subjects, those in the second cohort were , more likely to acknowledge gender barriers to their ambition. At the same time, they were quick to emphasize that they tried not to let these limitations stop them. This awareness in the part of the second cohort could be attributed to the greater consciousness that was brought to the fore by the 1960s and 1970s women's movement, regardless of the individual interviewees' politics. As stated by historians Steve Mintz and Susan Kellogg, "In general the feminists awakened American women to what they viewed as the worst form of social and political oppression--sexism. The introduction of this new awareness would go far beyond the feminists themselves."[51] Simply put, the second cohort subjects as a group exhibited more awareness that external barriers existed against women and this pattern of greater awareness can in large part be attributed to the women's movement.

The women's movement of the 1960s and 1970s, through questioning existing societal structures, helped create new sources of legitimization to women's experiences, altering women's and men's expectations about everything from the

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[50] Subject 26 (b. 1934), p. 8.
[51] Mintz and Kellogg, *Domestic Revolutions*, p. 208.

sexual division of labor in marriages in particular to the place of women in society in general.[52] The women's movement, however, did not completely clear the path for women in the second cohort; it merely made these subjects shift their strategies of how to navigate through the business and political structures of society. Women of the second cohort were not as obviously blocked from pursuing a non-traditional career path, but they consciously had to make different choices in their lives, such as marrying or having children later or not having children at all, in order to successfully pursue these careers. The societal structures were still in place--women just had more freedom to move around within them--but the debate about actually reorganizing the structures themselves, and actually making those necessary changes so women did not continue to labor under undue burden, was yet to take place. As historian Sara Evans points out,

> The legal structure has changed, but the vision of equality that undergirds those changes continues to be illusive. Women's opportunities for work and for equal compensation remain systematically limited. The structure of work outside the home and the continued expectation that women have primary responsibility for child care and housework still force mothers into impossible choices between the demands of work and of family.[53]

Although the 1970s through 1990s saw a rise in discourse amongst feminist scholars regarding the need to reexamine the foundations of how the practice of science is formulated, actual public policies on associated impacting structures, in particular

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[52] Julie A. Matthaei. *An Economic History of Women in America: Women's Work, the Sexual Division of Labor, and the Development of Capitalism.* (New York: The Harvester Press, 1982), p. 301.
[53] Sara M. Evans, *Tidal Wave: How Women Changed America at Century's End.* (New York: Free Press, 2003), p. 2. She also points out "The crumbling of legal barriers has also created an illusion of equality, espeically in contrast to the earlier, over forms of discrimination.", p. 235.

child care, did not change to such an extent that even second cohort subjects did not have to shift their life strategies.[54]

There were negative consequences as well that came with the awareness about women's experience and greater opportunities for women entering the workforce brought about by the women's movement. When, prior to about 1975, there were fewer women in the workforce, a woman working in a non-traditional field was not necessarily seen as a threat to the others on her team, who were primarily men. Sociologist Rosabeth Moss Kanter referred to this phenomena as "tokenism," in which the representative few in the minority group are not present in enough numbers to shake the existing structure: the tokens' presence is not a threat and, in fact, they must usually bend themselves to the prevailing structure. Thus, the majority of the group can fall back on preexisting expectations and traditional behaviors.[55] However, once women starting entering the workforce in greater numbers starting in the late 1970s, women went from being the "token" woman on a team to a genuine threat to the livelihood and existing social structure of the others on the team.[56] Not surprisingly then, as the structures around the workplace formally opened up to women, a backlash against women in those positions, or against the women's movement in general, developed. As Henry Etzkowitz and others describe, "As proportion of women increased, their interaction with male coworkers and the support they received for

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[54] Sue V. Rosser. *Re-Engineering Female Friendly Science.* (New York: Teacher's College Press, 1997); Londa Schiebinger. *Has Feminism Changed Science?* (Cambridge, Massachusetts: Harvard University Press, 1999).

[55] Rosabeth Moss Kanter. *Men and Women of the Corporation* (New York: Basic Books, 1977).

[56] Subjects 25 and 32 in particular related instances of backlash against them in their workplaces in the late 1970s and early 1980s.

promotion from male coworkers decreased. Thus, the larger the minority the greater the discrimination against it."[57] Again, although the experiences of this study's subjects reflect the impact of the women's movement--a shift in expectations from 1960 to 1990 about what women could do with their lives and careers--these experiences also show that women continue to have to navigate through a structure that does not give full recognition to their realities.

Although I have tried to represent these subjects' experiences as accurately as possible, inevitably my own biases have informed this study. While each individual subject felt her experience was unique, from my interviews with 26 of them I saw patterns emerging: for the first cohort marriage and children affected career goals moreso than for the second cohort; women in the second cohort felt strongly that the atmosphere in America's public schools was anti-intellectual; schooling and career decisions by all of these women were shaped by a combination of internal motivations and external forces. While the subjects reading this may not have understood their lives as the product of larger social forces, the patterns presented in their interview transcripts point to a significant shift in the United States in expectations for experiences of women before and after the women's movement of the 1960s and 1970s.

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[57] Henry Etzkowitz, Carol Kemelgor and Brian Uzzi. *Athena Unbound: The Advancement of Women in Science and Technology.* (Cambridge, United Kingdom: Cambridge University Press, 2000), p. 110. Alice Echols also describes this as "the marginalization of feminism." *Daring to be Bad: Radical Feminism in America 1967-1975* (Minneapolis: University of Minnesota Press, 1989), p. 294.

RESULTS

Who Were These Women? What External Influences Affected Them?

These twenty-six oral history interviews offer a snapshot of the experiences of women in the post-World War II computing industry. Although this study does not provide absolute statements, it does lead to significant conclusions that stand as a benchmark for other scholars to use. This thesis, specifically the interview transcripts that begin on page 65--provides a large data set in and of itself, a copy of which is deposited in the PSU Library. The tapes of the transcripts are not available due to the agreements made with the subjects at the time of the interviews that their participation in this study would remain anonymous, as a number of interviewees identify themselves on the tapes.

The general themes I examine in the rest of the introduction include the impact of family structure and other external supports such as teachers, peers, and educational environment, as well as the subjects' internal motivations--a love of logic, being comfortable as one of few women in predominantly male environments, a determination to support oneself, and, through a long series of smaller, cumulative decisions, the decision to major in a computer-related field or return to school to study programming.

All of the subjects experienced a strong influence from parents about their education as well as moderate or substantial support from particular teachers and siblings, supportive peers, or spouses. The subjects likewise benefited from encouraging, sometimes all-women or other non-traditional educational environments.

Parents

Parents influenced subjects most powerfully through the encouragement they gave their daughters to achieve academically. Above all, all subjects' parents influenced subjects by academic expectations: Most subjects received an unspoken assumption from their parents that they were going to college.[58] Subject 25's comments are typical in this regard: "It wasn't something that was discussed: it just was a fact of life. The sky was blue, gravity worked, and everybody was going to do well in school and go to college."[59]

In addition to encouraging daughters to go to college, parents provided role models of what subjects could do professionally. Sometimes this role modeling came through the subject's exposure to their father's work in a technical field such as chemical, mechanical, structural or electrical engineering.[60] A father's work in an engineering field did not necessarily guarantee early exposure to the computing or engineering fields, however, if the father's work was classified, which was the case for two subjects.[61] Both subjects in this instance never heard about or saw their father's work. This stands in contrasts to other subjects who had fathers who brought equipment from work home for them to play with, actively discussed with them ideas

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[58] Subject 30 (b. 1944), p. 1; Subject 30 (b. 1944), p. 3; Subject 14 (b. 1933), p. 13; Subject 26 (b. 1934), p. 6; Subject 27 (b. 1942), p. 1; Subject 20 (b. 1949), p. 2; Subject 17 (b. 1952), p. 1; Subject 10 (b. 1953), p. 2; Subject 9 (b. 1955), p. 11; Subject 25 (b. 1959), p. 3; Subject 15 (b. 1959), p. 2; Subject 16, p. 2; Subject 24, p. 5; Subject 13 (b. 1966), p. 2; Subject 6 (b. 1969), p. 11

[59] Subject 25 (b. 1959), p. 3; From Subject 8 (b. 1965), p. 7: "It was always expected that we would go to college. That was never a question. It was not *if*, it was *where*."

[60] Out of the 26 subjects; 8 had fathers who were some type of engineer; chemical engineers (3), mechanical engineers (3), electrical engineers (1), ceramic engineer (1); Subject 15 (b. 1959), p. 2; Subject 16, p. 1; Subject 1 (b. 1961), p. 1; Subject 8 (b. 1965), p. 2, 3; Subject 18 (b. 1966), p. 1; Subject 13 (b. 1966), p. 1, 3; Subject 5 (b. 1967), p. 11; Subject 8 (b. 1965), p. 4.

[61] Subject 16, p. 7; Subject 15 (b. 1959), p. 2.

of things they were doing at work. Fathers also encouraged their daughters to pursue financially lucrative careers, instilling in them the fact that they would be expected to support themselves one day.[62] As Subject 24 stated: "My dad was probably the first person to point out to me that the average female salaries are half that of a man's and you can't live on that and I never wanted to be dependent and that was what my dad was going for."[63] The absence of a father (deceased) in one case raised a subject's awareness about fiscal realities.[64]

Subjects' mothers usually had less technically-oriented careers than the fathers. For the most part they were homemakers. Most of the mothers who did work held jobs that were traditionally female, such as teaching or secretarial work, but some mothers (5, or 19%) worked as bookkeepers or accountants.[65] Role modeling from mothers with technical backgrounds initially stood out as a key hypothesis; however, although mothers in these numbers-related careers may have subconsciously had an effect on some subjects, no interviewees specifically cited this as influencing their career choice.[66] Some subjects did cite the influence of artistic mothers on what became the interviewees' interest in the style of problem-solving involved in computer programming--as a creative process that the interviewees described as both art and

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[62] Subject 20 (b. 1949), p. 2; Subject 24 (b. 1964), p. 5; Subject 23 (b. 1942), p. 1-2; Subject 22 (b. 1966), p. 2.
[63] Subject 24 (b. 1964), p. 5.
[64] Subject 21 (b. 1952), p. 2, 3.
[65] Subject 1 (b. 1961), p. 6; Subject 8 (b. 1965), p. 2, 3; Subject 18 (b. 1966), p. 1. Subject 23's mother worked as a bookkeeper from the time Subject 23 was 13 years old; Subject 21's mother worked in banking; Subject 25's mother was a CPA,; Subject 13's mother was a CPA, but became one after Subject 13 left for college; Subject 28's mother was a bookkeeper.
[66] Subject 25 (b. 1959), p. 2; Subject 15 (b. 1959), p. 2; Subject 13 (b. 1966), p. 1, 3; Subject 28 (b. 1969), p. 1.

science.[67] As Subject 8 remarked: "There's a certain amount of art to it. For it to be a science you have to only do things that have been done before, when you apply cookbook formula or known procedures...no engineering field is like that, because you're not solving the same problem you solved before."[68] Mothers also supported their daughters by advocating for their educational opportunities, which the subjects attributed to their mothers' own unfulfilled aspirations.[69] In addition, through their mothers, interviewees felt connected to a larger tradition of "strong women," which helped them to position themselves emotionally and intellectually while pursuing college majors and careers deemed "male."[70]

In addition to a father's profession and parents' support and encouragement, subjects described a family atmosphere of learning that developed an affinity for analyzing and solving problems that are common in computer logic.[71] Subject 17 describes her experience of traveling to museums or wilderness areas with her parents: "They would ask me questions, constantly keeping my mind going. I really learned to love detective work--'What do you think makes that tick?--they never squelched the curiosity."[72] Subject 11 remembers growing up in an environment where analytical inquiry was likewise valued: "At our house, problems were expected to be solved with

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[67] Subject 8 (b. 1965), p. 2, 3; Subject 5 (b. 1967), p. 2, 11.
[68] Subject 8 (b. 1965), p. 4.
[69] Subject 8 (b. 1965), p. 7; Subject 13 (b. 1966), p. 12.
[70] Subject 23 (b. 1942), p. 18, Subject 14 (b. 1933),p. 5, Subject 15 (b. 1959), p. 8; Subject 25 (b. 1959), p. 1; Subject 8 (b. 1965), p. 29.
[71] Subject 17 (b. 1952), p. 3; Subject 11 (b. 1954), p. 3, 6; Subject 31 (b. 1955), p. 6; Subject 1 (b. 1961), p. 5; Subject 22 (b. 1966), p. 2; Subject 6 (b. 1969), p. 4, 5; Eskeles Gottfried, James S. Fleming, and Allen W. Gottfried, "Role of Cognitively Stimulating Home Environment in Children's Academic Intrinsic Motivation: A Longitudinal Study." *Child Development*, 69 (October 1998): 1448-1460.
[72] Subject 17 (b. 1952), p. 3.

some sort of logic and data. I mean, you just couldn't point and scream at your siblings...there was always an intellectual approach to things."[73]

More generally, interviewees' parents and other primary caregivers (for example, grandmothers and day care providers) encouraged these women to explore less-gendered roles.[74] In these families, non-traditional pursuits such as playing basketball, doing woodshop instead of home economics, or preferring construction tools over dolls were tolerated for daughters, even if these parents struggled between encouraging their daughters to pursue non-traditional opportunities and what was traditionally expected for females.[75] As Subject 26 described the toolset and workbench her parents gave her when she was five or six years old: "My mother must have gone along with this, but she was horrified at her daughter being so nontraditional. She always tried to make me a lady, and she finally gave up, I think."[76] Women growing up from the 1950s through 1970s thus saw in both their mothers and fathers a range of options for their adult lives. Some subjects were encouraged to go into traditional female fields like teaching, but in general they were left to their own devices or encouraged to pursue technical careers. Occasionally, parents gave mixed messages to subjects about "proper" female behavior and work pursuits, but subjects were able to overcome this.[77] For instance, Subject 27 remembers being told to excel in her academics by both parents, but being reminded by her mother, upon learning

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[73] Subject 11 (b. 1954),p. 6.
[74] Subject 14 (b. 1933); Subject 17 (b. 1952).
[75] Subject 7 (b. 1945), p. 1; Subject 20 (b. 1949), p. 2; Subject 17 (b. 1952), p. 1; Subject 11 (b. 1954), p. 3; Subject 28 (b. 1969), p. 1.
[76] Subject 26 (b. 1934), p. 10.
[77] Subject 13 (b. 1966), p. 2; Subject 14 (b. 1933),p. 13, Subject 14 (b. 1933), p. 29; Subject 26 (b. 1934), p. 10; Subject 27 (b. 1942), p. 3, 4, 5; Subject 23 (b. 1942), p. 2; Subject 11 (b. 1954), p. 3.

her daughter's genius-level IQ score, to not let any boy know she was smart: "Oh you never tell a boy ever!" [78]

Siblings

The women interviewed did not attribute much significance to sibling influence, although sisters and brothers did on occasion contribute to a subject's decision to follow a career in computer programming.[79] Initially I had hypothesized that a sibling's profession would indicate larger tendencies within a family (a preponderance of children following technical careers), but the numbers (which are impressionistic and cannot be considered hard statistics) are ambiguous on this point: ten out of twenty-six subjects (or 40%) had siblings who also worked in technical fields. This compares similarly to Murray in that she found only a moderate co-occurance between career choice and siblings in technical careers. However, elements of sibling support occasionally added to subjects' movement towards technical work themselves.[80] For instance, Subject 14's older brother, who later became an electrical engineer himself, encouraged her to take the engineering track in high school as he knew she was good at math.[81] Other subjects with siblings in technical fields did not necessarily receive such active encouragement, but seeing their sibling or extended family member, such as a brother-in-law, engaged in such a field may have encouraged the subjects to try it themselves.[82]

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[78] Subject 27 (b. 1942), p. 4.
[79] Subject 23 (b. 1942), p. 7; Subject 25 (b. 1959), p. 2, 5; Subject 6 (b. 1969), p. 9; Subject 14 (b. 1933), p. 10
[80] Murray, *Women Becoming Mathemeticians,* p. 57-64.
[81] Subject 14 (b. 1933), p. 10.
[82] Subject 13 (b. 1966), p. 2.

Teachers

In addition to parents, junior high and high school teachers and college professors had great influence on these women's pursuit of technical careers in computer programming. Teachers' and professors' influence appeared, in fact, second only to the influence of parents in this regard: every single subject (100%) mentioned their parents as being supportive of their education, and 20 out of 26 subjects (77%) mentioned teachers as helping them in this way. Subject 15, about to drop the major, went to talk with her advisor, who told her: "It's really hard to get into the computer science program now. Don't drop the major yet...just start over. Pretend like none of the transfer credits were there and take the beginning computer science classes and see what happens."[83] Subject 21, also about to drop out of what she described as a miserable first year in her computer science masters program, went to her advisor's office at midterms: "I would say 'I am leaving--I can't take it anymore.' He would say 'wait until the end of the quarter.' My advisor said I could do it. He really dragged me through that year."[84]

In general, the influence of teachers from elementary school through high school was a significant factor for these women. Teachers instilled a love of science, math, and logic-based academic topics such as philosophy and Latin that interviewees felt helped develop their analytical skills.[85] The interviewees were quick to emphasize that it was a teacher's enthusiasm for science, math, and other topics, not the teacher's gender, that influenced them most. As Subject 6 described her sixth-grade enrichment

[83] Subject 15 (b. 1959), p. 10.
[84] Subject 21 (b. 1952), p. 5.
[85] Subject 7 (b. 1945), p. 9.

computer instructor: "He was just genuinely interested in the math and science itself. And that's where I am most comfortable, with other people who are passionate about this."[86] Only one subject cited a specific female math teacher with a Ph.D. as instrumental in her future career choice, and in only one case did a female math teacher actively recruit one of these women into a scientific field.[87] Other subjects (2 out of 26, or 8%), did note that seeing women doing computing work inspired them to try programming.[88] Subject 9 describes a point when her nursing department computer went down, and the technical support department sent a female technician to fix it: "She was the nicest woman in the world...typing all these commands in DOS. I remember looking at her and going, 'That is the coolest thing I've ever seen.' And she said, 'You know, it's not really tough.' And I went, 'No way.' And she goes, 'Way.'" [89] Only one subject reported an experience with a math or science teacher that discouraged her from pursuing math or scientific pursuits, although others had experiences one could also describe as discouraging: Subjects 10 and 16 both were unable to take a year of their junior high math because the class had room for only one more student and their respective schools thought a boy would benefit more from the course. [90]

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[86] Subject 6 (b. 1969), p. 3.
[87] Subject 7 (b. 1945), p. 5; Subject 14 (b. 1933), p. 9; Subject 18 (b. 1966), p. 2; Subject 7 (b. 1945), p. 5; Subject 14 (b. 1933), p. 10; Subject 8 (b. 1965), p. 13, 14; Subject 18 (b. 1966), p. 1; Subject 22 (b. 1966), p. 2; Subject 13 (b. 1966), p. 3; Subject 5 (b. 1967), p. 6; Subject 6 (b. 1969), p. 11; Subject 21 (b. 1952), p. 3.
[88] Subject 10 (b. 1953), p. 15; Subject 9 (b. 1955), p. 24; Subject 9 (b. 1955), p. 25; Subject 10 (b. 1953), p. 15.
[89] Subject 9 (b. 1955), p. 24.
[90] Subject 1 (b. 1961), p. 2; Subject 13 (b. 1966), p. 4; Subject 9 (b. 1955), p. 8, Subject 10 (b. 1953), p. 4-5, 8, Subject 16, p. 3.

