# GENDER CODES

## Why Women Are Leaving Computing

Edited by

**Thomas J. Misa**



**A John Wiley & Sons, Inc., Publication**

# Gender Codes

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In memory of Karen J. Freeze (1945–2009), scholar and colleague, who in her life successfully bridged notable divides between nature and culture, industry and academe, research and family, and East and West.

# Contents

# Foreword

In 1966 there was already a "manpower" shortage of trained (or even untrained) programmers, operators, and software designers. The situation became a crisis when an estimated 50