Often, early exposure to computers created an abiding interest that inspired the interviewees to pursue science, math, and computing in college, which in turn encouraged them to pursue computer-related jobs through high school and college, such as tutoring in math or working in a computer lab.[91] This is where college professors were most instrumental. Professors provided the final push that helped launch subjects into computer programming careers. At some point, even the strongest computer science enthusiast doubted herself, usually in college, sometimes considering abandoning their computer science major and going into teaching, not because of pressure from parents, but because they felt they were not good enough for the program in which they were enrolled.[92] As Subject 6 stated: "Am I good enough or not? I couldn't figure it out...I'm obviously not bad at it, but my grades aren't good, so therefore I guess I'm not really good at it and I'm fooling myself."[93] For fourteen subjects for whom this occurred, college professors made a positive difference by encouraging, advising, and otherwise helping the subjects endure the often challenging computer science curriculum.[94] As Subject 5 described one of her professors, "I remember he always worked really hard with me. I'd get stuck on certain things and he'd spend extra time with me helping figure stuff out and he gave me advice...that was really when I started thinking about going for my masters degree as I started

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[91] Subject 23 (b. 1942), p. 2; Subject 23 (b. 1942), p. 5; Subject 27 (b. 1942), p. 4; Subject 27 (b. 1942), p. 7; Subject 30, (b. 1944), p. 7; Subject 30, (b. 1944), p. 8; Subject 21 (b. 1952), p. 6; Subject 17 (b. 1952), p. 4; Subject 11 (b. 1954), p. 5; Subject 11 (b. 1954), p. 10; Subject 11 (b. 1954), p. 11 ; Subject 8 (b. 1965), p. 2; Subject 8 (b. 1965), p. 19; Subject 8 (b. 1965), p. 20; Subject 8 (b. 1965), p. 21; Subject 18 (b. 1966), p. 2; Subject 22 (b. 1966), p. 5; Subject 5 (b. 1967), p. 4; Subject 5 (b. 1967), p. 5; Subject 6 (b. 1969), p. 3; Subject 28 (b. 1969), p. 1; Subject 28 (b. 1969), p. 2.
[92] Subject 6 (b. 1969), p. 16; Subject 13 (b. 1966), p. 7-8; Subject 14 (b. 1933), p. 14.
[93] Subject 6 (b. 1969), p. 15.
[94] Subject 21 (b. 1952), p. 5.

talking with him."[95] Professors also helped subjects gain needed practical experience through connecting them to work in computer labs and internships and assisting them through professional networking to then obtain their first jobs after graduation.[96]

School Environment and Peers

Another key external factor that subjects cited as significant to their success in computer programming was a supportive school environment: a private school, all-girls' school, all-women's college, or community college.[97] As Subject 9 describes her private school, "I remember all my teachers, I just don't remember anybody standing out particularly as super...because they were all really great. I had a wonderful education."[98] Subject 15 describes the experience of her first programming class: "I really loved the community college experience...the class, the teacher, and the students ended up working together to make the class successful for all of us."[99] Teachers and a core group of friends in the midst of a larger cohort of classmates fostered an atmosphere in which subjects felt encouraged to ask questions without being ostracized as a "nerd" or a "geek."[100] The "geek factor," the perception that science and math conflicted with socially proscribed roles for females, was especially present from the 1960s onwards, according to the interviewees.[101] While only one woman out of the eight people (12.5%) in the first cohort noted this, nine out of 18 in

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[95] Subject 5 (b. 1967), p. 11.
[96] Subject 21 (b. 1952), p. 5; Subject 17 (b. 1952), p. 6; Subject 25 (b. 1959), p. 6; Subject 5 (b. 1967), p. 11; Subject 21 (b. 1952), p. 6.
[97] Subject 25 (b. 1959), p. 9; Subject 15 (b. 1959), p. 8; Subject 15 (b. 1959), p. 10; Subject 1 (b. 1961), p. 6, 7; Subject 7 (b. 1945), p. 5; Subject 9 (b. 1955), p. 4; Subject 9 (b. 1955), p. 9.
[98] Subject 9 (b. 1955), p. 4.
[99] Subject 15 (b. 1959), p. 7.
[100] Subject 18 (b. 1966), p. 2.
[101] Subject 10 (b. 1953), p. 10.

the second cohort (50%) did. Again, this points to a greater consciousness on the part of the second cohort, a consciousness raised for all second cohort subjects by the women's movement, regardless of how women saw themselves politically or whether or not they considered themselves to be feminists. However, one subject in the first cohort noted this as a general anti-intellectual bias she experienced in high school: "I got good grades regardless [of social pressures]. And the kids really set you apart for that."[102] Women in the second cohort, even if they did not feel the stigma of being a "geek," experienced the tension between an anti-intellectual attitude from their peers and school environment and the intellectual capabilities they, and their encouraging parents, knew they possessed. Although generally subjects were able to withstand being a minority amidst male peers, not feeling comfortable in a mostly-male environment created a barrier for a couple of subjects who wanted to pursue programming as a career.[103]

The advantages of an all-girls school environment, according to three subjects, included more opportunities to take on leadership positions in school government, newspaper, sports, and other activities--positions that commonly went to boys in co-ed environments.[104] Two subjects who attended school outside the United States found this in their environments as well, as did one subject who attended Catholic grade school and another who attended a private school. Subjects who attended these schools discovered environments in which learning and academic achievement were

[102] Subject 14 (b. 1933), p. 11.
[103] Subject 9 (b. 1955), p. 8; Subject 10 (b. 1953), p. 8.
[104] Subject 9 (b. 1955), p. 9.

something to strive for, where "it was OK to be smart."[105] Subject 18 felt that at her all-girls high school it was OK to be herself and ask questions and speak out: "All of that was encouraged and expected and much easier to do [than in her coed junior high]. It felt like a safe environment. It didn't feel like people were going to ridicule you or make fun of you if you said something really stupid...it was as basic as that."[106] Subject 24 describes her grade and junior high schools in Hong Kong and Singapore as being both core to the American expatriate community and full of supportive, if demanding, teachers: "The cool kids were the kids with the best grades and in the study clubs...the cool kids were the smart kids; no exceptions. Not a lot of sports at those schools."[107] Subject 6, who grew up in Canada, describes her grammar school: "There was definitely a respect for education...the other girls and I were considered geeks...we didn't fit in socially, but there was never an anti-school attitude. It was always assumed that you'd go to school and you'd do your best...good studies were respected."[108]

One subject who went to an all-women's college noted a similar supportive environment there as well.[109] As Subject 18 described, "I liked the fact that the emphasis [at the college] was on learning and there wasn't the constant distraction of big football games, big dorm parties...although we had plenty of fun and we goofed off all the time, the focus was really on classes and classwork."[110] These opportunities

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[105] Subject 18 (b. 1966), p. 2, 3; Subject 6 (b. 1969), p. 7; Subject 24 (b. 1966), p. 3; Subject 18 (b. 1966), p. 2.
[106] Subject 18 (b. 1966), p. 3.
[107] Subject 24 (b. 1964), p. 2.
[108] Subject 6 (b. 1969), p. 5.
[109] Subject 18 (b. 1966), p. 2, 3.
[110] Subject 18 (b. 1966), p. 4.

were particularly rare previous to the passage of Title IX in 1972, which opened up equal funding and opportunities for girls and women in sports.[111] Subjects that did not go to an all-girls or an academically focused high school sometimes expressed regret for not having a more socially supportive high school experience.[112] In contrast to an environment in which the "cool" kids were the smart ones, subjects--mostly in mixed gender schools--experienced environments in which it was *not* "OK to be smart." [113] Subject 24 describes the shock she felt at coming to high school in the United States after spending the majority of her previous schooling in Hong Kong and Singapore: "American kids bragged about how bad their grades were and if your grades were good they called you a geek. It was my first experience that the smart kids were not the cool kids. Everything seemed to be the exact opposite of my high school in Hong Kong."[114] Subject 6 experienced similar shock coming to an American high school: "I found people more threatened [by her intelligence]. I definitely felt more social pressure to go off and get drunk than I did to go off and do math."[115] As Subject 8 describes her high school in Idaho: "It was definitely uncool to be intelligent. I don't know whether that has to do with the age change and trying to attract boys or whether it was a Boise thing...we had the jock group, and they barely had C averages, and they were cool. And if you weren't in that group, you weren't cool."[116]

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[111] Civil Rights Title IX 1361. Title IX essentially bars exclusion from any federally-funded activities, including school activities, on the basis of sex.
[112] Subject 31 (b. 1955), p. 8; Subject 24 (b. 1964), p. 2; Subject 6 (b. 1969), p. 8; Subject 24 (b. 1964), p. 5.
[113] Subject 18 (b. 1966), p. 2, 3.
[114] Subject 24 (b. 1964), p. 3.
[115] Subject 6 (b. 1969), p. 8.
[116] Subject 8 (b. 1965), p. 10.

Same-gender institutions were not the only places where subjects experienced the kind of supportive learning environment they described as being helpful for them in exploring mathematics and other "hard" science. All three subjects who attended community colleges expressed the importance of the supportive nature of these particular academic environments in enabling them to move ahead in computer science.[117] Subject 15 noted that in her first computer class (on Apple BASIC programming language), "Whereas my typical response to not understanding the teacher would have been, "Oh, I'm stupid, I don't get it," in this case I knew other people in the class and I knew none of us got it."[118] Even larger universities, if a subject had encouraging professors and a supportive peer group, could help provide the right learning environment that helped subjects feel safer exploring the field. As Subject 1 described her experience with a computer science professor who she felt was able to develop a bond with students at her large state university: "He spent a lot of time with his students to make sure you understood everything. And if any part of class was falling behind he would stay after class to work with those students and make sure everybody...understood everything as we moved forward."[119]

For some of the interviewees, academic environments in which sports and dating were not emphasized were especially important.[120] Subjects noted that the heavy emphasis in high school on popularity and dating detracted from their ability to

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[117] Subject 25 (b. 1959), p. 7; Subject 15 (b. 1959), p. 8; Subject 16, p. 5, 6; Subject 18 (b. 1966), p. 8; Subject 1 (b. 1961), p. 6, 7
[118] Subject 15 (b. 1959), p. 7
[119] Subject 1 (b. 1961), p. 6.
[120] Subject 24 (b. 1964), p. 3; Subject 6 (b. 1969), p. 5; Subject 31 (b. 1955), p. 6.

develop a sense of themselves academically.[121] Subject 31 remembers crying herself to sleep at her ninth grade state science fair because none of the boys asked her to dance:

> Why'd they have a dance at the state science fair anyway [laugh]? I was very well socialized wasn't I? I go to the science fair and I'm worrying about the dance! At that age, however, it is part of why a lot of girls veer off from doing math and science because they understand that what they need to do to be accepted is often to deny these pursuits. It's not a conscious thing.[122]

Subject 13 concurred, remembering hiding her aptitude for math in middle school because she didn't want to "stick out." She estimated that this desire to fit into one's peer group was a large component of why kids, particularly girls, turn off from math and science: "They don't want to stick out or be different. They just want to be part of the cool crowd. There is so much pressure to be part of the cool crowd."[123] Subject 24 felt that the pressure to be popular and date as young as 14 years old was not universal, but unique to American culture: "The need to date, be accepted in peer groups. I'm sorry--those are not biological, those are cultural, and all of them go against girls getting an education in math and science. And they don't exist in other cultures."[124] As experts in education and adolescent development have established, adolescents often stop pursuing academic goals if they perceive it puts them outside the pecking order of their peer group.[125] Subject 18 remembers of her coed junior high: "The whole thing with boys and girls was very awkward. We were always

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[121] Subject 8 (b. 1965), p. 8; Subject 14 (b. 1933), p. 15, 16.
[122] Subject 31 (b. 1955), p. 7.
[123] Subject 13 (b. 1966), p. 13.
[124] Subject 24 (b. 1964), p. 9.
[125] Judith A. Howard and Peter L. Callero, eds. *The Self-Society Dynamic: Cognition, Emotion, and Action.* (New York: Cambridge University Press, 1991).

worried about what the boys were thinking and they were worried about what the girls were thinking."[126] Peer support manifested in a variety of ways, and once subjects found supportive peers, they felt they fit in and could be themselves. As Subject 6 stated about finding her niche in college: "I started meeting the geeks and things started looking up!"[127]

Subjects in this study each experienced a unique combination of external elements in their lives that guided them towards careers in computer programming. This said, other factors were also at work, factors that social psychologists refer to as "intrinsic motivations."[128] For example, a child who is working hard in a class just because they love the subject matter and enjoy doing the work is doing so out of "intrinsic" motivations--this is, motivation derived from engaging in an activity for its own sake, for the satisfaction and sheer enjoyment that it brings--versus a child who works hard to obtain a high grade or please their parents. Many of these women had within them such "intrinsic motivations," choosing to follow up on their early exposure to computers with more computer experiences; being comfortable in largely male environments, despite being a minority; having confidence in their intelligence, ability, and suitability for an environment that often was suspicious of women; and having the determination to support themselves financially as adults.

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[126] Subject 18 (b. 1966), p. 3.
[127] Subject 6 (b. 1969), p. 13.
[128] Allan Wigfield, Jacquelynne S. Eccles, and Daniel Rodriguez. "The Development of Children's Motivation in School Contexts," *Review of Research in Education*, 23 (1998): 73-118; Definition of "intrinsic motivations" from the Dictionary of Social Sciences (accessed through Oxford Reference Online through University of Washington Library, June 11, 2005): "Motivation derived from engaging in an activity for its own sake, for the satisfaction and the sheer enjoyment that it brings, and for no other reason. Such intrinsic motivation is often associated with great persistence and high levels of achievement."

Who Were These Women? Intrinsic Curiosity and Not Just Math

Following Murray's findings that "First and foremost, they [women mathematicians] had to have a natural, intrinsic *curiosity* about mathematics," one of the most significant intrinsic or internal motivations exhibited by the interviewees in this study was their curiosity about and love of logic.[129] This is significant because traditionally mathematics--as opposed to logic--is held up as a key predictor for success in computer science.[130] In contrast, these women expressed an early and persistent attraction to cognitive processes centered on logic and problem-solving. In the interviews, subjects often took pains to distinguish between math and logic, insisting that logic, and not necessarily math, was essential to what drew them into computer programming work.[131]

Many subjects (15 of 26, 58%) were drawn to what they considered *both* the "arts" and "sciences." Several, in fact, took pains to point out that engineering or computer programming could not just be lumped into the "sciences" They considered programming a creative process or an art. What they enjoyed about their work was the

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[129] Murray, *Women Becoming* Mathematicians, 71.

[130] Nathan Rountree, Tamar Vilner, Brenda Cantwell Wilson, and Roger Boyle, Predictors for Success in Studying CS: Technical Symposium on Computer Science Education, Proceedings of the 35th SIGCSE technical symposium on Computer science education (New York: ACM Press, 2004), p. 144-145. Accessed via http://portal.acm.org/citation.cfm?id=971300.971351 September 23, 2004; John Konvalina, Stanley A. Wileman, and Larry J. Stephens, "Math Proficiency: A Key to Success for Computer Science Students," *Communications of the ACM*, 26 (May 1983): 377-382.

[131] Subject 11 (b. 1954), p. 6; Subject 16, p. 3; Subject 16, p. 5; Subject 1 (b. 1961), p. 4; Subject 18 (b. 1966), p. 3; Subject 22 (b. 1966), p. 2; Subject 8 (b. 1965), p. 18; Subject 8 (b. 1965), p. 19; Subject 1 (b. 1961), p. 5; Subject 13 (b. 1966), p. 8; Subject 6 (b. 1969), p. 3; Subject 6 (b. 1969), p. 10; Subject 15 (b. 1959), p. 9; Subject 11 (b. 1954), p. 7; Subject 11 (b. 1954), p. 10; Subject 20 (b. 1949), p. 2; Subject 20 (b. 1949), p. 4; Subject 32, p. 9; Subject 21 (b. 1952), p. 4.

"*craft* of programming."[132] They loved logic because they found it like solving a puzzle. These subjects loved problem-solving in every form--in childhood puzzles, story problems, philosophy, and math. Logical problem-solving is how subjects sometimes described their later computer programming jobs and how they approached thought processes in everyday life.[133] Math in and of itself was not what subjects found enticing. As Subject 1 stated: "computer science...it's like someone giving you the pieces of a puzzle--now put the puzzle together and make it work."[134] Subject 31 described herself as "an excellent programmer. I enjoyed it. It was like doing jigsaw puzzles."[135] Subject 8 felt that programming was "just a giant logic problem."[136] Subject 30 described loving to both diagram sentences and study physics: "I would come home from school and tell my mother how a refrigerator worked...so excited to learn how these things in the universe worked."[137] Subject 11 spent many hours while recuperating from a skiing accident doing story problems out of a book on symbolic logic that her father was using to teach a community college math class: "Those problems of 'A man has three pigs. One always tells the truth, one always lies, and one sometimes tells the truth and sometimes lies...which pig tells the truth? I got hooked on those kinds of puzzles." [138]

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[132] Subject 17 (b. 1952), p. 4; Subject 8 (b. 1965), p. 25; Subject 8 (b. 1965), p. 25; Subject 1 (b. 1961), p. 8; Subject 24 (b. 1964), p. 12; Subject 8 (b. 1965), p. 4; Subject 8 (b. 1965), p. 17; Subject 25 (b. 1959), p. 7.
[133] Subject 8 (b. 1965), p. 25; Subject 6 (b. 1969), p. 18.
[134] Subject 1 (b. 1961), p. 5.
[135] Subject 31 (b. 1955), p. 16.
[136] Subject 8 (b. 1965), p. 19.
[137] Subject 30, (b. 1944), p. 5.
[138] Subject 11 (b. 1954), p. 6.

When the interviewees did connect with math, it was sometimes not because of a love of math, but because of an aversion to other subjects. Some subjects (10 of 26, 38%) gravitated towards mathematics or computer science because it allowed them to avoid what they saw as the ambiguities in literature, the humanities, and the social sciences, fields in which there seemed to be no single "right" answer.[139] Other subjects (13 of 26, 50%) fell between either completely loving or hating math and often enjoyed science, social science, and humanities classes.[140] Half also noted an early love of reading and noted feeling particularly drawn to languages or logic, seeing a tie between the two.[141] Some subjects liked certain aspects of math or science, but not others.[142] For example, Subject 10 loved physics, but hated biology, considering it "icky."[143] Subject 23, who loved geometry and algebra, could not stand biology either.[144] Subject 28 professed no affinity whatsoever for any of the life sciences.[145] Some subjects who worked for years as successful software engineers neither liked nor did well in mathematics when going through school.[146] Not surprisingly, many (13

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[139] Subject 10 (b. 1953), p. 10; Subject 13 (b. 1966), p. 4; Subject 13 (b. 1966), p. 5; Subject 13 (b. 1966), p. 3; Subject 5 (b. 1967), p. 8; Subject 23 (b. 1942), p. 6; Subject 27 (b. 1942), p. 3; Subject 22 (b. 1966), p. 3; Subject 11 (b. 1954), p. 6.

[140] Subject 30, (b. 1944), p. 4; Subject 32, p. 3; Subject 10 (b. 1953), p. 6; Subject 18 (b. 1966), p. 3; Subject 18 (b. 1966), p. 1; Subject 11 (b. 1954), p. 3; Subject 17 (b. 1952), p. 3; Subject 17 (b. 1952), p. 5.

[141] Subject 21 (b. 1952), p. 3; Subject 25 (b. 1959), p. 4; Subject 11 (b. 1954), p. 2; Subject 9 (b. 1955), p. 5; Subject 24 (b. 1964), p. 12.

[142] Subject 32, p. 3; Subject 30, (b. 1944), p. 4; Subject 26 (b. 1934), p. 8; Subject 23 (b. 1942), p. 5; Subject 10 (b. 1953), p. 5; Subject 10 (b. 1953), p. 6; Subject 8 (b. 1965), p. 20; Subject 25 (b. 1959), p. 5.

[143] Subject 10 (b. 1953), p. 5.

[144] Subject 23 (b. 1942), p. 6.

[145] Subject 28 (b. 1969), p. 1.

[146] Subject 9 (b. 1955), p. 21; Subject 9 (b. 1955), p. 26; Subject 8 (b. 1965), p. 7; Subject 8 (b. 1965), p. 8; Subject 8 (b. 1965), p. 10; Subject 15 (b. 1959), p. 1; Subject 15 (b. 1959), p. 3; Subject 17 (b. 1952), p. 5; Subject 8 (b. 1965), p. 20; Subject 25 (b. 1959), p. 6; Subject 27 (b. 1942), p. 2; Subject 31 (b. 1955), p. 3; Subject 30, (b. 1944), p. 8.

of 26 or 50%) believed that aptitude for math is not a necessarily accurate indicator for doing well in computer science. As Subject 31 stated, "You don't have to have a lot of math to do computer science! I've never used my calculus or linear algebra....to me the appeal is in inventing processes."[147] In fact, most subjects (18 out of 26, or 70%) considered calculus, traditionally considered a key predictor for identifying suitability for computer science, as irrelevant to the work. Although some enjoyed their calculus classes, many found calculus a barrier to moving ahead into programming and what they considered more "logic" oriented classes.[148] As Subject 15 stated: "There was absolutely no desire to take calculus..., but there was enough love of the computer science that 'OK, if that is the hurdle I have to get over, I'll get over it.'"[149] Indeed, some subjects had to repeat calculus in order to "get" the math.[150] In this regard, subjects' experiences demonstrate the tension between how computer science developed in the 1960s--out of mathematics or engineering departments--and what actually drew these women to the field.

In general, the interviewees disagreed with the view that there was only one kind of thinking appropriate to success in computer science. About a third (9 of 26, 35%) felt they had developed analytical thinking through other courses, sometimes hands-on classes.[151] This is supported by recent research showing that experience with

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[147] Subject 31 (b. 1955), p. 17.
[148] Subject 11 (b. 1954), p. 5; Subject 11 (b. 1954), p. 6; Subject 8 (b. 1965), p. 25; Subject 31 (b. 1955), p. 17; Subject 9 (b. 1955), p. 6; Subject 15 (b. 1959), p. 8; Subject 28 (b. 1969), p. 2; Subject 5 (b. 1967), p. 5.
[149] Subject 15 (b. 1959), p. 8.
[150] Subject 6 (b. 1969), p. 14, Subject 8 (b. 1965), p. 24.
[151] Subject 10 (b. 1953), p. 12; Subject 31 (b. 1955), p. 7; Subject 18 (b. 1966), p. 14; Subject 9 (b. 1955), p. 5; Subject 17 (b. 1952), p. 5; Subject 8 (b. 1965), p. 11; Subject 7 (b. 1945), p. 6; Subject 15 (b. 1959), p. 9; Subject 24 (b. 1964), p. 2; Subject 24 (b. 1964), p. 4.

an academic topic, even more than aptitude for the topic, is a more predictive indicator for women than for men.[152] High school girls consistently have higher grades in math than boys, but the cultural norm still appears to be that more girls than boys believe they cannot do math--more hands-on experience appears to help counteract this attitude. Previous programming experience is also cited as a key factor in future success as a computer science major.[153] That the subjects in this study persisted in the field indicates that they utilized multiple cognitive processes in learning mathematics and computer science, despite instruction that did not recognize these varying cognitive processes. Love of computer science was based fundamentally on an affinity for the logic processes involved with computer programming, not mathematics per se.[154]

Based on the experience of these women, math alone is not the only indicator--or perhaps even a relevant indicator, of an individual's aptitude for computer programming. The variety of academic disciplines and cognitive learning styles through which these women developed their knowledge of computer science is a significant factor that helps explain the limited number of women who entered the

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[152] Hilary M. Lips and Linda Temple, "Majoring in Computer Science: Causal Models for Women and Men," *Research in Higher Education,* 31 (Feb 1990): 99-113; Elizabeth Fennema, Thomas P. Carpenter, Victoria R. Jacobs, Megan L. Franke and Linda W. Levi, "New Perspectives on Gender Differences in Math: A Reprise," *Educational Researcher,* 27 (Jun-Jul 1998): 19-21.

[153] Norma C. Ware, Nicole A. Steckler and Jane Leserman, "Undergraduate Women: Who Chooses a Science Major?" *Journal of Higher Education,* 56 [need year]: 73-84; David T. Burkam, Verlie E. Lee and Becky A. Smerdon, "Gender and Science Learning Early in High School: Subject Matter and Laboratory Experiences," *American Educational Research Journal,* 34 (Summer 1997): 297-331; Corrina A. Ethington and Lee M. Wolfle, "Women's Selection of Quantitative Undergraduate Fields of Study: Direct and Indirect Influences," *American Educational Research Journal,* 25 (Summer 1988): 157-175; Pamela E. Kramer and Sheila Lehman, "Mismeasuring Women: A Critique of Research on Computer Ability and Avoidance," *Signs,* 1 (Autumn 1990): 158-172; P. McKenna, "Programmers: Concrete Women and Abstract Men?" *Journal of Computer Assisted Learning,*17 (2001): 386-395.

[154] Subject 9 (b. 1955), p. 5.

field of computer programming during the post-World War II decades. Even subjects with very recent experiences in higher education found that the very structure of computer science as a field does not match with how or why they were drawn to it.

DECISION-MAKING PROCESSES

Who Were These Women? What Internal Motives Drove Them?

A significant intrinsic factor that helps explain women going into computer programming is found in the interviewees' decisions to major in computer science or otherwise pursue this field. Most of the interviewees (24 out of 26, 92%) recalled clearly a specific point, usually in college, at which they decided deliberately to pursue a career in computer programming. This decision followed from the woman's love of logic, combined with the knowledge that they could make a good living in the field (21 out of 26, 81%).

The ways in which women decided to become computer programmers were shaped by the time period in which they lived: the first cohort of my subjects went to college and work before the 1960s and 1970s women's movement. The second cohort went to college and into the workforce from the mid 1970s onwards, that is, in the thick of this movement. This is not to say that women in the first cohort lacked autonomy in their lives or that women in the second cohort did not value their families. It does, however, underscore how individual decisions are related to social expectations, as well as how individuals internalize or resist internalizing these

expectations.[155] In addition to whatever external barriers (overt or subtle discrimination from both men and women who did not think subjects were conforming to proper gender roles), sometimes subjects' own decision-making limited their ability to move ahead, as was the case for many in the first cohort who thought "I will not pursue my career now because I need to be a wife and mother." Women were actors, individuals with agency, in their own lives and not just subjects being acted on by the forces around them, although certainly their decisions were informed by their social context.[156]

Women's "meandering," not going in a straight path to computer programming, sometimes involved barriers external to their own thought processes, sometimes due to people outside themselves who thought that women shouldn't be pursuing such a non-traditional path.[157] It was not just men who created these barriers--other women sometimes were the "external" barrier to subjects getting ahead, for example, suggesting they should not become engineers. For instance, Subject 26 describes how the head of GE's technician program, a woman, "tried to explain to me why I should be a technician rather than an engineer, with no chance for advancement, a hundred dollars a month less pay. She said, 'This is what the women do.'"[158] Other external barriers included not being able to have more early exposure to computers brought into a classroom because hordes of their male student counterparts were

[155] Subject 23 (b. 1942), p. 12; Subject 27 (b. 1942), p. 11; Subject 13 (b. 1966), p. 9; Subject 31 (b. 1955), p. 9; Subject 15 (b. 1959), p. 1; Subject 16, p. 3; Subject 1 (b. 1961), p. 2; Subject 18 (b. 1966), p. 9; Subject 32, p. 8; Subject 32, p. 9; Subject 7 (b. 1945), p. 7; Subject 7 (b. 1945), p. 9; Subject 7 (b. 1945), p. 11; Subject 7 (b. 1945), p. 14; Subject 16, p. 3; Subject 6 (b. 1969), p. 7.
[156] Subject 10 (b. 1953), p. 4; Subject 9 (b. 1955), p. 6; Subject 9 (b. 1955), p. 8; Subject 16, p. 3.
[157] Subject 20 (b. 1949), p. 3; Subject 14 (b. 1933), p. 17; Subject 27 (b. 1942), p. 8; Subject 7 (b. 1945), p. 9; Subject 23 (b. 1942), p. 9; Subject 27 (b. 1942), p. 9.
[158] Subject 26 (b. 1934), p. 8.

surrounding the computer equipment.[159] Women had to fight against both subtle and overt messages about "appropriate" gender behavior in order to tell themselves that they could, in fact, succeed in computer programming.

Like the women in Margaret A.M. Murray's study, the decision-making of the subjects of this study did not fit the male norm in the sense of obtaining a technical degree and then entering the work force directly. Womens' patterns generally followed what could be termed "sequencing," that is, alternating between paid work and staying home to raise children. This usually consisted of working for several years, taking "time off" for 3-10 years to raise young children, then returning to the workforce.[160] In this regard, subjects "meandered" into the field.[161] Other interviewees meandered into computer science differently: they started with interests in math, logic, and computer programming, then became involved with different work, returning to computer programming after they had burned out or discovered there were few jobs in the other field.[162] These subjects' decision-making processes about work evolved and changed through and after college. Although a male counterpart might also "meander" into the computer programming field, his doing so usually was not impeded or delayed by having children or following a spouse to a different job.

Having children, and fiancees' or husbands' life and work decisions, affected the interviewees' ability to develop careers in computer programming. This was particularly the case for the first cohort of women. Every one of these women at one

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[159] Subject 10 (b. 1953), p. 7; Subject 10 (b. 1953), p. 8; Subject 24 (b. 1964), p. 6.
[160] Williams, *Unbending Gender,* p. 82, 85; Crittenden, *The Price of Motherhood,* p. 31.
[161] Subject 23 (b. 1942), p. 12; Subject 27 (b. 1942), p. 11.
[162] Subject 18 (b. 1966), p. 9; Subject 27 (b. 1942), p. 11.

point chose to forgo their career in order to defer to their husband's job opportunities or to raise children.[163] In addition, these subjects were often (4 out of 8, or 50%) engaged to marry at the time they graduated from college. They chose to follow their husbands to the latter's first post-graduate jobs and consequently either began their careers late or stepped out work to have children, returning when their children were well into grade school.[164] The women making these choices were living in a world marked by outside pressures to conform to a particular social norm. For example, one subject interviewed with Dow Chemical and DuPont but after graduation followed her husband to his job in Florida. There, she was offered a programming job at Cape Canaveral, an hour's drive away, but turned this down because, as she put it, "I got married to be with him."[165] Another subject who entered the workforce in the early 1960s married upon graduating from college, worked several years as a programmer before having children, then returned to work when her children were in grade school. Another followed her husband to his job in Japan, had a child, and then waited until her child was in grade school before returning to the workforce. This jaunt slowed down her pursuit of a computer career: "I didn't do anything technical or math oriented for four years over there [Japan], then lived in Boston for a few years and stayed home with my daughter."[166] After Subject 20 and her husband moved to Colorado and her child was in early grade school, she returned to school to start pursuing a Masters in

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[163] Subject 14 (b. 1933), p. 16; Subject 14 (b. 1933), p. 18; Subject 14 (b. 1933), p. 19; Subject 14 (b. 1933), p. 20; Subject 26 (b. 1934), p. 11; Subject 30 (b. 1944), p. 9; Subject 30 (b. 1944), p. 10; Subject 7 (b. 1945), p. 13; Subject 20 (b. 1949), p. 4.
[164] Subject 26 (b. 1934), p. 13; Subject 23 (b. 1942), p. 12; Subject 32, p. 3; Subject 7 (b. 1945), p. 13; Subject 16, p. 5.
[165] Subject 14 (b. 1933), p. 19.
[166] Subject 20 (b. 1949), p. 4.

Information Science at Colorado State in the early 1980s. Subject 27 went straight from undergraduate to graduate school in a non-computer science field, married, had a child, tried to make it in a different field (anthropology), but experienced gender discrimination in graduate school and returned to computer programming to support herself and her daughter after her divorce. As she describes her experience, "I did marry a fellow graduate student at one point, telling him that my career was equally as important as my marriage would be and it turned out he never believed that all along...I think he just thought I'd stop and be barefoot and pregnant or something."[167] Returning to graduate school to obtain her degree, she was told, "While I was holding my little two-month old baby, that I would not be given my degree--I was to stay home and take care of my child and if I fought it my husband would not be given his degree."[168]

Some of these "meanderings" should perhaps be viewed not as barriers, as they involved subjects consciously making choices: as Subject 26 pointed out, "well, it's [getting married and having children] just what you did."[169] Some subjects moved directly into the workforce after their computer science degrees, but this was the exception rather than the rule for women in the first cohort.[170] In other words, although subjects exercised individual autonomy, their choices were also affected by both external and internalized social norms and gender expectations. Their "meanderings" display career paths common in women's, but not men's, lives.

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[167] Subject 27 (b. 1942), p. 9.
[168] Subject 27 (b. 1942), p. 9.
[169] Subject 26 (b. 1934), p. 8.
[170] Subject 27 (b. 1942), p. 4; Subject 27 (b. 1942), p. 9; Subject 31 (b. 1955), p. 10.

Subjects in the second cohort much more often moved directly from college into the workforce. In contrast to the earlier group, all of these women either went straight from college into careers or continue directly from college to graduate school.[171] They expected to develop a career and also expected that partners and husbands would respect their educational and career goals and follow them if necessary.[172] Members of this cohort either waited to have children (4 out of 18 second cohort total, or 22%) or chose not to have children at all (13 out of 18 second cohort total, or 72%).[173]

Notably, a significant percentage of women in the later cohort (15 of the 17 married subjects in the second cohort, 88%) married only after completing their graduate degree or establishing themselves in a career. In contrast, four out of the eight subjects of the first cohort (50%) were engaged or married by the time they finished their undergraduate degrees, and the other four in the first cohort temporarily ceased pursuit of a career (i.e. until their children were well into grade school) when they did marry. In other words, marrying had a career-thwarting affect on 100% of the first cohort but only 5% of the second.[174] One member of the first cohort, who attended college in the early 1960s, remarked that she always was the one to take the two-hour bus ride to her fiance's location: he never visited her. When asked specifically if her fiancée ever came to visit her, she replied: "No. I always went

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[171] Subject 21 (b. 1952), p. 6; Subject 17 (b. 1952), p. 5; Subject 11 (b. 1954), p. 12; Subject 31 (b. 1955), p. 12; Subject 18 (b. 1966), p. 8.
[172] Subject 5 (b. 1967), p. 16.
[173] However, three of the subjects without children, all in their early thirties at the time of the interview, were contemplating having children, so the final total of those who chose not to have children at all might be closer to 10 out of 18, or 55%.
[174] See also, page 41.

there."[175] This stands in contrast to a a member of the second cohort, who began a long-distance courtship with her future husband in the early 1980s while in graduate school, which she was able to more easily maintain through daily online chats.[176] In addition, he came to visit her from time to time.

A notable distinction between the later and earlier cohorts is the fact that, among the former, increasingly it was the woman's, not man's, job opportunity that prompted a move. Men became trailing spouses (9 out of 18 in the second cohort, or 50%).[177] This shift was partially due to increasing globalization (i.e. couples would move wherever one of them could find employment) and partially due to changing expectations of women's roles. As women's roles changed in the context of the women's movement, so did expectations about men's roles, albeit slowly and not without resistance among men who had grown into adulthood in the pre-feminist culture. However, even though subjects' decisions about what to do after college had more to do with following their own career goals and less about following a partner, old, engrained patterns still continued.[178] Subject 15 followed her husband from Portland, Oregon, to Arizona for him to pursue a Ph.D.[179] Subject 5, born in 1967, described the conflict between her new marriage and a job at a software company: "I started [the job] in January and we got married in August and he wasn't really

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[175] Subject 7 (b. 1945), p. 9.
[176] Subject 5 (b. 1967), p. 15; Although the World Wide Web, the graphical interface to the Internet, did not appear until 1992, the Internet itself began in 1969. Communications technologies such as email was available shortly thereafter even though the Web was still a ways off.
[177] Subject 11 (b. 1954), p. 12; Subject 31 (b. 1955), p. 12; Subject 16, p. 5.
[178] Subject 22 (b. 1966), p. 7; Subject 15 (b. 1959), p. 12; Subject 13 (b. 1966), p. 9; Subject 20 (b. 1949), p. 4.
[179] Subject 15 (b. 1959), p. 14.

comfortable with me being gone all the time...it was just creating a lot of stress. Although she tried to trade work in order to address her husband's wish that she stay in the same town as he, company management discouraged her from taking this route so she shifted into another department.

During the 1970s and 1980s, marriage became less a barrier to the careers of women and sometimes even helped a subject's entry into computer programming. Husbands increasingly encouraged their wives; if computer-savvy, they helped with computer programming homework and helped their partners better understand how to network and interview. [181] Spouses colleagues at work, like peers earlier in life, could likewise be supportive of a subject's technically related endeavors, which subjects say sometimes helped in their entry into the field for study or work. [182]

In comparison to women in the first cohort, those in the second cohort had a much greater chance of having been exposed to computer technology earlier in life and a much greater chance of having worked in a computer lab or as a tutor in high school or college. Subjects also took greater initiative in following up on their computer expertise and pursuing further practical, hands-on computer work during and after college.[183] This early exposure to opportunities and a greater emphasis on establishing a career solidly before marriage marks a generational change. Subjects growing into adulthood in the mid 1970s and beyond did not allow relationships to

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[180] Subject 5 (b. 1967), p. 17.
[181] Subject 16, p. 5.
[182] Subject 25 (b. 1959), p. 11, 12; Subject 10 (b. 1953), p. 17, 18; Subject 11 (b. 1954), p. 13; Subject 9 (b. 1955), p. 27; Subject 31 (b. 1955), p. 9; Subject 15 (b. 1959), p. 11, 12.
[183] Subject 1 (b. 1961), p. 12; Subject 11 (b. 1954), p. 12; Subject 11 (b. 1954), p. 10; Subject 22 (b. 1966), p. 6; Subject 13 (b. 1966), p. 9; Subject 28 (b. 1969), p. 4; Subject 6 (b. 1969), p. 19.

alter their plans as much as the previous cohort. Out of the 18 individuals in the second cohort, 15 (83%) had completed their undergraduate degrees and were established in their careers before marrying.[184] In contrast, four out of the eight women in the first cohort (50%) were engaged or married by the time they finished their undergraduate degrees, during a time in which being married more likely entailed following their husbands' careers instead of pursuing their own. The other four women in the first cohort temporarily (i.e. until their children were well into grade school) ceased pursuit of a career when they did marry.

Although careers were also important to the women in first cohort, the world in which they lived presented greater barriers to their achieving educational and career goals. The "meandering" of women in the early cohort had to do with gender-based restrictions and assumptions about the kind of work women could or should perform. For example, well into the 1970s school districts sought to hire math or science teachers who also could coach. Along with the implicit assumption that math and science were male subjects, before Title IX opened up school sports for women schools regularly sought to hire teacher-coaches, which magnified existing barriers to women in science teaching.[185] Similarly, barriers to women in military officer ranks affected their ability to succeed in the defense industry. As one subject remarked, she had continuing difficulty in finding work because most of the jobs in aerospace

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[184] The sixteenth person became engaged while in graduate school and dropped out of graduate school to move to be with her fiancee, the seventeenth person came into computer programming as a second career after she was married and had three children, and a final subject never married (therefore, 16 out of the 18 who married completed their education and established careers first, or 88%).

[185] Title IX, passed by U.S. Congress in 1972, banned sex discrimination in schools in both academics and sports opportunities, thereby opening up more opportunities for girls to participate in sports; Subject 14 (b. 1933), p. 20; Subject 14 (b. 1933), p. 21.

engineering were rooted in "the old brotherhood of people [men] who had been in the military."[186] Since she had come of age during a time when very few girls went into the military, she did not have a chance to participate in the building blocks of that industry.

There were residual aspects of American culture that created more layers that women had to handle in pursuing their careers. Several second cohort subjects noted that opportunities they had in school or work seemed to them like a "kind of affirmative action" and that this carried a stigma in the workplace.[187] As Subject 27 describes her hiring as a technical manager in the defense industry: "There was a lot of problem with me being the only woman in management...at one company they got very upset with their hiring management from outside and then four men refused to work with me because I was a woman and the company supported them, found them other work."[188] Moreover, although access to job opportunities for women had expanded by the late 1970s, support systems such as childcare and gender blind employment practices had not.[189] More generally, women described the persistent pressure, as one subject put it, of "male bravado."[190] As Subject 31 described one of her fellow computer science students interviewing at the same time as she did: "It wasn't just that he wasn't very good, but he thought he was hot shit...he was really arrogant about it."[191] Additionally, Subject 6 observed a gender difference in how

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[186] Subject 27 (b. 1942), p. 13.
[187] Subject 10 (b. 1953), p. 16; Subject 25 (b. 1959), p. 13; Subject 32, p. 6; Subject 27 (b. 1942), p. 11; Subject 27 (b. 1942), p. 12.
[188] Subject 27 (b. 1942), p. 11.
[189] Subject 27 (b. 1942), p. 13; Subject 23 (b. 1942), p. 15.
[190] Subject 9 (b. 1955), p. 28; Subject 31 (b. 1955), p. 11; Subject 25 (b. 1959), p. 12.
[191] Subject 31 (b. 1955), p. 11.

people assessed their own work: "I've noticed men speaking up without having their bases covered and I haven't noticed women doing that...I have seen men rating themselves much higher for equivalent work that I would say was lower."[192] Often, however, these barriers created a determination in the interviewees to succeed.[193] As Subject 13 described, "I liked being one of the few women in the classes. It made me unique...I stick out and I like that. It was probably more of a motivator than a deterrent for me...I just think I really like the challenge."[194] Several women similarly pointed out that even at the time of the interviews they were not taken seriously as authority figures, and that this was especially frustrating when they were the only person with formal computer science training on a project team.[195] The cavalier attitude that subjects observed in male programmers often led to bad programming practices, such as inadequately or incorrectly commented code.[196] Subject 9's first work assignment after finishing her computer science degree was maintaining about 100,000 lines of database code: "There wasn't one line of code [comment] in it. And it was programmed by this guy who fancied himself an artificial intelligence programmer, and it was the most bizarre way of running a database I've ever seen in my life...nested function after nested function...it was just a mess."[197]

These "snapshots" of women who worked in the computer industry as programmers from 1960 to the early twenty-first century provides insights into the

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[192] Subject 6 (b. 1969), p. 21.
[193] Subject 16 (b. 1959), p. 6; Subject 9 (b. 1955), p. 29; Subject 13 (b. 1966), p. 5.
[194] Subject 13 (b. 1966), p. 5.
[195] Subject 9 (b. 1955), p. 30; Subject 9 (b. 1955), p. 31; Subject 1 (b. 1961), p. 11.
[196] Subject 9 (b. 1955), p. 31.
[197] Subject 9 (b. 1955), p. 39.

factors that shaped the education and careers of women pioneers in the computer field following World War II. Women had full and open access to education but were discouraged in subtle ways from pursuing what were, for women, non-traditional careers. Only through a conscious decision-making process, fueled in parts by love of problem-solving and an awareness of the need to financially support themselves, and encouraged by parents and key teachers and peers, were they able to counterbalance society's messages about gender and persist in pursuing their chosen line of work.

CONCLUSION

The experiences of the subjects of this study, like Margaret A.M. Murray's in *Women Becoming Mathematicians*, reflect two generations of women who lived in a society that placed barriers before them as they embraced new roles and identities within an emerging industry. Their ability to move forward was rooted in a variety of factors: parents who supported their daughter's technical and scientific education and encouraged them to think of supporting themselves; similarly supportive peers in childhood; friends and spouses in college and adulthood; and educational environments where teachers provided encouragement and support for women following careers in the computer industry. These early experiences were invaluable for the women studied here. That most loved logic, even above mathematics, points to how they did not fit into the prevailing paradigm of the "computer nerd." They made their way into computer programming through internally-motivated "meanderings" and despite external barriers. They forged a path of their own making--oftentimes defiant of convention and always persistent and courageous--as they shaped their careers in the emerging industry centered around computer programming and technology.

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APPENDIX A:

A NOTE ON THE ORGANIZATION OF THE TRANSCRIPTS

The question "Why are there not more women in computer science?" is one that has been asked by both scholarly and business communities since women entered the workforce in large numbers starting in the 1970s. Although there exists a vast literature covering how to involve more girls and women in computer science today, as well as a smaller body of literature outlining the few female pioneers in the field, little has been written about the women who, despite historical exclusion, actually participated in the computing industry as programmers and software engineers beginning in the 1960s. Who were the women going into this part of the labor force during this time? What was the path of women who were successful in the field? What motivated them? What deterrents did they face, and how did the women in the field overcome them? Did the women's movement of the 1960s and 1970s have an impact on women who went into the field? Did late twentieth century feminism affect their experience in the workplace?

To answer these questions, between October 2001 and April 2002 I conducted 1½- 2 hour oral history interviews with twenty-six women who had worked in computer programming between 1960 to 1990 then transcribed and analyzed the interviews to discern any emergent patterns. Two distinct cohorts emerge in the analysis: one cohort of subjects (8 interviewees) born before 1950 who came of age largely before the second-wave feminist movement of the 1960s and 1970s, and a

second cohort of subjects (18 interviewees), those born after 1950 who came of age at the height of the late twentieth century women's movement. The analysis presented here helps answer the question of why there are not more women in computer programming, what characteristics were held in common by the women who did go into this field, any particular barriers these women faced to pursuing such careers, and how a particular social and historical context affected the consciousness and decision-making processes of individuals in their education and careers.

Included in this printed thesis are two representative transcripts, one from each cohort (Appendix C, Subject 14 and Appendix D, Subject 15). Every transcript was not included in printed form for the thesis as this would have brought the final page count to well over 2000 pages. Transcripts from all twenty-six interviews are, however, included on the CD that accompanies this interpretive introductory essay and appendices. These transcripts on CD contain only internal pagination, which is how they were referenced in the citations.

The twenty-six oral history interview transcripts on the CD accompanying this thesis are organized in chronological order according to the birth year in the following format: **01_b1933_subj14feb20.doc**. The first element, "01" indicates the age of the subject and the "b1933" represents the birth year of the subject. Thus, transcripts of interviews with subjects born earlier in the twentieth century appear before those of subjects born later. This was done in an effort to assist in analyzing the data and themes over time. The final element "subj14feb20" indicates the subject number assigned to that subject, based on the date of the interview, in this case, February 20,

2002. Subjects with lower subject numbers were interviewed earlier in the process (October 2001 through December 2001) and subjects with higher numbers were interviewed later in the process (January 2002 through April 2002). Several of the CD transcripts (Subjects 14, 26, 23, 7, 11, 9, and 8) were transcribed by a professional transcriptionist in an effort to process the interviews more expeditiously. These transcripts are therefore in a slightly different format than the rest of the transcripts, which I transcribed myself.

The analysis of these transcripts gave some answers to my initial questions. The women going into this part of the labor force between 1960 to 1990 were white, middle class women who had parents, teachers, and peers, if not entire school environments, all encouraging them to achieve academically. There was not one set path of women who went into the field: some subjects (35 %) came to computer programming as a second career later in life, while others majored in computer science in college and proceeded to work in the field directly. However, one commonality most of these subjects shared, whether in the first or second cohort, were their motivations for entering the field: primarily, they loved logic and problem-solving (and not just as these cognitive processes were presented through mathematics) and were aware that they could make a good living working in computer programming. Most of the deterrents they faced consisted of lack of access to actual computer equipment or occasionally to math classes during their education (boys swarmed around the equipment; middle school algebra classes with one seat left gave that seat to a boy instead) and also being in a gender minority in their classroom and workplace

settings and, as a consequence, having to deal with some discriminatory attitudes or hiring practices. They were able to handle these barriers, however, largely through focusing on what they loved about programming and through mentally positioning themselves as being at an advantage because they were in the minority, not viewing their minority status as a liability.

The women's movement of the 1960s and 1970s, and with it, concepts brought out by twentieth century feminism, impacted the career and relationship expectations subjects held, as well as impacting their decision-making processes as they navigated through their careers. Analysis of these transcripts revealed a shift in subjects' experiences of decision-making in going into computer programming as well as a notable shift in marriage and child-rearing between the first and second cohorts. Four of the eight (50%) in the first cohort, born before 1950, were engaged or married before graduating from college and all (100%) had children, most typically taking years out of their work life to stay home to raise young children. In contrast, 15 out of the 18 people (83%) in the second cohort waited to become engaged or married until graduating from college and only 6 out of the 18 in this cohort (33%) had children, and those who did deferred childbearing until later in life. Additionally, subjects in the first cohort were more likely to attribute their unusual minority status in the profession as an artifact of individual decision-making processes of other women, but subjects in the second cohort were more likely to recognize that there were gender-specific barriers that existed to going into their profession, although they had not allowed those to deter them. These two major components (a shift in marriage and childbearing and a

shift in attribution for why not more women were in this field) point to the impact of the women's movement in the late 1960s and 1970s in the United States. Thus, although few of the subjects of either cohort actively identified themselves as feminists, clearly those in the second cohort experienced a social and historical context in which basic tenets of the women's movement, such as the right for women to pursue their own careers and control their childbearing, had taken hold in the general consciousness.

A true assessment of these subjects' experiences, however, can only be brought to light after further data has been gathered. The transcripts included in this study represent a "convenience" sample, those of people readily available and willing to be interviewed, and as such do not represent a more homogenous group from which clearer data could be derived. For example, future related studies could be done on women who worked for a particular software company over time (IBM, Microsoft) or who all attended the same university, or on the experience of both the men and the women in a particular company and within the labor force in general in the late twentieth century. In addition, a further examination of the meetings, conferences, and proceedings of how computer science developed as a discipline should be done in an effort to understand what in the present day curriculum serves today's workers and what are artifacts from the discipline's inception. Only when such additional data is gathered from these varying resources will more definitive conclusions be able to be made from the data already gathered in this study.

APPENDIX B:

LIST OF TRANSCRIPTS

Order	Birth year	Subject number	Interview date
1.	1933	14	February 20, 2002
2.	1934	26	March 21, 2002
3.	1942	27	March 23, 2002
4.	1942	23	March 8, 2002
5.	1944	30	April 26, 2002
6.	1944	32	April 30, 2002
7.	1945	7	November 2, 2001
8.	1949	20	March 5, 2002
9.	1952	21	March 6, 2002
10.	1952	17	February 18, 2002
11.	1953	10	December 6, 2001
12.	1954	11	December 7, 2001
13.	1955	9	December 2, 2001
14.	1955	31	April 15, 2002
15.	1959	25	March 16, 2002
16.	1959	15	February 15, 2002
17.	1959	16	February 19, 2002
18.	1961	1	October 4, 2001
19.	1964	24	March 11, 2002
20.	1965	8	November 16, 2001
21.	1966	18	March 3, 2002
22.	1966	22	March 8, 2002
23.	1966	13	February 2, 2002
24.	1967	5	October 26, 2001
25.	1969	6	October 26, 2001
26.	1969	28	April 5, 2002

APPENDIX C

TRANSCRIPT OF INTERVIEW WITH SUBJECT 14

Subject #14
Interviewed: Saturday, February 9, 2002 - Portland, Oregon
Degree: Double major in Physics and Mathematics
Institution: University of Nebraska
Year graduated: 1954
Year born: 1933

I: We are recording and it is Saturday, February 9, in Portland, Oregon and I am... All right, so I'm with Subject #14 on Saturday, February 9th, in Portland, Oregon. So you go ahead and tell me... Let's start at the beginning.

S: It's W-----.

I: Got it.

S: Thank you.

I: You're welcome. I have a very strange last name too and everyone always transfers the "e" and the "i." It's very annoying.

So, why don't we start with when and where you were born and how many brothers and sisters you had?

S: Okay. I was born in 1933 in Spokane, Washington. That was the depth of the depression and it was very, very, a small number of children per thousand population was born that year. So, and I did get to the point that job hunting was so hard. There was a scarcity of people at the beginning levels for jobs because there just simply had not been enough works at the time we were born. That was an interesting angle on.... My mother had a master's degree in economics and was a supervisor of all the home ec teachers in Spokane, Washington.

I: Really?

S: Yeah.

I: For the high school?

S: For the high school.

I: Interesting.

S: For the secondary and because at that time it was relatively rare for a woman to have a masters and my father had been pulled out of school when he was in fourth grade. And, worked as a truck driver for a wholesale grocer. It was an unusual match.

I: So, he was...

S: It was an unusual match. He was a truck driver for a wholesale grocer. And, I had an older brother, who was four years older than I was. And then when he was seven and I was three that marriage failed. And my mother immediately remarried to a man who had an eighth grade education and a lot of experience working on his father's apple orchard and who had worked as a lumberjack. And because of that time though, divorce laws were so rigid in the state of Washington that if my mom remarried in less than two years in the state of Washington, she was considered a bigamist.

I: Wow.

S: So we went to live in Idaho and my step-dad worked. I think he [?] store, partially owned, or something, a lumberyard, where they were felling trees to make into lumber for two or three years. And then it was okay for Mom to live in Washington State again. So we came back to Green Bluff, Washington, which is outside of Spokane and is an apple growing area. And his father was a major orchard owner there. We leased another orchard, except that would be my step-Grandfather was one of these key orchard men. And we leased another orchard and lived in a small, rented house that was on that land. And, it was still the Depression time. Things were tough. My brother went to the little school in... one of the family's favorite stories on me was that I always wanted and when my mom remarried there were two older stepsisters who were older than he was. One of them was probably already in high school when I was a toddler. They were a lot older than I. And the kids all went off to school and left me home alone. And so there was a story that I went out on to the road, which was a highway. And those sidewalks aren't anything and toddled off to go to school. And they had to come and find me and that is one of the only times I was every spanked was for going off on the highway to try to get to school.

I: So you knew the thing... that you were going to be with your brothers and sisters and, man, that was a good thing.

S: Yup.

I: Your earliest, positive association.

S: One of my oldest memories is running away to go to school (laugh).

And then when I was seven years old, my maternal grandmother came to visit and my brother was having a real hard time. He couldn't accept his stepfather. There were all kinds of emotional problems. And my grandmother lived alone and was comfortable financially when she said I'll take him and raise him. Our family doctor said if you take him out of the household, take his little sister too because by that time there was another child that was theirs so they had two that were his, two that were hers, and one that was theirs, and then he said if you leave that one little girl back herself in that mix, she may be psychologically upset. So, my grandmother was 63 and she took an eleven-year-old boy that had already been a juvenile delinquent and a seven-year-old girl, took us back to Nebraska.

I: Wow. Now this is your mother's mother?

S: Uh hum. So all the rest of my rearing was essentially by my grandmother. I had two short periods that I spent with my mother. The rest of the time, up through graduating from college, my grandmother was mother and father to us.

I: Now, tell me about her attitudes to your...

S: My grandmother.

I: Your grandmother.

S: Grandma, to her, education was the most important thing in the world. She had been almost orphaned as a baby as a very young child and had lived around with distant relatives and so forth. And she actually had a nervous breakdown in early teens because she was placed in a home that didn't live near enough to school so she didn't get schooling. She had a nervous breakdown because she couldn't go to school. And she tried to go to college, but there wasn't any money. And so, in about 1895, she graduated as the valedictorian, first in a class of five, from our high school was on the frontier of western Kansas and she gave her valedictory speech was for women's' suffrage, in 1895, and she wrote off to the eastern universities that she heard of, so it was the big, well known, prestigious universities. And said, I want to come to your school but I will have to work part-time to help pay the expenses. Can you recommend a job that I could take or I could be a student and work at the same time? And they wrote back and said that only ladies could attend their schools and that ladies did not work.

I: Well that was very pompous of them. So, what did she do after that?

S: Well, she had taught primary school after she finished eighth grade. She took a test and she could teach in rural schools.

I: At the age of thirteen?

S: Uh huh. She went to the county seat and took the test for teacher's certificate, which she got. And she could teach rural elementary as an advanced teenager. So she had taught before she went to high school. So when she finished high school, then she went to live with her grandmother in Deer Lodge, Montana, which was *really* the frontier.

I: Right.

S: And I think her first school was in Missoula. She taught primary the first three grades, the primary room with second and third. Virtually, all of her students had a European father and a Native American mother. And she taught them English while she taught them to read.

I: This is back in the 1890s?

S: Yeah, late 1890s.

I: Interesting.

S: Then, she went to summer school, to a normal school in Denver. A normal school is the name for a teachers' college. And she took a very concentrated summer course in what they called, kindergarten, which meant working with the youngest children that were in the public schools. And after that, she could go into bigger and more restrictive public schools because she had this summer, post high school training. I think she taught in the Deer Lodge, Montana, schools for a while. And then the man who had been one of her high school teachers had been writing to her the whole time and they finally decided to get married. They got married in Deer Lodge, Montana, and went by train to western Nebraska where his parents lived and he ran the general store in Coles, Nebraska. He owned WLES, a town that no longer exists. But it was the town where... it was Willa Cather's home area.

I: I know her well and I wrote my undergraduate thesis about her.

S: Oh, did you? I think she lived in a nearby town that is still alive, but she was right from that area. The little town of Coles no longer exists. Then, one day.... he could come home for lunch. He ran the general store and he could come home for lunch. And one day he came home for lunch and said that they were going to have to leave this town. He said a car just drove through. The first car he had every seen. He said we are six miles from the county seat. This town has no future. As people get cars, this town will die. He could see his life. So, he looked around in western Nebraska for another way to make a living and the town of Trenton, Nebraska, T-R-E-N-T-O-N, wanted to have a bank. And somehow he made connections and had meetings with the movers and shakers of the town and probably the general store owner and the various people who did have businesses in the town. And he figured out if they sold every

piece of land and every investment and everything they had, every cent they had saved over the years from the store, that he could be the founding stockholder and the other men in the town bought shares too. And, he was the.... they opened the bank with him as the president. So he founded the first bank in Trenton, Nebraska. And then by this time, my mother had been born and when she was about ninth grade age, which would be, what, fourteen, fifteen, thirteen, fourteen, he had a real severe heart attack. And in those days, they thought they would have about six months to live if they had a bad heart attack and they gave him six months to live. He immediately sold the bank and started staying home and everyone kept asking him questions because he was their banker and so they realized that the new guy that bought the bank was never going to get their trust as long as he stayed in town. So they had to pick a place to go to move, to put him in retirement. And they were about halfway between Lincoln, Nebraska, and Boulder, Colorado, which is where the two state universities were. And Mom was going to be going to college in the next year or two so they.... Boulder is probably too high of an altitude for his heart problem so they moved to Lincoln, Nebraska. And she lived there until she was 96 years old.

I: Wow. Isn't it weird how the decisions that we make when we think, ah, I will just be here for a few years and then seven decades later?

S: So, they moved to Lincoln, and my mom went to Lincoln High School, and the University of Nebraska and took home ec. And I think she probably, I don't know if she had a straight A average, but I think she was a high achiever in the home ec program.

I: Well, certainly with her mother, your grandmother was very...

S: ... education oriented...

I: ... you could get through anything. I'm not surprised by that.

S: When she graduated, she taught in a small town in Nebraska for one year. And then she went back to the University of Nebraska and got a master's degree in home ec education. And from there, while she was sending her resume around and so forth, she was hired by Spokane into the supervisory role. That's how...

I: That's how that all got connected. Interesting. That's so fascinating that... I mean it sounds like your grandmother had endured a lot of hardships in terms of her access to education and so as you were growing up and hearing these stories...

S: And to her the most *important* thing was that we not be deprived of that because of the wars and the Depression years were so hard on us, the middle-aged family financially, that if my grandmother had not intervened we would not have been able to go to college probably.

I: So you were seven years old when you go live with her. Describe to me, you may not remember grade school, like anywhere from grade school to high school, what your memories were in terms of the, as you became involved in academics, kind of what you found yourself drawn to or when you came home and say "Oh, Mrs. Smith did something amazing in [?]

S: I was trying to remember which of my grade school teachers I remember and I don't think I ever had a *really* bad one because I don't remember having had one that I just thought was awful. But, before I moved to Nebraska, I had a wonderful first grade teacher out in the rural, outside of Spokane. It was a three-grade room and by the end of the year she was letting me sit with the third graders. And so I had a ball. It was probably my best year in school. Because the schools then were so inflexible, it was really tough to be a high achiever. I was always waiting around for the other kids to finish their work and stuff.

I: Did you experience... did you get bored?

S: Well, yes, I think so although I was "little miss goody two shoes."

I: Okay.

S: I probably didn't express it. But, when I moved to Lincoln, Nebraska, during the summer, so I went into the beginning of the school year as new to the system, and they were very conscious of that, because the other kids had been in first grade in the same building, but I was put in a class for second graders and the first day of class, she had 2 + 2 is 4, 2 + 4 is 6, and so forth, I knew the answers on the board and she said, look it, she talked to me a little about what I had done in first grade, and, of course, I had really done three grades at once. And I told her. And she said, I think we better go down and visit with the lady at the office. And so, she took me down to see the principal, and at that time, Lincoln had 2A and 2B. They let you start the second half of a grade in the fall. So they skipped me a half year.

I: Did that help at all?

S: Oh, yes, because then they were beginning to do stuff that I hadn't had. And, then, in, and I don't remember any of the other teachers individually. But, when I was in fourth grade, Lincoln decided to stop having these off-year kids. And, in one fell swoop they cured it all in one year. And, everybody had to go back and repeat one of the half grades.

I: That must have been a.... [?]

S: It was just awful! Looking back on it, the thing for a city school system to do to about a third of their kids, you know. And the principal of the building that I was in felt that that wasn't right and she went through all of her grades that had an off-year and chose the four or five kids that she thought could be accelerated and brought us out of the class room and tutored us. She must have done all of her bookwork at home at night. And she was a real heroine. And she took us and tutored us quickly through the half-year that we were going to miss and skipped us. So by now I am a whole grade ahead for my age. And another thing that is funny is that the man I married was in her fifth grade and he was in her special group that she skipped in fifth grade and she did it for me in fourth. And that ended up to be Nancy's mother and father. (laughter). And his family and my grandmother were kind of [?] Grandma probably knew about this connection but I didn't know about it until perhaps after we were married. We had both been skipped a half grade by the same principal. There is now a building in Lincoln, Nebraska, named after her. She was really...

I: She sounds amazing.

S: Yeah.

I: ...I mean that was a fortuitous thing...

S: It certainly was not gender based. It was very definitely ability based. The rest of the kids just simply had to repeat a half-year.

I: ...[?]... I mean it might have meant that you had to repeat a full grade. I mean.... you might just have decided to be a truant in school.

S: I probably wouldn't have, but certainly some kids would.

I: So you are going through grade school. You are getting into middle school....

S: And, of course, at that time, that was called junior high.

I: Junior high, right.

S: And my favorite teacher was the drama teacher. And her name was Lulu, L-U-L-U, B. More, M-O-R-O-E. I even remember her name, and I took drama from her. And I think she was also my homeroom teacher. And we did a one-act play for a school assembly and there weren't enough boys in the class so I had the lead boy part in the play. And as my homeroom teacher, they gave her a chart. We apparently had taken some kind of ability test. I kind of probably liked the [?]. And I scored high enough on it that they gave them a chart and they were suppose to take our grade point average and place it on that chart under the score we had gotten on this ability test and give us

an efficiency rating. And that was one of the things that appeared on our report card. Well, I had straight 'A's.' I had the highest possible grade point, but my score was off the charts on the test so she extrapolated up to where my score was and straight 'A' was a 4 which was the [?] (laughter). In eighth grade I understood what was going on there well enough that I was really mad at Lulu B. for giving me that low score on my report card when I couldn't get it when it was mathematically impossible for me to do any better. I don't think I hated her for it or anything but... when looking back on it it's interesting that I... you know that I went to talk to her. "Miss More, I've got straight 'A's' how could I possibly be a low rating?" And so she showed me her charts and how she had extrapolated it.

I: So it sounds like your self-identity as it [?] in your later childhood was very firmly identified with your academic performance.

S: Absolutely. Absolutely.

I: Okay, that's...

S: I was, I was the straight 'A' big bookworm that everybody hated. And so be it.

I: Now you think, "so be it," which indicates to me that you just did not care what other people...

S: I certainly behaved as if I didn't. I suppose in my heart I cared. But, I wouldn't give up getting good grades in order to get them to like me.

I: Was part of that because of the reinforcement that you got from your grandmother about the importance of... had part of who you were, because you were going and getting constant reinforcement about academics were important. It was okay to be smart.

S: Absolutely.

I: Because that I think is really key in terms of a person's ability to be resilient and make it in a situation where they walk in the room and maybe they are one of twenty people and they are the only girl or whatever. You know what I mean? It sounds like you were already building pieces of resilient and those are the kinds of things that I am *vastly* interested in.

S: And also my mother was a relatively assertive female so and, of course, my grandmother had kind of looked after herself for years. So I think it is very much genetically built in to be relatively assertive females or whatever.

I: Well, you can kind of see what the game was, you said. And you liked the teacher.

S: Yes, I liked her very much.

I: You liked her...

S: And, so I went home and explained to grandma why I got the low number and she accepted it and on we went, you know, so it was okay. There was nothing you could do with the red tape system so everybody understood it was kind of false number.

I: Sure. So, you enjoyed drama. Were there any other topics that you enjoyed?

S: I took piano lessons. I was a serious student of music. And I took them from an excellent teacher who had wonderful taste and she trained me well enough that I knew I wasn't a very good performer. So, I never aspired to be a musician or music teacher because I felt my performance in music was way below the best and that I was capable of the best in some fields.

I: So how did you sense about yourself? You were probably very aware of yourself in terms of, okay, okay, I can do piano, but I kind of suck at it, so what were you aware that you were good or liked?

S: Well, I got.... the lowest grades I got during elementary and junior high were in arithmetic. The only thing I got B's in. I got straight A's, except for an occasional B in arithmetic.

I: Interesting. And did that....

S: And then when I got to high school and I could go to *Math* instead of arithmetic, the way my mind works, the difference between math and arithmetic is real important, because I was immediately recognized as a high achiever in math and I was enjoying it.

I: And do you think the fact that you were recognized for your academic ability in that field had something to do with like, "Oh,"... I'm being recognized therefore, "Hey, okay, I like this. This is a good thing! I am going to do more of this."

S: And the teachers would talk to me about what are you registering for next year and encourage me to take the next higher level of math. I got very positive feedback from my math teachers.

I: And that was for all of them?

S: Well, I specifically remember Miss Wibel, W-I-B-E-L. She was a math teacher and she was head of the math department for that high school. And I can't remember what year I had her. I wonder if it wasn't my junior year. But she would come by my desk and drop a newspaper-type thing on my desk and it would be the monthly letter to newspaper for math teachers or something like that. She literally or directly recruited me to become a math teacher.

I: Interesting. So she could see that you were talented and that you had an aptitude and encouraged you in that direction....

S: And, of course, for... She was a woman math teacher and she spotted a girl who probably could achieve well in that and I think that there was very much was a gender angle there. She really wanted to encourage a girl to go on to make sure that this top societal assumption that was because it was math or science, I couldn't do it because I was a girl would not affect me. And, of course, she didn't have to worry... She knew that my grandmother would support me in anything education, academic. I appreciate that she had given her valedictory speech in a western town on women's suffrage... "You've come along way, baby." Well, she was already there before 1900.

I: Right. It's interesting to know... Actually, we have been having the same struggles for way longer than anyone of us every think.

S; What I am told is that in the early 1800s, with a rural base society, women farmed along side their husbands.

I: They did.

S: And that it was during the Victorian era where they got much labor saving devices and the rise of the middle class that men put their wives on a pedestal and they perceived it as a social achievement if she didn't *have* to work.

I: Right. That's exactly what you're describing very [?]... the rise of the middle class and the need to distinguish themselves from the working class and the aristocracy, the upper class, so our women stay home and take care of the children and they don't *have* to work, that's what they do. It's very [?] and it arose partly out of the Industrial Revolution and... I could go on about this. I want to get back to your life. So you are in high school and having encouragement from this teacher and it sounds like you had other teachers who encouraged you...

S: When I registered for tenth grade, something very key happened. Because I had gone out and lived in Washington State with my mother during the year I was in ninth grade, and when I came back, my brother was home. He may have been home from the navy. But, he was home and it was time for me to go down to the high school and

register. It was a great big building. It was hard to find your way around it. Grandma said why don't you take Jean down and help her register. So we went down together. He was four years older than I and had just graduated from that high school. And they gave me a choice of taking clerical preparation, college preparation, and college preparation was divided into arts and sciences and engineering. If you chose arts and sciences, you immediately had to start out with a foreign language. And then the history of social studies, English, and all that stuff. If you chose engineering, you didn't have to take a foreign language so that freed one period a day and that time there were only doing five periods. And, so you could take more math and science and stuff like that and were recommended to you if you were an engineer without being somewhat handicapped by having giving an hour every day to a foreign language. So he said, well, hey, you know, you like math, why don't you take this engineering track. So I said fine.

I: So your brother just commented at that moment and again one of these kind of weird forks in the road.

S: And, or course, he turned out to be an electrical engineer and he knew I liked math. He wasn't doing it just simply off the top of his head.

I: Right. Right. He did it so he could...

S: ...we didn't set down with a family conference with grandma and say which way should Jean register. I'm not sure we even realized that we would be faced with this decision until we got there. So I ended up registering for engineering prep, which emphasized math and science. And I liked it very much. It worked. So I stuck with it. But, I think that was a real turning point.

I: Because the classes through the next three years of school were very much focused on math and science and it sounds like you had been at that moment kind of at the door of being in your element for the next three years.

S: And that put me in these classes where these women teachers actively recruited me and stuff.

I: Besides that one math teacher you mentioned, were there other women in the engineering track where teachers would encourage you or men for that matter, anyone, any teacher who was encouraging in any way?

S: The physics teacher happened to be a woman.

I: Really! Interesting.

S: I was the only woman in my physics class, but the teacher happened to be a woman. She was extremely colorless. I think she was competent in personality, but competent in physics, but she didn't have any outgoing personality. So she was just like a walking, talking book. I don't remember her as being especially appealing to me as a teacher. And I don't think it occurred to me that Elizabeth Beall [?], that the physics teacher was a woman. But, I think in that era it would have been, I betcha, that most big city high schools had men physics teachers. But, I was very aware that I was the only girl...There were certainly more girls in the math classes, although I wonder if there were any girls in the most advanced math classes.

I: Now this is the late thirties?

S: I graduated in 1950. I graduated from high school in 1950. And, I think maybe in the... I actually registered for two math courses at the same time and one of the semesters in my senior year. I took senior math, which in those days was trigonometry and solid geometry at the same time. And I bet I was the only girl in the solid geometry class. I don't even remember. I was so used to it by that time because of physics.

I: So, I have a question because this has come up with some of the other subjects and I think it is really important in terms of answering one of my key questions about how to help... [?] now. Because I mean obviously there is individual differences in how people react to inner liking or not liking being in situations like that. Sometimes my subjects have reported feeling very comfortable and some of them reported feeling very uncomfortable when in situations where they were like one of the only or one of two females in a group of thirty people. You said it didn't occur to you that it was unusual that your teachers happened to be female, but you did notice that you... how did you react to that? Did you just say, well, ... [?]

S: Well, I was so used to being unusual anyway because I was always... [?] and got good grades regardless. And the kids really set you apart for that. So I was used to being set apart any way. And I think I also had a batch of awfully nice boys because they ended up going to the University of Nebraska with me and I didn't even realize some of the things they did which supported me until later I found out about it. So, there was a core of maybe five or ten boys that I had gone right up through physics and stuff where they ended up at college level who were extremely supportive.

I: In what ways were they supportive?

S: Well, they were just... you know they didn't shun me because I was a girl. They just treated me like one of the guys, which at the point is what's needed. And, none of them ever dated me. They just accepted me as one of their group.

I: So you had peer acceptance, which in my mind, again, doesn't matter, but if you were teenagers...

S: ...very important.

I: And so even like, by the same token, in terms of what I am studying, if a guy decides to... if he wanted to become a nurse, you know, if he had peer acceptance, then maybe he, you know, he'll feel strong about doing that, but if he is ridiculed... I don't even know a lot of 40 year olds who could withstand trying to deal with that.

S: Yea, look at boys if you are interested in the ballet or something.

I: Right, exactly.

S: My son was not a good, was built like a football player, not interested in playing football and wanted to be a cook. And I said, he... and that was during the height of the noise feminism, and I said, hey, I want sex equality, I don't want you hawking about feminine equality. I want my boy to be able to aspire to be a cook too.

I: It's great that you had... I hope it's not as unusual as what I found so far, but I expect that it's [?]

S: Yeah, I think I was probably at this point plain lucky that I had... and it was, it was a very quiet, natural kind of support. It wasn't real overt and I wasn't even so much conscious of it, but... in retrospect, I realize those boys were very accepting and up in college I will tell you about a couple of experiences I had where I found out, after the fact, that they had actually tried to help me behind the scenes.

I: So, by the time you get to the end of high school, I mean, you... your identity as a young seventeen year old person, very strongly tied in doing math, mathematics and sciences and being a very good student.

S: I think in the other order, a very good student first who happened also to take math.

I: ...in part of that being a very good student is like the main part of your identity... okay.

S: I added up being first in the class of forty...

I: Four eight...

S: 484 kids.

I: So you were valedictorian of your class. Do you have anything that was a separate [?]

S: No, in fact, what they did was they had a teaching contest that chose our senior speakers and it was not the valedictorian at all. It was kids who applied and auditioned to do the speeches.

I: So your grandmother must have been present when you were the valedictorian.

S: And remember that I was very conscious of the fact that my mom was still alive and my grandmother was doing all this voluntarily. And the only way I could say thank you was to be valedictorian.

I: Interesting.

S: And I... that was not necessarily conscious, but I can remember when they called me up to give me the key that they gave me because I was valedictorian, it was a surprise, because with that many I was .01 higher than the next student, partially a grab bag who would get it out of the top twenty-five. But, I walked up on stage and I shook the hand of [?]. The principal was shaking my hand and I think you didn't tell grandma and I was crying because she would have been so thrilled to be there to watch me get that. They were so busy keeping it a surprise for me that they didn't let her know... They could have found her after school.

I: But she must have been excited to hear about it anyway. So, here you are, valedictorian of your high school class and a very proud grandmother who helped bring... [?} and a lot of what your identity was. It sounds like it wasn't a matter of if you were going to make a [?]

S: Oh, yeah. And I think that the only thing that could possibly have kept me out of college would either be rank poverty or mental, you know, be mentally handicapped or something. The assumption was there that we would go to college if we could. And, in fact, my brother had; he had run off to the navy before he graduated from high school and darn near broken her heart. That was part of why I wanted to, I at least wanted one of us to do well. Scared her to death. He ended up taking that test you can take for high school equivalency and graduated fifth in the class the following year. So we graduated almost the same... pretty close to the same year because he went into the navy without having graduated and after he had been in the navy for a while, he had time to take this course and graduated with a later class. So, but he was still home. He wanted me to go to Purdue. He had started at Purdue, which at that time was a big name in engineering schools. And, she really didn't want me to leave home. She didn't want me to be lonesome. And, so she kept dragging her feet and said, no, no, she should just go here to Nebraska. You know, she could live at home and I could take

the bus down to college. And so it worked out... we would take meals together and he'd start working on her at meal... [?] Actually, I don't remember if they asked me very much or not, but I was sure listening whether I was going to Nebraska or Purdue. And, finally, he started really lobbying hard. He had been a debater and such. He was lobbying hard and finally she looked him square in the eyes, she's not going to Purdue because I can't afford it. And we both knew darn well that wasn't true (laughter). But, she finally could have afforded it very well if she had wanted to. And we both said, Oh, and that was the end of the questions. Jeans was going to Nebraska.

I: So, you said okay, I am going to Nebraska. Grandma wants that. Grandma is willing to pay for it. I'm all over that...

S: You betcha. You betcha.

I: ...all over that. So when you got to college...I

S: And I had to register for college and declare a major.

I: Right. So how did that occur, like what... what your real major was.

S: You know I went along with grandma partly because I knew what I did in my freshman year would not cast me in concrete, that if I really didn't like it I could change. So I ended up signing up in teacher's college for math and science to be a secondary math and science teacher... And they had us sit to... the thing that was probably the equivalent of the SAT. We had... then they came out to the Lincoln High, which was one of their two big feeder high schools and had us take a half-day off classes and actually administer the test right there in the high school building. And they did it the day of our senior assembly that I had found out that I was valedictorian. And why you couldn't beat me... But I creamed that test (laughter). So I sat down with a registration advisor from teachers college that summer and he had this chart with me and they had circled our score, our percentiles, I think. And I was 8999998. And he said, well, I think you could major in anything you would like to. And, I said, well, the only thing I know for sure that I don't want to be a home ec teacher because that was what my mom was. And I really didn't know. So, he said, well, they had a counseling department and you can go in and take a battery of tests and they will point you in the direction of your aptitude. So, on the day I registered I knew I was going to go through this testing routine and try to become more sure, but [?] I registered for teachers college, math and science. And then I went to this place and took the tests and I don't remember—one was some kind of an aptitude test and I scored in the 95th percentile for engineers and we all laughed and said, wasn't that funny because I was a woman. And I accepted it.

I: You looked at that and went that couldn't be right or something like that?

S: Well, I, you know, wouldn't it be nice if I were a man because that would be the direction that I would go. But, that was very reassuring for math and science. So I didn't change any of my registration for my freshman year. But, I absolutely hated the education classes. They were so dumb. And they acted like they could take anybody who had no aptitude whatsoever and make them a teacher, which I didn't agree with. And I seriously looked at the four-year curriculum that they were going to have me take and I was going to be one year ahead of my high school students in all of the different subjects that I was supposedly qualified to teach. I didn't like that at all. So, I looked into taking, staying a math major, but going over to arts and sciences from the teachers college which was a much more academically demanding curriculum. And I had to start with beginning French. I knew when I switched that I had to take 18 semester hours of French to get my minimum requirements. It would not count for my [?]. It was a big decision to make and my grandmother had wanted me to prepare to be a teacher because she said that's your insurance. It was like having an insurance policy; if you become a widow, you would be able to teach.

I: But, you couldn't necessarily be an engineer and not be the backup plan...

S: No, we weren't really aware that it was possible. But, it ended up in the sorority that I ended up in and as far as I know we had the only two women on campus who were actually registered as engineers and they were in my sorority. I have no [?] that it ended up that I had sorority sisters who were—one of them was one year ahead of me and one was in my year and one was taking mechanical engineering and the other was taking architectural engineering. So I did hear them that they would at least let you register. I didn't know if they would be able to find jobs. I had originally specified chemistry as my minor and I didn't particularly like chemistry, especially the lab work. So I though I would try physics and I had liked physics in high school so I though probably I would do all right in it. And after I had been in the physics department for a while, I figured out that I was the first major they ever had. So I was the first woman physics major at University of Nebraska.

I: The first physics major there ever?

S: The first major. They had had women who had taken a couple of advanced courses, but I was the first one that ever put together a second major.

[Tape 1, Side 2]

S: ...a major and one of my professors wrote back, and put it in the next issue, and he was quite sure I was the first woman major.

I: Wow. And [?] one of the classes you mentioned earlier that some of the [?] you had been in math classes with had also come to University of Nebraska [?] and other classes with them. What were some of the things you had [?]

S: Well, when I took chemistry, I happened to get a lab teacher. You know we had... the big professor did the lecturing and then we were divided into labs and we had grad students as our lab teachers. It later transpired that the lab teacher I had was mentally ill. I was the only girl in the lab. There were many women in the lecture, but I was the only girl in that lab. And he went down to the... they had the names in alphabetical order and he called off, and then he would say, *Miss Davis*, you know right at the very first word he uttered that he was playing some games with the fact that I was the only woman. Several different times in lab, he would [?] up a piece of paper, and my god, (pause)

I: That's kind of weird.

S: Well, finally, about the sixth week in class, I went into the major professor's office and said, I just *really* am sorry to upset the apple cart, but I'm being mistreated by my lab teacher and I told him about the sexual implications. And said, well, the boys from my class were in here weeks ago reporting that. I have been waiting for you to come in. Why didn't he do something about it when the boys reported it?

I: Yes, exactly.

S: He does [?] let me switch to a different lab class. But, I ran into that guy again about three years later in an [?] honorary and he was pulling things that were weird then. And I heard... I think he lost his job as a graduate assistant because of weird behavior. They didn't kick him out of college, but they [?] his job.

I: So, you got out of a potentially yucky bad situation and were able to get into a more positive and more supportive academic...

S: I think that one was a perfectly normal graduate student who might have been embarrassed because there was... I don't think I was the only woman in that [?] section either. But, that was the time that I knew specifically that the guys had dome something to back me up and the guy even told me about, just looking after me. And I had a feeling that they were kind of in the wings watching for things that might need to be done in the other years too.

I: So you had kind of like this protective pseudo-brother helping you.

S: Yeah.

I: So you're going through getting this physics major and it sounds like your are thoroughly enjoying the [?] and...

S: Math was my first major and physics was only a second major and I really didn't have anything...

I: So you were a double major.

S: I was a double major.

I: Okay. So you are enjoying the physics and the math classes?

S: Math primarily.

I: Math primarily, yeah. And, so you're going through college and so you're getting into your senior year. What are your thoughts in your head about what you are going to do next?

S: Well, of course by that time, I had started dating this guy whose family knew us. And by fall of my sophomore year, my second year, we started dating. And it kind of grew like topsy. It finally got to the point where he said, remind me to marry you someday. We were steadies and people began treating us like old married folks because we apparently acted that way together. So, by the time we were seniors and we were like that... Our grandmothers were [?]

I: They were real excited.

S: They had been good buddies before we were born. So, it came down to a point that Jean go out and look for a career job or does she become an MRS. And, I went ahead and did resumes and started sending out... going to the job interview place and reading the bulletin board and setting up interviews for the people that visit campus and everything, just as if I was very seriously going to go to work after college.

I: You graduated in 54?

S: But, I was a double major in math and physics with a Phi Beta Kappa [?] and Sigma Chi.

I: Oh, wow. Phi Beta Kappa...

S: Sigma Chi is the honorary... you have to be nominated by two science related departments. And, it's supposed to be research oriented and you are only a junior member if I just got a bachelor's. And, then if you are a high achiever as a graduate

student, you become a full Sigma Chi. And I was nominated by both my math and physics. And [?] Epsilon is the math honorary for schools that support the curriculum that makes them eligible for Phi Beta Kappa. And, I turned out to be the president of

[?] Epsilon in my senior year. And for some reason, I was [?] class cohort for women. I was the only woman in the math honorary that year. And that was not historically true. Usually, there were quite a few, you know, three or four women out of a dozen would be in the math honorary. And that year I was the only woman and I was probably nominated because that man who had been the graduate assistant that was out of his head, gave me a joking nomination. He made a big joke of nominating me. And I said, well, considering the attitude by which I was nominated, I refuse. And one of the boys and his cohort jumped in and said may I make a serious nomination. And I said yes and I will accept. And the secretary of the math department said now don't you be disappointed. I mean they are not going to elect a girl. And they did! It meant that I had to do all the work. And I had to find the speakers and set up the meetings and they could all come and sit.

I: ...that was the president of...

S: They knew what they were doing. But, it was a very nice honor.

I: So, wow, you were in the honor society [?]

S: Yes.

I: [?] ...so you are sending your resumes out and [?]

S: And I did go, for the first time in my life, I flew back to Dow Chemical [?]. I interviewed at DuPont and Delaware and interviewed a chemical company in Buffalo, New York. And they all paid my way and wined me and dined me, you know, the [?] interview stuff. Then, in April, the head of my department called me in. Well, actually I made an appointment to go and talk to the head of the department to report that one of our professors was not teaching his class adequately--one of our advanced math classes. And I wasn't going to get a good grade because you couldn't learn anything form him. I said I can't go in. It would be sour grapes. I'm not getting a good grade, but I said you are the president of the math honorary. You have to go in and represent us and report this. I took my courage and my [?] and went in and reported to him and told him that all of the men in the class had asked me to represent them as the math honorary president. And he started quizzing me. Well, what did I think that he did that was inadequate and how would I have done it differently: And it was my job interview because a week later he offered a full-time job to be an assistant at the bachelor's level to teach the beginning classes in the math department.

I: Wow. Forget Dow.

S: And I, of course, I could have just stayed living at home with my grandmother. The salary was [?]

I: But, how was that... that must have been a great honor for you to essentially have this person say, you know we think you...

S: ...they had taken a special vote to not have two graduate assistantships and pool those two salaries to have me because the engineers were going to have a revolt about bad teaching in the math department. And I was a known factor and the guys that they would have gotten in as [?] systems might have been good mathematicians but lousy teachers and they just [?] where they had to have somebody they knew who could teach.

I: And they know you could do it.

S: Well, you know, of course, that was this interview but I didn't realize it.

I: Right. That's very interesting.

S: So, I wrote [?] and said, okay we have to make up our minds whether we are getting married in June or not because I wrote all the companies that I had been interviewing with and said that I have decided that if I work at all I will accept this job teaching at Nebraska. And they had plenty of time to recruit somebody else. And he said the one thing that they asked of me was that I would make up my mind before May 1st so that they could advertise for graduate assistants before it was too late in the spring to catch people. So I wrote Gary and said, okay, are we getting married or what? Because if we don't get married, I will get a job at the U. And so he always teased me all the rest of his life that I had proposed. He wrote back and said, oh, let's get married... He was at 3M then. He had graduated in January. Okay, let's get married this summer and I will probably have to go the air force because he was an ROTC lieutenant. In fact, he had been called into the air force and was supposed to go to Rapid City. So he said, let's go ahead, get you graduated, and then we will get married sometime during the summer, the first time I can get a three-day leave from Rapid City because it's not that far from Lincoln. And so that was our plan and I was going to stay home with my grandmother and learn how to cook that summer so I could get married. About May 1st, he got a letter from the air force saying we don't want you at Rapid City; we want you in Florida in June. With three weeks notice, we had our wedding five days after my graduation day.

I: So your intention to teach at the university, that was not going to happen?

S: I went for an MRS instead.

I: Okay. Then you graduated, got married, went to Florida, all in about two weeks.

S: Yes. And I went to the employment bureau of the State in Florida. They said that because I was an air force wife that almost no corporation would look at me because

they knew for sure that I would have to move with him by the time I was doing them any good. The corporations just were not taking military spouses. But, the Cape Canaveral, which is now Cape Kennedy, was so hungry for anybody with a science degree that they would hire me just on the basis of my grade transcripts. I didn't even have to go for an interview. And, of course, at that time it was a secret air force base.

I: Really? I didn't know that.

S: If I could pass the high secrecy screening, they already had a transcript showing my high scores in math and physics, but they would hire me, and I could drive 60 miles each way and make a pretty decent salary. And I said, nope, I got married to be with him, not to spend my days on the road. Orlando was 60 miles each way from the coast so I turned that down. I could have taught math at the high school level for about $1600 a year or some horrid low price. I couldn't stuff math down the throats of the kids that didn't want to take math which is what you get in public high school for that price so I ended up as a Sears credit clerk.

I: Which is, of course, exactly what you probably thought you were doing with your life.

S: I found that job for myself by walking the streets. The state employment bureau could not find me a job because they couldn't under employ me. And I went out and underemployed myself. I brought home $36 a week. It was $40 a week minus $4 in taxes with my nice little Phi Beta Kappa bachelor's in my hip pocket.

I: You probably are not the only one that went through a similar thing. After I graduated as I was working as a temp secretary, a year or two after graduation, thinking this is not why I [?] my undergraduate thesis. What was I thinking? Interesting. So how long were you guys there and how long was your husband in the air force?

S: He was in for two years.

I: Just for two years. My dad was in the air force actually.

S: When I married, he thought he was going to be a career military. I expected to be a military wife when I married him. But the military broke his heart. He stayed in the absolute minimum of two years that was required from his ROTC and came back to 3M. He had been at 3M before called into active duty.

I: So then you came back to Lincoln.

S: No, 3M is in St. Paul. That was why when ended up in St. Paul. And I never worked after I got pregnant with Nancy. I was laid off from Sears and I knew I was pregnant and did not look for another job.

I: So you worked there for a year or something?

S: Five months.

I: Okay. So you are pregnant and then she is born in Florida and then you guys move up to Minnesota and then what happened.

S: And then he stayed at 3M until he died at 45 and I was just Mrs. 3M and in those days if your husband rose to management in the company you get a lot of work in support of him. You packed him in a few minutes notice so he could jump on a plane and go out of town and stuff like that because it was *assumed* that a young man that was going to rise in the company had a very supportive wife. That was the way society was set up. And I don't think they would have looked at him quite as favorably if I had had some job somewhere.

I: It would have been seen as not supportive of him?

S: Yeah. And he was two years younger than ... I was a very active volunteer and housewife. Then when John was in junior high, the younger of the two children, I decided to go back and get a certifiable master's in secondary math. And I snagged a job as a graduate assistant who tutored for the math department at the University of Wisconsin at [?] Falls. And they waived my nonresident tuition because I was living in Minnesota and it was right across the border with Wisconsin. They waived my nonresident tuition. And I don't think I got any dollars but that was a big advantage to waive nonresident tuition for graduate school. And I did that until I went out and interned. I had a full-time internship for half a year. It was a total of two years and I ended up with a master of arts in teaching, an MAT in secondary mathematics. And I had almost straight A's. I did fine in that course. I started dealing with the placement people to find a job. The newspaper was full of stories about oversupply of teachers. It was not gender based. Then when I would ask for the handouts for the schools for openings for math and science teachers, they were all... the math and science teachers who could coach football...

I: You are not the first subject to say that and I think this is *really, really* important.

S: And it is legal because they were small schools and they could ask for someone to replace the teacher they were losing.

I: Right and Title 9 hadn't occurred yet.

S: It was on the books that it wasn't illegal to hire someone to cover exactly the same subjects that your predecessor had covered. And 70 percent of the job openings that year, the math and science teachers were tied to male sports.

I: So this is like the late 1960s?

S: The early 70s because I graduated from my graduate degree and Nancy graduated from high school.

I: I was just trying to track on the time here.

S: I must have been forced because I was 39 when I started. 33 and 40 is 73, or 72.

[Discussion with daughter in distance]

I: Okay, somewhere in the late 60s, early 70s.

S: I was 39 and still counting.

[Discussion with daughter in distance]

I: I am just looking at the clock just to make sure that we aren't running out of....

S: I got two job interviews and I sent my resume to a lot of places and I got *two* interviews. One was for tech school, the first high school tech school that was being built but wasn't open yet for the following year. And the human resources guy picked me and then described me to the math teacher who said, "A woman shouldn't have to teach a bunch of guys that want to be welders."

I: So they kind of filtered it for you. Wasn't that nice of them.

S: So the human resources guy called me back and said, "Now, we can invoke the law and push him out of this. It would be, you know, the law is on your side and I will support you." And I said I don't think I want to teach side by side with a man who has been [?] So I said thank you, but no thank you. The other one was for the tech school that was already established that was associated with St. Paul public schools. I think I had in person interviews and he said it was down to three final candidates. He had gigantic numbers of people apply. And I was down to the top three and he got a notice

from the St. Paul public schools that the high school math teacher with high seniority had been pushed out and that he was required to take him so he no longer had an opening.

I: So then what happened? I mean what did you do after. I mean it appears to be a dead end. What do I do now?

S: Well, my husband said we've always wished that we had a house that faced the lake and so he had assigned me the job to go and find us either a lake cottage or a home and that gave me a challenge and something to do with my days. It was a lot of work. I did find a full-time home that was on the St. Paul River and we did buy it. So the kids didn't have to change schools. There were in the same school district. That was a big job. I don't know how women who work full time do it.

I: Oh, yeah. Thinking about... when I moved and my apartment got burglarized and it really under duress and I had friends helping me and I lived in people's houses for awhile so complete duress, but I don't know how...

S: This was a large established household with lots of personal stuff.

I: That is definitely a huge project. So you did that and then once you got moved in and settled.

S: I kept getting more challenging assignments in volunteer work. I ended up being a state officer in AAUW, Women's Voters, and things like that. And I finally took a half-time job in social service to senior citizens which was kind of like doing volunteer job where your expenses are... It was a real labor of love and I was making a tiny pittance.

I: So you are doing this. You are working half time and a couple years later your husband died.

S: Right. He dropped dead of a heart attack at work.

I: And your life probably changed overnight.

S: Yes, because I was no longer Mrs. 3M. It was an identity change thing. Besides all of the grief, we were really a close match.

I: I think this is a good time for me to turn over the tape so I make sure I have enough time here and we will hear about your post Mrs. 3M existence.

[End of Tape 1, Side 2/Begin Tape 2, Side1]

S: ... on December 28th and he died on February 28th.

I: Wow, so she...

S: I went from a household of four to a household of one in just a two or three month period. That was very rough.

I: This is 1975?

S: 78 was when he died.

I: 78. So then...

S: In the meantime, they had been calling me from University of Wisconsin at River Falls where I had been the graduate assistant and saying do you want to finish out a quarter for Professor So-and-So who was ill. Instead of having subs, a person had to decide if they were going to come back at all that quarter and if they couldn't then they would hire someone in as a full-time teacher to teach out the rest of that term. And so several different times, the gal who had signed my master's paper, my mentor, of course, the head of the department, she would call me and say, do you want to fill out a quarter for Professor [?] and I had always said no, but I knew she thought my work was okay and she might be interested in me to teach at River Falls even though a lot of their professors had doctorates. They were using master's degrees as academic staff. So I went over and told her I would be available. He died in February and I started working the following September. But they already knew my work because I had been their graduate assistant and I had been a real success.

I: You were a known factor... So you are teaching. You thought you were just going to be teaching for that one quarter for this teacher.

S: They did. I was hired under different euphemisms for temporary for about four quarters and then they offered me the opportunity to become an assistant professor. Which is lower? An assistant or associate?

I: Assistant.

S: Yeah, the lower of the three. That meant I was on faculty track, on tenure track. In a way it was an honor, but there were some people who were not terribly clear about what they were saying, but they were saying, what do you really want to get into tenure track? And the reason was because the tenure track when you hit your sixth year, they are not going to invite you back for your eighth year, you're out. And I had read somewhere that under the Wisconsin state institution and that I would be out after

"x" number of years as academic staff anyway. The time clock was on regardless... by the time I got the title, I got a few more dollars a year.

I: So you were teaching math?

S: Top math and the need for computer science teachers was horrendous so for one quarter. No, for one full calendar year, three quarters, I only taught one class at River Falls and I was a paying full-time student in the MBA program for business computers and I took the second year without taking the first because I already had a master's. And did I run to stay in place [?]

I: Holy cow! You went straight into advanced business, programming type classes!

S: Yeah.

I: Holy cow!

S: Without taking the first year of basic stuff for MBA.

I: That hurts my head just to think about it!

S: It was the year that Amanda was born so I told all the kids that I was the grad school grandma. And they were pretty nice, but most of them weren't [?] And I had one wonderful professor who was a super mentor. I worked very, very, very hard and learned COBAL, a horrible computer language, and practical applications, end user relationships to the computer which was a new concept at that time to really think about the end users. So I have a one-year's postgraduate but I was not a degree candidate. And they had people who had Ph.D.'s that they had turned away because they weren't taking nondegree candidates.

I: You were the specially...

S: And they felt that they had as the big regional university, they had a responsibility to the small colleges in the area to help them prepare the teachers they needed so they let me in under that. And they said keep it a secret. Do not tell anybody that you didn't take the first year and you are not a degree candidate. So I did. I ended up teaching about half-time beginning math and half-time beginning computer access, primarily for business majors. But, I actually taught the third year class called software engineering one quarter. God, those kids were cheated. They were cheated. Everybody in those days who were taking computers were cheated because there was just not enough teachers.

I: And this was in the late 70s, early 80s time period.

S: Yeah. There was such a gigantic explosion in demand and if you got the training, you got a job in a corporation because you could make twice as much as you could by teaching.

I: So it is kind of a similar problem to what we had up to last year essentially.

S: Every small college in the world wanted teachers for computer classes. They had to cover all these warm bodies. For people who used to say they didn't know what they wanted to major in, now it was computers, because that was what they thought they could make money at. There were tons of beginning classes and some [?] there weren't any good at. Lovely job.

I: And that is another thing I wanted to talk to you about. It sounds like the need at various points in how the history of computer science as a field developed in the United States to deliberately keep people out and it sounds like this was one of the times because it was like ... [?]

S: They didn't have any true interest in computers and they had no aptitude whatsoever. The testing, I don't think you can have testing to predict success in a field where you have no experience. So the only way you could do was let them register for a class and tell them to go around and figure out they couldn't do it. But I ended up writing. I wrote the curriculum for a new major in our business oriented computer bachelor's that we encouraged them to take as a double major ... [?].

I: So for those people who really didn't have the aptitude, you helped steer them on?

S: Well, we hoped they had a pretty good aptitude, but they weren't interested in high flying, high tech, so much as they were in how computers could be useful in business. And that wonderful mentor at Minnesota had allowed me to completely change one of the assignments in one of our classes to develop this curriculum as my kind of like a quarter paper for class. And I got college credit for it and then I turned it in up to the Wisconsin system and after about a year, it was accepted as a new major.

I: So basically your inspiration as a teacher was seeing what worked and what does not working and your ability to act as a mentor to encourage you to say, you know, go for it. Try an experiment. See what happens. And you had the autonomy as the teacher for this class to do that and see what works in your laboratory with these guinea pig students. And then having written it up, it could have gone nowhere, but it apparently, it sounds like you did the right puzzle and the right time. And as the initiator changed...

S: And the students were at the door and I was able to connect their desire with what was an acceptable academic arrangement so it put me worthy of a college bachelor's degree.

I: Now something that I am very interested in. I have a lot of friends at work, and we get a tuition discount working at Oregon Health & Science University, for Portland State. That is where I got my degree. But a lot of them have tried to go through the computer science department and even if they are able to get through the first

sequence of classes, like I have a friend who works full-time and has a three-year-old kid and she has a very supportive husband, but she doesn't have twenty hours a week to do the programming homework. She says that it's not that I don't understand the concept, it's that I can't keep up with the pace that I ...

S: And does she end up having to wait in line to get a terminal college degree? That was a problem in the 70s.

I: Really! I don't think that's so much a problem. I think it is....

S: It worked better for people who were matriculated at the University of Minnesota and who had come over and registered for classes with us because they could get in to our computer...

I: Really. Wow!

S: It was that bad of a hardware shortage.

I: That is very interesting. So there was a lot of motivation within the academic discipline to cut down on the number of students, if they could, because of lack of access to...

S: Either that or make sure that they made their wishes known so that we could go to the state administrators and say give us the bucks for the computers. There were people who were waiting for us.

I: Were you and others able to do that?

S: Well, yeah. I think River Falls was one of the first satellite colleges. You know there is University at Madison and University of Milwaukee are huge state universities and then were satellite colleges that were originally teachers colleges. And we were one of the first satellite s that had computer major.

I: So, between then the early 80s when you were doing this and now, I mean....

S: I can't really tell you because when I hit six years they did not tenure me. And I could have stayed on for a seventh year or I could quit knowing that I didn't have a future. And I decided to quit and personally I was treating it like a sabbatical. I figured I had one year. I could be out for one year and I could still get a job in a small college somewhere because there was still a horrendous need. But if I stayed out more than one year, I would get obsolete. And I *loved* not working full time. And I have been a very active mom here ever since. Now I'm 69, but I was about 55 when they did not.... and in Wisconsin if you were not invited back for your eighth year you would have had to have left in your eighth year.

I: So, you took the year of sabbatical, essentially...

S: And I never looked for a job again. And I have been active in the volunteer sector and I understand how volunteer organizations are using computers and stuff. But otherwise I am totally obsolete. Of course, it's changing.

I: What I am interested in your observations. You've really been at the nexus of a key part of the history of how computer science developed in the United States. You just described how just access to the equipment ... and how demand... [?]

S: Well, society was becoming aware. The high schools were beginning to acquire computers. They were just beginning to get some, mainly Apples. My first computer at home was the little Macintosh like this with the tiny screens. The first computer classes I taught were on a HP with telephone in time-sharing. And our computer on our campus supported all the high schools in that whole section of Wisconsin with telephone in timeshare. We teachers, one year they finally got a terminal in to each of our offices and we were on timeshare who were sharing that computer with the high schools. It was like another customer of computer science.

I: It's very, very interesting. When you were teaching, during this six-year time period, and you were trying to cope with just this, I mean do you have any observations about the composition of your classes in terms of race or gender.

S: There were... certainly having women in the class was not unusual. There might have been an occasional class where there were only two or three just because of the way the timing fell out for their schedules. But, I am not sure if it was exactly half and half, but it was not rare for a woman to major in....

I: Was it like ten percent?

S: No, no. It was not rare for a woman to major in either math or computer science and we were in its own department of that school. Now during that same era my home school, the University of Nebraska, there computer science major grew up in their electrical engineering college. So you can imagine that was a very high tech, probably the graduates of that one would have gone on to IBM, HP, and so forth, to work on original equipment, OEM—original equipment manufacturers. And there were probably schools where the only thing they taught was business [?]. And we did have... our original major was written so that it was suppose to be a scientific computer *science*. And then *I* created the second curriculum for a major that was business related computer oriented.

I: I am sure I could look this up with vast hours of research but do you have a sense off the top of your head because you were a professor and advising the students. Do

you have sense of what choices the students were making in terms of going in to what parts of industry or parts of academia or making other choices? Where were the young women making these choices?

S: I was kind of horrified that as a society, at least at our little college, they didn't think about what they were going to do with their degree until after they went through the graduation line. When I got a bachelor's in 54, if you didn't already have a job before you went to graduation, there was something wrong with you. I finally created a senior seminar where I taught them how to go through interviews and how to write resumes and stuff like that. Because they weren't working on what they were going to do and thought they would worry about a job after I graduate. I was appalled then and I am appalled now. How did they decide what to take if they didn't know what they wanted to do?

I: Unfortunately, our whole economic structure has radically changed so much that we've been... Now, or when I graduated in 91, even if I had gone for a massive amount of interviewing, as an English major, ... practical experience...

S: We certainly encouraged our kids to do internships for that reason. We tried to develop mentor system for internships. We were making an effort without a heck of a lot of success. It was getting so we had faculty relationships with companies because the Twin Cities is one of the silicon valleys. That's where...

I: It's okay. They had companies that were viable for...

S: Two or three of the great, big, famous... Honeywell is there. 3M is there.

I: So you were doing a lot to try and provide services for the kids who... it sounds like they... to what can you attribute that? It sounds like to me that between when you graduated in 1954 and these people are graduating or doing their thing in 84, thirty years difference, to what do you attribute the shift. Was it just the difference between kids in Nebraska and kids in Wisconsin or?

S: I think it was the prosperity of their parents. They weren't hungry enough. Our parents had been raised in the Depression. I was born in the Depression. So, we were ... when we got hungry.

I: So you did what ever was practical to move toward that end?

S: And a lot of them, especially if they entered computer, they had this societal view that there is a desperate need for computer people and that some computer company, somewhere, is going to need them. And all you had to do was get the bachelor's degree and they will be there which was true to an extent, but it's nice to get your resume ready and I had a guy who played in rock band and he got C average and

aspired to work for IBM. Somehow that didn't come true. But the day IBM came to that university for their in person interviews, he cut his hair.

I: So he knew finally that he wasn't getting the whole picture.

S: I couldn't go to him and say, I'm sorry that you cut your hair because there is no way that IBM is going to even glance at you with a C average. I mean we had one girl who had straight A's and IBM did invite her down to Rochester for an interview. And I don't think they took even her because it was such a small school with a reputation for grading easy. They took Nancy, but Nancy had a bachelor's in something else *and* a bachelor's in computer and two foreign languages and linguistics besides her computer languages. They took her.

I: Basically, the culture, the messages that people were getting from their parents and from society about...

S: ... and the newspaper...

I: ... and the newspaper and media about what to expect out of life in terms of how hard they would have to put into it was very different from the business expectations were. Look, you need to be an A student from a really competitive school if they are really going to seriously take a look at you. It is almost like the kids in that generation lived almost in a different world than the businesses.

S: And when they were born, prosperity was high. And they never, probably, unless they came from an unusually poor family, they never knew being hungry. They never knew hunger. I can remember my brother coming home from grade school and saying, so and so kids have oranges in their lunches. And Mom says, yeah, there on WPA. So they could have oranges because they were taking welfare and we couldn't because we didn't have enough money. How many kids in your generation have any idea what that is like? The first time I had a doll for *me*, and not a hand me down, was when I want to my grandmother's. Because I didn't have any older siblings that were female so there were no hand me downs available.

I: I think this is very much a class issue because I know from the people whom I was with in school. I mean there was an expectation we were going to college. That was it. It was similar to... there wasn't a questions of whether you were going or not. You were going to go. But I also know that there are a lot of people, more and more kids, right now today, who are growing up in financially dire circumstances.

S: In comparison to their peer group expectations...

I: It makes me wonder... does that mean people, right now, in impoverished circumstances are more motivated to go forth and go to school. I don't think that really equates.

S: But, I think what we did, while we were in school, we thought more about working. We tied school and work maybe in a way they don't know. May be it was just because my grandmother certainly had always planned ahead and looked... when she thought about things, she thought about the future of circumstances, the future consequences. May be that's just something that came through our family line. Not all families share it. I know certainly my son's ex-wife's family never thought about future consequences ever to the point where it is a handicap. And so that can be a familial thing.

I: Well, it's interesting because a couple of the others whom I have spoken reiterate what you have been saying in terms, I want to go to this because I kind of like math and I know I can get a job when I graduate.

S: Like my grandmother wanted me to take teachers college because women could always teach. And that was gender. Now my brother, she didn't say that to because she didn't think he needed to be a teacher in order to find a job. Of course, she knew that because I was a woman that I needed to train in a field that was commonly hired as female.

I: So your brother got a different message essentially.

S: Yeah. He took engineering and she never, ever fought that the least.... Because it was logical for a man to get a job in engineering.

I: But, it doesn't sound like when you signed up for those classes in high school that it was an issue for her. She didn't say that that wasn't a feminine thing to do.

S: Well, she said I kind of wish you would get that insurance policy of getting a teacher's certificate, but I think an awful lot of the decision making for me, my parents, and my advising teachers was at least unconsciously based on the fact that I was a high achiever. Certainly the way a couple of the professors in the physics department who had a reputation of advising my classes, "You are going to major in physics? Those men will eat you alive!"

I: So they knew the atmosphere was not necessarily real supportive.

S: One of the first days with this one man who was known as a real ogre, he asked a question in class, but I was sure was a rhetorical question that he had based on intentionally saying something wrong in the previous paragraph. And I was following him closely enough that I was confident that he had made a mistake on purpose and

the next questions was why doesn't this work. And I said because you were *wrong*. I can literally hear the boys in the class. Everybody in the class went [gasp]. And he said, Miss [?] and you can tell his attitude toward me changed that day. What if I had been a "C" student? He would have probably eaten me alive. So an awful lot of why I succeeded and this is certainly male chauvinism because it was I was a high achiever. Had I been an average student I would not have been able to do what I did.

I: Right and this is another part of my theory that... if a person who has a very high interest and aptitude in a subject, they are going to pursue it not matter what the obstacles, external or internal, might be. I am concerned about those on the margins, those who are pretty interested in it, but given enough blows, would say, you know, how worth it is it.

S: ...Part of it is confidence. Not just interest, but confidence.

I: Right. Exactly right.

S: They might be just as interested in it as I was but they weren't as confident that they could succeed. For example, they would have never spoken up and told that professor he had made a mistake. And yet I thought that was what he was asking for. And it was.

I: This is one of the things that the nurture that our.... people who are in computer science classes, when they are getting their grades, and they are getting a "B." The guy who is getting a "B" or "C" is going to think he is doing decently. And a woman who is getting an "A minus" or "B plus" will feel that she is failing. And I actually have several subjects who said they went into computer science, this was in the 80s, and then chose to get out of it because they thought they were not good enough. A lot of it is internal perception and I deeply want to know what is it about our general society now...

S: They had to have gotten over this business that when they were in grade school everyone said, you *like* math!

I: Right.

S: In high school, they said, gee, you must be a brain if you are getting a grade in math. I mean society still feels... I am quite sure there is still a lot of mothers that send their little girls off to grade school thinking I can't do math because I am a girl. I am afraid that is still happening.

I: Oh, you're right. It is still happening. So the attitude is in the female parent that identify with the attitude so they internalize the fact that, oh, I guess it is okay for me to not be good in math.

S: We had a gal come and speak to our AAUW and she had a doctorate in home ec and she came specifically to talk about, don't let your girls stop taking math and science because it narrows down their career choices too much. If they want to be a nurse, if they want to be in home ec, she started listing off some of these classically female careers, they will need math. And she listed for us the graduate math she had taken for her PhD. She had had more math than I did. And I had been a math professor. Just an incredible high level of scientific math.

I: She was framing it in the context, okay, here are the things that are appropriate paths for young women. Well, guess what, even with those you are going to need...

S: ...math and science. And at River Falls, we had a special workshop every spring where particularly the women teachers brought in junior high girls to her career thing and the teachers knew, although the girls may not have known ahead of time, that each of the career fields that they were going to be talked about... they were all about science and math and things that are not classically women's careers. The women were told that you are not going to talk about women in science; you are going to talk about what you do in your career area. But all the counselors were female. And they talked about what they had taken in school in order to do that kind of thing. And math and science always loomed high and it was very well attended. The teachers really brought the girls to us in droves. I don't know how effective it was for the girls. The teachers kept coming back.

I: There's something that I am involved with this year. I think they are in their 20th year and it is called an "Expanding Your Horizons and it sounds very similar to that. It is going to be held in April and they are going to have a bunch of people....

S: I think ours was a little bit subtle. It was billed as careers and it was kind of the second level.

I: Right. They are trying to do this also, but the focus is not on let's talk about women in the professions. It is more like, hi, I am a police offer. Here is what I do. Here is why I love my job. If you like these kinds of things too, you might want to think about doing this. You have just covered a huge amount of ground and certainly when you get your new email system up, I definitely need to get in contact with you. I am sure I am going to have some clarifying questions. Before we turn off the tape though, any final parting thoughts in terms of your own experience, in terms of why there are not more young women going into computer science today. I mean supposedly our opportunities are wide open. I mean, why aren't we doing it? What do you think?

S: I don't know. Do you suppose it is because the women mentors, just like the ones who created the seminar, have relaxed because they think the problem is over? I don't know. I didn't realize it was going down.

I: I think that maybe that's part of it.

S: Certainly the press is not emphasizing making sure women have equal rights like they did during the peak of the seventies. There was a peak of women going on for graduate degrees in math and science in the twenties. Martha Gallagher was my mentor was a PhD maiden lady from the University of Rochester. She had gotten her PhD in maybe 33... She was a lot older than I was. And she said there was a peak of women and at that time it was because if you were interested in science, the only kind of employment she probably could get was college professor. So, if women were really interested in science, they went on for the PhD and went into college teaching.

I: So some of it has to do with the options that may or may not be open and maybe because so many more women are doctors and lawyers and there are other options open, they may think computer science doesn't seem to be the thing.

S: And some of them are screened out because they don't take enough high school math. And then it gets to be expensive. You have to stay in college longer and you are paying tuition and you take the cheaper option. You don't have to take a whole lot of makeup courses. So you can accidentally screen your kids out of a whole lot of fields by **not** making them take, **making them** [laugh]... anyway, **encouraging** them to take math in high school.

I: Sure. And it goes back to the problem we talked about of what the peers would think. The peer acceptance... because, you know, if I am fifteen or sixteen, I mean I remember going through this argument with my dad. I took as much math and science as I could in high school with the exception of not taking calculus because my perception at the time was that the teacher of this class, and some of my classmate really like him, was that if you didn't know exactly what you were doing, he would just either ignore you or make fun of you. I really wasn't naturally good in math although I was really good in science; it just kind of got all.... everything, you know, baby with the bath water, I just through it all out. It continues to trouble me why young women... like I taught in computer classes and we have this group of young women come through—a grade school group, a junior high school group, and a high school group—to learn about new web stuff in relation to health care. In the high school group, we ask them what their aspirations were. Some of them wanted to be doctors, some lawyers, and some in business, but **none** of them said computer industry. And I said, why? They said I don't want to give up my whole life to do that. So the perception I think, you know, female people tend to be socialized to have important [?]...

S: ...to be anti-social.

I: Exactly. It's important to connect with other people and so if I am 20 years old and in college and the program is set up to weed people out because that is how the

academic discipline involved throughout a necessity. I am trying to tie this to history in a way to make some sense for my advisor.

S: Does the English Department not discourage kids who get "C's" and "D's"?

I: You mean in college?

S: Yes.

I: I would think that they do, but I just don't know.

S: In physics, if you don't go on for a graduate degree, you probably can't get a job in physics. A bachelor's is not end preparation for employment. I think that somewhat carries over in computer science. Certainly, the computer science that's taught as a science rather than as taught as computer access or business applications. They are really different fields.

I: I think it really depends... I do know that... well, up to last year, when the economy crashed out, if you had a bachelor's of science in computer science that was very sought after degree. But, if you wanted to do serious academic research, absolutely you would have to have a master's. That would make sense. If you were getting C's and D's in English Department, they...

S: ...probably wouldn't encourage you to go on for graduate work.

I: Right. Part of what I am thinking also is if you are an English major and you haven't done your homework the night before, you can be up at 3 in the morning, "B.S'ing" your way through a ten-page paper. It's not fun, but you can do it. However, if you are trying to do a program, like in COBOL or some other thing, you cannot "B.S." you way out of it. You **really** have to put the time in.

S: Well, the attention to detail. It's like an accounting degree. You can't "B.S." because the numbers have to be right in accounting and the language has to be precisely right for the dumb computer to read it. We thought of that as a related thing when Nancy was going career. She did not go into computer science. She went into science to.... anthropology with a museum design emphasis. And it was fool work. There are two jobs in the whole of the United States for her career. So she ended up going back then and getting a second bachelor's in computer. Her father and I just looked at each other and grinned because we always assumed she would go into accounting or something like that because she was always interested in every detail being right.

I: It sounds like that is kind of required, that kind of thinking.

S: That is kind of a built in demand I think in computers and maybe it takes a certain kind of personality. And does the media no longer say if you're a wreck and have a degree in computers, you can get a job. Because that explosion of need that I saw when I took special courses to teach it, that was the kind of feeling everybody had. If you could just take computer, you could get a good paying job. I don't think they have that attitude any more.

I: I think in our culture, in American society, it is a very typical thing to have what ever is the latest, best thing. I remember when I graduated physical therapy was the best thing. And since I was then working at the health science university, I said, well, I graduated and was a temp and got to be a secretary, I was an English major so I guess I should go back to school and take a couple years of chemistry and biology and become a physical therapist. I started down that road and completely hated it. But, I was caught up in that too. Here is what we are **not** taught as a society to follow our internal direction at all. And I think that is part of the problem.

S: What we should be taught is a way to make that work as a way to make a living. Instead of you have to change your interest to get into a field that is automatically a way to make a living.

I: Right and that should be key instead of, look, you don't need to look at whatever is the latest and greatest. That's always going to change. But, whatever interests you that will probably going to stay fairly constant through your life. In a way, we almost need to... in addition to whatever transformative thing we did at the higher education level in terms of transforming computer science. We almost have to transform how people think of.... people would have to take responsibility for their own choices.

S: And we have to work with... like if you are worried about a girl, not enough girls, going into computer science. Is it just girls or is it everybody? Is it gender? That could have started when they were in grade school. Are the grade school teachers still telling girls they can't do math and science?

I: I don't think any teacher now could directly go out and say that, but I think that especially in junior high school, girls go through this bizarre kind of plummet in self-esteem, what their peers think of them is really important. No one wants to stand out and look weird. If being a nerd is not seen as good or geek, which a lot of people associate with computer stuff. But computer stuff is hugely collaborative. So the image of what it is does not appeal to a thirteen-year-old and has nothing to do with the reality ten years from them. And I think that's part of the problem—is having that disconnect. I could talk to you about this forever, but we have gone through our two hours and I very much, deeply...

[End of tape]

APPENDIX D

TRANSCRIPT OF INTERVIEW WITH SUBJECT 15

Subject #15
Interviewed: Friday, February 15, 2002 - Portland, Oregon
Degree: Computer Science
Institution: Washington State University
Year graduated: 1983
Year born: 1959

LZ: Why don't we start with what you are doing right now.

#15: Right now I'm the president of a high technology software engineering contract services firm. I started the business when I was working as a software engineer and I continued to work as a software engineer for the first several years, having the business, and then about six years ago I quit doing software engineering on a day to day basis and started doing management on a daily basis. That's when I transitioned into the role I am presently in.

LZ: Can you tell me more about the kind of work provided by your firm?

#15: It's like Kelly Services or Manpower or a temporary help agency that specifically focused on senior software engineers and specifically targeting the hi tech industry as opposed to an IT consulting firm which would be able to help any kind of industry, this one is...we specifically just target hi technology and software engineering as opposed to IT.

LZ: So basically like the software engineering departments of Intel and other companies like that versus the networking that might go on where I work?

#15: Yeah.

LZ: Interesting. I imagine, as you indicated in your emails, that it's kind of a slow time.

#15: Something like that (laugh). Very slow, yeah.

LZ: So you majored in computer science and got your degree in 1983. What is your earliest memory of having any kind of affinity for technology or computers?

#15: I had *no* affinity for technology, math, science or computers all going through junior high and high school. Not when I first got in to college. It was in my second year of college, spring quarter, I took computer science class or a programming class.

And the reason I took the class is that I had a crush on a couple of guys in the class. And *that* is when I discovered my affinity.

LZ: That's wonderful. Life is kind of haphazard like that!

#15: I know!
LZ: A couple of subjects felt it was clear that during school they liked math, but they hadn't really thought about it, but in some cases it might be completely random.

#15: Yeah, there's no way I would have gotten into this in any kind of ...following any kind of logical progression or thought patterns. Or if I looked at "This is what I am interested in, therefore this is what I would do" I would never have gotten here. It was pure chance.

LZ: Interesting. We're going to come back to your time in college. I'm very interested to hear more about what the dynamics were, but in terms of keeping me straight in terms of the data that you are giving me, I need you to go backwards in time to the when and where you were born, how many siblings, what they are doing now, what your parents did, etc.

#15: OK, so my dad was a mechanical engineer and he's retired now and my mom has had kind of secretarial bookkeeping types of jobs, but she mostly didn't work when she was raising the family.

I was born in Seattle in 1959 and I'm the oldest. I have a younger brother and a younger sister and my brother is a carpenter and my sister is a structural engineer.

LZ: That's interesting. So growing up you saw, you had an engineer in the family, so it was just kind of there, but you didn't say, "Hey, I want to do what Dad does."

#15: No. Well, my dad worked at Boeing and he worked on programs that had security clearances and so he never brought the job home with him. I was totally not...I had no understanding of what he did...Now he did use his mechanical engineering talents at home a lot. He built a lot of our furniture. He would fix anything in the house that was broken. Everything about our house worked perfectly because he kept it in perfect working order, but that was never anything I was really a part of, it just sort of happened.

LZ: Describe to me, if you can remember, what were your parents' attitudes like in terms of education in general and in terms of people going into non-traditional careers in life.

#15: You know I would say I don't what their attitude was about that. They tended to reserve judgement on a lot of things. Like they wouldn't tell us, "Oh, I like these

friends of your's and I don't like these other friends of your's". I'd kind of never know which friends they liked and which friends they didn't like. And that kind of translated into everything. I don't really know what their attitude was about traditional versus non-traditional roles.

On the other hand, their attitude about education was totally clear. They wanted us to go to college. Which is not to say that we all did; my brother never went, he was lucky to get through high school. But they were both college graduates and they thought that was important to have a college education, whatever your major was. And so from a very young age, I had always intended to go to college and that was definitely supported.

LZ: What did your mother major in?

#15: She majored in clothing textiles and art...not quite home-ec. It's a more...it's not exactly fashion design, but it's sort of halfway in between home-ec and fashion design, so very traditional kind of major for a female.

LZ: It's interesting that she did bookkeeping work if she majored in something like that, but again, what you major in almost has nothing to do with what you do for the rest of your life (laugh)...

#15: Right. And the only kind of job you would get with a major like that was working in a department store and that was hard work for low pay, so she ended up doing secretarial work...it was a better job. In the course of doing secretarial work she learned basic things about bookkeeping and started doing some of that...

LZ: Is there anything else you, whether or not you think it's related, that you would like to share about what your family environment was like?

#15: You know, I don't know what would be relevant and what wouldn't be relevant. Nothing specific comes to mind.

LZ: In terms of your education, I'm thinking about K-12 education, what are your first memories of thinking, "I really like this topic" or "I really don't like this topic" or "I really like this teacher" or "I really don't like this other teacher"? What was your experience school in terms of the teachers and subjects you connected with and didn't connect with?

#15: I really did not like math and I really did not like science. I figured that out pretty early on. I had, in junior high school, some bad math teachers, but in high school I actually had a couple of good math teachers, so I didn't like math, but it got a lot easier, and I had good teachers. I loved the social sciences. I loved history...it was my favorite topic. I was really interested in foreign languages. I studied Spanish.

Unfortunately I had bad Spanish teachers. I stuck with it all through junior high and high school, but there was like one Spanish teacher at the school – if you don't like him you can't switch. I loved studying language so much I stayed with it, but the teachers weren't good. I had some good history teachers. I had one absolutely fabulous history teacher who was my favorite if I look at my whole K-12 education.

One thing that's really important to me, I found when I look back on my education and what I think about teachers, is the first thing a teacher had to do in order for me to like them, was they had to be respectful to all the students in the class. There's a lot of teachers that like the "smart" kids or like the "popular" kids or they don't like any of the kids [laugh] and the teachers I really admired and connected with and who inspired me were all teachers who believed that all of their students had potential and encouraged all of their students and made class fun and interesting and were fair. This one history teacher, I loved the subject matter to begin with – it was just fascinating. And he knew how to manage the classroom, so he knew how to get everybody focused on him and paying attention, so you didn't have disruptive students in the class because he knew how to get all the students on his side. And he just knew...he made things interesting and challenging at the same time, so he didn't sugar coat it and make it too easy. So he was like the best teacher. I had a fabulous economics teacher. I had a couple of good social studies teachers in junior high school.

LZ: What was the year you had this really fantastic history teacher?

#15: That was my senior year in high school. It was 20th century history.

LZ: Clearly you're liking of school was connected very much with foreign languages, social sciences, history...

#15: I liked English. I didn't have any really fabulous English teachers, but it was a good subject for me. I liked writing.

LZ: Do you have any memory in K-12 when you thought, "Hey, I am really good at this" ?

#15: It was very clear to me that history was my favorite subject and that I liked it and I was good at it, but I don't really think I formed an identity around that because it's kind of an amorphous thing. It's a little bit easier to form an identity around a sport that you're involved in or a musical instrument that you play or something like that. Definitely I had a passion for the subject and I recognized that and that I was good in it, but I wouldn't say I really identified with it a whole lot.

LZ: In your later high school time, was it in your mind that you were going to major in history?

#15: I didn't know what I would major in. When I thought about majoring in something in college I thought about getting a job after I got out of school and I thought, "History, sure, I'd love to major in history, but what kind of a job would I get with a major in history?" So I didn't know what I wanted to major in. I knew I wanted to be in the social sciences field in general. I thought maybe foreign language, maybe history, maybe something else. There weren't really any sociology or psychology classes at my high school, so I didn't get exposed to that in high school or I might have thought that would be pretty interesting. I was just undecided.

LZ: Tell me about your decision-making process in terms of where you went to college.

#15: I decided I didn't want to go to a really big school, like a state school, the big public 4-year universities. Because I loved social sciences and liberal arts I started looking at smaller liberal arts schools, but it had to be something that was affordable, so it couldn't be some of the most expensive schools. I read tons of different brochures. I read about a lot of schools around the country, but financially it made more sense to go to something closer to home so there wouldn't be the expense of having to travel off to school. One subject that I'd always been fascinated by, but had never been able to take because my high school didn't offer it, was Latin. I just really wanted to study Latin. So that became one of my criteria for picking a school, that it had to have Latin. Well, I was not really sophisticated and I didn't understand that just because a school lists something in their catalog, it doesn't necessarily mean they're going to teach that class all the time [laugh]. They might teach it sometimes.

So I was looking for a small, liberal arts college that offered Latin, that was close to home and if I could get any financial assistance that would really help. So I ended up going to the University of Puget Sound in Tacoma because they gave me a partial scholarship and it fit all my other criteria.

LZ: But you got your degree from Central Washington?...

#15: Washington State University. We'll get there [laugh]...this college isn't going to last very long.

LZ: So UPS did not offer Latin?

#15: Yes, but only every other year or every third year, so I was very disappointed in that. It ended up I only stayed there one year and it was not a good fit for me at all. It was very...most of the people who went to the school were from pretty well-off families and I definitely felt like I didn't fit in. I was from a middle class, just plain old middle class family and a lot of the kids there were from pretty wealthy families. Definitely it was kind of a culture class for me. These kids, they just didn't understand

that money doesn't grow on trees. I had always grown up in a family where we had watched what we spent our money on and I wasn't surprised, but we always looked at how much things cost. We always tried to get good deals and a lot of decisions were driven by, "Well, you can't do this because we can't afford to do this." These kids had just never experienced that.

Really the defining moment for me that year in school, as soon as I got to school I found a job, working 15 hours a week or something in the cafeteria so I could make money to cover books and classes, and that's really not that many hours. It's really not that much. But there would be times that I would go to work instead of going to a meeting in the dorm or something. I remember this one dormmate of mine telling me "You know you're missing out on school. You shouldn't be doing this work and washing dishes when you should be participating in university life. You're not getting anything out of that. You should be socializing more." There was a total disconnect. This person had no understanding. That people have to work for a living.

Also I worked in the cafeteria. The cafeteria was run by two men and every single other person who worked for them was a woman and those men terrorized the women who worked for them. A lot of those women were trying to live on social security and they couldn't make ends meet, they were past retirement age and this job was what stood between them and starvation. These guys who ran the cafeteria operation knew that and they were just these little warlords. And the women really helped each other out, they came together. The would cover for each other. There were these rules, like if you were going to work in the cafeteria you had to be able to lift up 5-gallon buckets of soapy water; these are physical, bonafide occupational requirements that you had to meet – they didn't have the FOQs back them. Those were some of the rules. And some of these women were too old and too frail to do that.

And so the other women would cover for them. And I just saw this and here were all these kids going to this school who had no understanding of the fact that most people have to work for a living, and here were these women that were just really being poorly treated by their bosses. That was really a defining moment for me in terms of my view of how the world works and I really believe there is such a thing as oppression of works, there are certain stratifications in society and there are people who don't necessarily understand what it's like to be at a different level.

And so, I had no remarkable teachers. I didn't have any bad teachers or good teachers. I decided at the end of that year that I didn't want to go to college anymore. It just hadn't done anything for me. So I moved to Moses Lake, Washington, which is in Central Washington, because I had a girlfriend living there and she needed a roommate. And I got a job. From then on, I supported myself. My parents had helped with tuition the first year of school, but after that I paid the rest of my way through school.

So then I got there, but my friend was going to community college there called Big Bend Community College. So I thought, "Heck. Maybe I'll just take a class on the side" because all I really knew was being a student up to that point. So I started taking classes at the community college. And then eventually I took a computer science class and that's where I got interested.

LZ: So this was in the late 1970s...and it was there you took the programming class that inspired you to continue in computer science further? So you were there for a couple of years taking those classes then?

#15: Yeah. I ended up just being there for two years. The first year there, I'm just taking classes for fun. The very first class I signed up for was history because that was what I like. Had a fabulous teacher. Took a philosophy class, an English class, took all fun stuff that I was interested in and had wonderful teachers. My community college experience was fabulous. I really believe in the community college system. It was the spring quarter there, my second year of college, and I took that programming class.

LZ: Going back to what you said earlier, there were some guys you liked who were taking this class?...

#15: I knew they were taking the class. Some guys I didn't necessarily have a crush on, but I knew. So I thought, let's take a class with some people that I know. What's this computer science stuff all about? I wasn't really intimidated by it, I just knew nothing about it. And that's what I was doing, just taking things that seemed like they might be interesting, so what the heck, why not?

LZ: Was it COBOL?

#15: Apple BASIC.

LZ: So you're working on the old Macs. Tell me about your experiences. Up until now you'd been taking history and these social science classes. Describe to me the transition from the beginning of the term on.

#15: The guy who was teaching the class had never taught before. So he throughout the term was figuring how to teach and how to relate to the student body. And so, my progression throughout the quarter, kind of parallelled his progression as an instructor. He didn't do very well at first. The good thing was, if I was confused about what he was saying, I knew a lot of other people in the class and I knew they were confused too. Whereas my typical response to not understanding the teacher would have been, "Oh, I'm stupid, I don't get it", in this case I knew other people in the class and I knew none of us got it. And then there would be other times that not everyone else would

get it, but I would understand what he was talking about and I could turn around and explain to them.

The class evolved. Being a community college there was a wide variety of students. It wasn't all like 18, 19, 20 year olds. Some of the 40 or 50 year old men in the class would have no compunction about telling the instructor that something wasn't working out well and needed to figure out a better way of explaining things to us. As I said, I really loved the community college experience and that class was a good example of it. The class, the teacher, and the students ended up working together to make the class successful for all of us. So the guy who taught it really learned a lot and eventually figured out how to explain it to us.

The programming piece just came really naturally to me. I didn't struggle with it at all. It seemed fun, it seemed interesting. My roommate claims that she knew before I knew that I was going to pursue this because she says I would go off to the computer lab and I would not come home [laugh]. I would go off and work on the homework and would come back and be all jazzed up and not tired. At the end of that term I thought, hey! I had found something I thought I could major in that I could get a job with [laugh] after I graduated and that had always been my concern about anything else I majored in: how would I be able to support myself with one of those majors? So that was my second year of college and at the end of that year I decided, "OK, I'm going to major in computer science."

LZ: Just after that one term.

#15: Yeah. It was a result of that one class.

LZ: Amazing! I have some theories about the heierachy that is invested into that academic discipline. You've given me a lot of good things to think about. Over the summer did you take classes or take time off?

#15: I think I took another history class during the summer [laugh], then starting in fall I got totally focused. I had to take Calculus. I was really lucky to take Calculus at a community college, because math was always a challenge for me. The other thing was that I ended up, in spite of this, I had a minor in mathematics. I took Calculus my third year of college, my second year at the community college. I took all three quarters of Calculus and that was a wonderful place to do it because it's a hard class. It wasn't dumbed down for community college students; it was the same thing you had in a 4-year university, but you have smaller classes and you had more attention from the teacher and you had labs that you could go to and get help.

It was emotionally a real difficult thing for me to think that I was going to take all this Calculus because I believed that I was not good at math and that math was a difficult

subject for me. But being in the community college in that atmosphere, I was able to do it and be successful at it.

LZ: How did you brace yourself from the first to go into the Calculus classes? Many people, primarily women, look at what would be challenging, difficult, hard, make them feel stupid about trying to take math or computer science and say, "I just don't want to deal with this. I'll just major in psychology." What gave you the gumption to say, "I know this is going to be hard, but I've got to do it?"

#15: I'm not sure why, but I had taken the same term, that I took the computer science class, I took a math class. Thinking back on it now I have no idea why I would have done that. But, to answer your question, the reason I was able to tackle the idea of taking Calculus is that it was going to be taught by the same person who had taught that math class that I had taken in the spring. So, I knew who was going to be teaching it and I knew who he was like and I felt like I could trust him.

LZ: You knew what you were getting into with that particular teacher...

#15: Yeah.

LZ: This is all very interesting.

#15: There was absolutely no desire to take Calculus, there was no enthusiasm to take Calculus, but there was enough love of the computer science piece that, "OK, if that is the hurdle I have to get over, I'll get over it."

Also that year while I was taking Calculus I was taking a whole bunch of programming classes and there was only one teacher, and he was the brother of the guy who had taught the Apple Basic class, so I kind of had an advantage because this one brother told his other brother that "You're going to look forward to have T— as a student because she's really bright and she likes this stuff." I formed a fabulous relationship with the guy who was teaching all the computer science classes. We did COBOL and RPG and we did assembler and we did more BASIC. We took a lot of different classses and he taught all of them and I had a really good relationship with him and I love it. It was fun and interesting and relatively easy.

LZ: What about it did you like? What particular aspects about it were appealing to you? Aside from the fact that you knew you could get a job in it later on?

#15: I liked the logic. The fact that everything could ultimately be explained. If you didn't understand what you're program was doing because it had a bug in it, it seemed inexplicable you know? "Why doesn't my program work?" But then utlimately you'd figure it out and go "Oh! This is why." So it was that there wasn't a lot of ambiguity.

It was real cut and dry. I'm a pretty organized person and I think I had organizational skills that were real useful. In a way programming is organizing a process for getting something done. I think I had some natural abilities in that area.

And it was really important to me. I don't like being the "stupid" person in the class. I don't like being anything but just about the smartest person in the class. And so I think part of it was kind of like "Success breeds success". If you're doing well then just that very fact that you got this program done in a nice, elegant way and you understood what you were doing and why what you were doing worked. The fact that you were successful doing that once may make you more inclined to go do it a second time.

LZ: That's interesting because all of the topic areas you'd enjoyed up until then tended to have ambiguity in them. It seems like you were able to move in both of those realms fairly easily. That is rare. Most of my subjects indicated that they gravitated toward one end of the (cognitive) spectrum or another. Eventually I assume you transferred?

#15: Yes. So those two years at the community college I was working full time while I was doing all of this. Working full time, going to school full time. Actually some of the time I worked even more than full time because I had some tutoring jobs on the side.

LZ: What were you tutoring?

#15: Math and computer science.

LZ: Tell me more about that.

#15: I kind of wonder, why did I do that? I already had a full time job. But I must have...you don't know how you're going to get yourself through school. It was really important to me that I put myself through school. That's not how I felt when I got out of high school, but once I "dropped out" after that first year and moved away and established myself on my own, it was just really important to me that I prove that I could take care of myself. The opportunity to earn any extra money. And because I had such a wonderful relationship with that computer science teacher who taught everything, and I did have a good relationship with the Calculus teacher also, I did a little bit of tutoring very basic math and I did a little bit of tutoring computer science. And I also did just like, supervised the computer science lab. That wasn't more than 10 hours a week.

LZ: So it was essentially through your connections, your good relationships that you'd built with these teachers that they knew you were someone who knew what she was

doing and could help out in these ways to help the students who weren't getting it. That must have given you a huge boost of self-confidence.

#15: I don't remember.

LZ: I don't want to put ideas in your head, I'm just speculating. So, you're working your butt off...I can't even imagine working full-time and going to school...

#15: Well when you're 20 years old...I can't imagine it any more either [laugh]. So then I transferred to Washington State in Pullman, so that's my fourth year of college. It's about 3 hours east. I had to move. So I got there and I had all these transfer credits because I'd taken all these computer science classes at the community college, so I got all these basics out of the way.

So I signed up for the classes, like I had to take an EE class and I signed up for the computer science class that was supposed to be the one I would have taken next, and a math class that I had to take and something else. And I was totally and completely lost. There was no relationship between the computer science that I had done at the community college and what was being done at the 4-year college level.

Calculus is the same anywhere; that background was fabulous, but the computer science background, in terms of principles of programming it was fine, good. But in terms of details of knowing how to use a terminal or what languages they are programming in, I was totally in over my head. I completely panicked. I freaked out. I said, "What did I think I was doing?" Yikes! I'm failing these classes. I took a quiz the first week or two in EE and failed it and everyone in the class was saying what a ridiculously easy quiz it was and I just thought, "Oh my god! What have I gotten myself into?"

So I dropped my computer science class; I dropped my EE (electrical engineering) class. I went to the German teacher and said, "Please let me transfer into German...I don't care if we're three weeks into the term. I'll study! I'll make it up." I picked up a German class, and I can't remember what else; probably a history class. And I said, "I can't do this".

Now, at the time, computer science was a very popular major and you had to sort of prove yourself in order to get into the department. I had just transferred into the department. There was a certain number of slots for computer science and I had one of those slots. So what happened at the end of that term, one of the classes I was taking was linear algebra. It was really fun. It was so easy. I liked the teacher and got along with him. It was nice to be taking a math class that I could understand pretty well for a change, because I really struggled at Calculus. I worked hard at Calculus. I had to work really hard at Calculus in order to understand it. So I really enjoyed this linear

algebra class. At the end of that term, I can't remember, this might have even been a chance meeting, like I just saw this guy in the hallway. But I sat down and had a conversation with that teacher, and I said, "Well you know I'm in the computer science program, but I don't like it and I'm not any good at it and here's my history and my background and I don't know what to do, but I think I'm going to drop this major and pick up something else." And he said, "Listen. It's really hard to get into the computer science program now. Don't drop the major just yet." He said "Just start over. Pretend like none of the transfer credits were there and take the beginning computer science classes and see what happens." I thought well, OK, I'll do that.

I didn't have a lot of hope then that that would work out, but I was started to get worried; I had been in college for four years, I wasn't anywhere close to graduating, I don't know what I'm going to major in – yikes! So I signed up for that beginning computer science class. And it was one of those big lecture halls with 200 students in them, then sections that were TA'd with 30 people. The person who TA'd my lab for that computer science class is now my husband [laugh].

So this beginning computer science class, this one was really easy. It was like "this is fun..this is what I remember liking". Then because I had a lot of programming experience, when we started doing our first programs, I thought "I know how to do this" and I'd write these really well-organized, well-documented programs and did all the error checking and checked all the cases. My husband, he still remembers that very first program I turned in that everyone else's were three lines that barely worked and mine had all these comments blocked in it [laugh]. So he was really encouraging and over the course of that term our relationship started developing, which is not kosher, but it happens.

So then I got an enormous amount of encouragement from him and I did really well in the class. Now it was easy. I had all the background.

Now it's the end of my fourth year and I'm back to majoring in computer science, I'm just going to put my nose to the grindstone and I'm going to take nothing but math and computer science classes until I graduate. The CS major required that you had some kind of minor related to computer science. History really wasn't related, so that was out. I was trying to figure how I could take the fewest possible classes to get to graduation date. I realized that I had taken enough math and then I needed to have this focus anyhow for computer science program, so math was the easiest thing to put the focus on. And then I had some really bad experiences in some advanced math classes – really some horrible teachers. But I got through it.

LZ: Tell me how you got through it.

#15: I can't even believe how bad it was. Going back now as an adult, I would have been all over that department. You can't let a person teach like that. That's just irresponsible.

LZ: What were they doing?

#15: He had notes; he did not communicate with the students at all. He came up and talked to the blackboard, writing some equations there and then he said "Do these problems in the book". He did not teach. He had some strange personality.

LZ: But you had rediscovered computer science.

#15: And I'm good at it.

LZ: As you were revisiting the classes you had first taken, what was your experience with that?

#15: Then it was fine. The very first class that I had taken; the one that caused me to panic and want to drop out, when I got to that one it was like "no problem". It was challenging, it wasn't easy, but I was clearly capable of doing it and I was clearly as well-prepared as anybody else in the class. Then Jim, my husband, had kind of talked me up to some of the other professors and said "You know, here's this bright young student coming along." So that got me a little bit of extra encouragement. And I got a scholarship my last year that the department gave that helped with tuition. Also I ended up getting a job my last year teaching.

So my last year at college, I ended up being six years in college, that last year I got a job TA'ing the introductory computer science class. I got the opportunity to learn what it's like to stand in front of a class and teach. The biggest bonus of that was I got an office in the computer science building. That was a huge bonus in terms of spending evenings there doing homework and that kind of thing and having a place I could be and could work.

LZ: So at the end of six years...

#15: I was totally ready to be done! [laugh]

LZ: So had you gotten more involved with Jim?

#15: Yeah. So we got married the same month I graduated and he was living in Portland by then, so I had to find a job in Portland. I had done some interviewing down in California, but that was kind of pointless since we weren't moving there. I had been interviewed by Tektronix through the normal campus interviewing process

and had failed the interview; they weren't interested in me. So then Jim and a couple of his friends – Jim was working at Tektronix by then – gave me some advice on how I might revise my resume and submit it to Tektronix again. That helped me get a couple of interviews and one of those led to a job offer. So I graduated from college and got married and went to work.

LZ: A lot of change.

#15: Yeah, it was hard. It was really hard, actually.

LZ: So you had a lot of change in a short period of time.

#15: I was living in Pullman, then I graduated, went home for a weekend, got married and I had had my apartment in Pullman moved down to Jim's apartment in Portland.

LZ: What was the first job that you got at Tek?

#15: I was working on a linker, on an assembler. That was it basically. It was a software tool group, so I worked on linkers and assemblers. The very first thing – this is kind of interesting; I hadn't thought about this before, but it kind of parallels my college experience. The first thing they gave me to do, I couldn't figure it out. I didn't get it. It wasn't fun. I wasn't having fun. It was pretty stressful at first. They gave me an assembler to work.

As I figured out later, the reason I couldn't do it is they'd given me someone else's code that was so convoluted and I was trying to look at that as the model of how you were supposed to make one of these things work. I just couldn't do it. That was pretty discouraging. Then I worked on this linker and it took me longer than it should have, but in the course of working on it I learned a lot, got really good at C programming, which I had not done in school, so I pretty much had to learn that on the job. So by the time I was done working on the linker I really, really understood C programming. Then they gave me some more assemblers to work on and then it was easy because I wasn't trying to work on that other stupid person's code.

They had a tool that would create an assembler and you would just stick into the specifics for the microprocessor that you were writing the assembler for. Rather than trying to start with something else someone had screwed up, I just did it from scratch and that was fine.

The truth is sometimes it's better if it's not documented. If the comments are wrong, it's twice as bad.

LZ: Explain to me what is a linker.

#15: A linker is something that takes, it takes multiple, you have a bunch of different code modules that you've assembled and you've got maybe some libraries and you want to piece the whole thing together into one executable, the linker is what does that.

LZ: How long did you work in that position?

#15: I worked in that position a year and a half, then I transferred into the oscilloscopes group. What I did there was, they were developing a whole new digital oscilloscope and it was like a huge software project; fifteen people on it. I did a piece of the software.

LZ: How long did you do that?

#15: I did that for a year and a half.

LZ: And then what happened?

#15: Then my husband decided to go back to school and get a Ph.D., so we moved to Arizona and I got a job at Motorola. Phoenix.

LZ: That must have been quite a change.

#15: Yeah, it didn't work out. After about six months there it was clear to Jim that he did not have the patience to get a Ph.D. [laugh]. And we didn't like...we loved Portland, so we only stayed there about nine months and moved back to Portland. I took a couple months off. Jim got his old job back at Tektronix and they moved us back up here. Then I started doing contract work. This was in 1987. I went to work for a really small company that was just getting started that was doing contract work and that's when I discovered that I really loved working as a contractor, way better than being an employee.

LZ: Tell me about that.

#15: Several things. One thing is that you're paid hourly. A lot of times as an employee you'd work these 60 hour weeks and you're on salary. You just get paid the same regardless. And if you do by some miracle get done early you don't feel like you can leave because you're obligated to work a 40 hour week. Being paid hourly where if you were putting in the extra hours you were getting the income to match that and if you got done early you could leave without feeling guilty about it – that just really fit for me. And then also working as a contractor is much less political. You don't get involved in all the political shenanigans that you do as an employee.

I actually ended up being sent back into the oscilloscope group at Tek as a contractor. So I had the perfect opportunity to compare and contrast my experiences. It was so much better being a contractor. It didn't matter who my manager was and all the politics amongst the managers of whose going to get promoted and whose side should you be on and what you do to get a good review and get a raise. All that stuff is just irrelevant. You've got a software engineering task to do and you do it and do it well, then they're happy with you and it's very straightforward.

I also enjoyed the variety being a contractor going from job to job. It was really good for me. It was hard – I remember that first job at Tek that was so difficult. Being put in a position and where you had to start a new job and start a new job I realized "Hey, this is a skill that can be learned...if you practice this often enough you can get good at it." It was more low-key, more flexible. It got more comfortable for me to go into new places and start a new job and see how different businesses were run. I really liked being a contractor.

So then what happened is the guy who was running that business shut it down and a group of engineers who had been working for him, including myself, started the business that I am still part of...that started in 1990. The past 5 or 6 years I've been doing pure management; no engineering.

LZ: What has that been like?

#15: How shall I answer that question [laugh]? I'm burned out on it right now. I'm really burned out on it. People have asked if I miss it (the programming) and I don't really miss it. It's extremely useful, being in the position that I'm in, that I have the real hard-core technical background because one of the things I'm doing is I'm going out and trying to sell our services to clients and so I go in and talk with a lot of first line engineering managers and I totally know what they are talking about when they talk about schedule flippage and system architectural issues and documentation and process and life cycles of code and all of that. I've been through all that stuff; I totally understand. I've been there. So I'm very credible when I'm talking to them and that's really good.

But I'm at a point in my life right now where I'm really thinking about all these things that I used to be interested in, like history and like foreign language and I'm really getting burned out on high tech; just the constant, constant change in the field. The fact that I look at my sister and I really envy her. She's a structural engineer and she learns these equations that apply to these materials, like you know you have a steel slab or a concrete slab or a steele beam and those equations never change for how the beams support the building. She learned her field once and just keeps getting better and better at it, practicing it. In computer science, the operating systems are changing, the hardware platforms are changing, the languages are changing, the libraries are

changing, the whole model is changing. It's exhausting. So even though I'm not having to do that anymore, my technical skills are pretty much atrophied now. It's just being in a field where that constant change is going on is wearing on me.

LZ: Why do you think there has been a decline since 1980 in women going into computer science?

#15: You know, I have thought about that a lot. My husband now teaches computer science at Portland State and PSU has a female head of the computer science department which is nice and there are some women on the faculty there. There were no women on the faculty when I went to school. Jim is, I think, very supportive of women. On the one hand I'm sort of prejudiced saying that. On the other hand I'm a good example of how he would be supportive of women because he really helped me go through. So it's kind of hard for me to separate my thoughts out about what are my thoughts versus what are Jim's thoughts that he's told me versus what some of his colleagues have told me and suggested.

But based on my own personal experience, the difficulty about computer science, I think one of the reasons there aren't as many women in that is because of all of the required classes that you have to take in order to take a computer science major. You can't just go in and be good at computer science. I was very lucky I didn't have to take Physics because I wouldn't have made it if I'd had to take Physics. But you have to take all these Calculus classes and you have to take, it's like computer science hasn't really grown up and become a discipline of its own yet. It's still attached to its old engineering background or its mathematical background or something like that. So it's hard to go in and do something that's pure computer science and I think if you could do that, present it that way, I think more women might be attracted because it wouldn't look like there were so many barriers that have to be surmounted in order to get there...I never used Calculus except to get through differential equations and I never used differential equations, you know and double E.

LZ: So what I hear you saying is that computer science as an academic discipline needs to tie in more to what industry needs really are or how field actually is in the working world?

#15: Yeah, it should be a little less...computer science is by no means a science. It may be someday, but we all know it's not right now [laugh]. No one can come up with a schedule and can say for sure that they can meet their schedule. We don't know how long these things are going to take. We can make some educated guesses and do some things to make our schedules come in a little bit closer to what we want them to be, but there's still a lot about the field that's not know or understood. I think if, at the educational level, that would be accepted and computer science stood more as a

discipline instead of as a part of math or a part of engineering or something like that, maybe it would be a little more accessible.

Now this is really, this statement is very much colored by my own experience because I really resented having to take all these classes that were really hard for me that were just required that were irrelevant to anything I ever did. Yeah, sure, somebody may be a computer science and end up in a field where you have to know your math, but you might equally end up in a field where you have to know your accounting.

LZ: What I hear you saying, and correct me if I'm not interpreting this correctly, is that computer science has, as a discipline, has to engage in a little more self-reflection about how people get through the program and what parts are useful and what parts are not useful?

#15: Yeah, what's reasonably important? What is this discipline all about? Do you really need? What are you going to use when you're out in the field? And I don't want computer science to turn into something where it's just training for industry. I really believe in the idea of a 4-year college education and a broad solid ... it's more important to teach people the principles than to teach people exactly how the MST class libraries work. But I think computer science could do that and could retain a strong sort of structural foundation. I'm not suggesting that it should become a lot of training classes.

LZ: I hear what you're saying. There are a lot of things that were problematic in my brief attempt to take programming classes. There were all these debates and conferences in the 1960s between engineering and mathematics. There was a huge desire to prove themselves as a discipline. I think they just threw every single thing they could in to prove that they were a real discipline "We're going to be hard enough that we're going to have respect in the academic world", but only a small percentage of people who get their Bachelor's in computer science actually go on and obtain Ph.D.s in computer science. It seems like we are not in a place of balance yet. We're either in totally vocational work or totally academic with no middle ground happening.

I'm interested to hear if there are classes your husband is teaching and what is his perception of the field as an academic discipline.

#15: He's teaching mostly graduate classes. Mostly networking, like TCP/IP and routing. Sometimes he'll teach an undergraduate operating systems class. He says he sees about the same number of women in the field that he and I saw back when he and I were in school back in the early 1980s. Sometimes even fewer. Now that I try to think what he says...it's not coming to me now.

LZ: You can always email or call me with these ideas. What are your thoughts with how we as a society can possibly encourage more women to go into this field?

#15: I did not put any notes near that question because I actually, the short answer is I don't know. I'm really not sure. I don't have any strong opinions about if we did this it would help. I do think that encouraging women in math and science more in the early years is a good thing and there are a lot of good programs, like AWSEM, that do that. When I look specifically at my own experience, what made the difference for me was mentoring; having those teachers that really paid attention to me and encouraged me. I don't necessarily think that I would extrapolate that out and say that that's the answer. You know there are mentoring programs out there. More mentoring programs may not be the answer.

LZ: There is no one answer to this. I'm just interested in talking to people who've been in the field what their theories are about that. You're right, there is no one fix. Certain things that might help encourage one person might have absolutely have no impact on another person. It sounds like you did have a hugely supportive environment in the community college environment where you were. Perhaps without that particular setting where you were, if you had started at Washington State...

#15: Oh yeah, yeah.

LZ: Some people can deal with that environment (of large lecture halls) and some people need to have a smaller class setting as you described where you have more attention from the teacher in helping you work out problems and whatnot. Is there anything else you would like to add at this time.

#15: Not that I can think of.

LZ: Thank you.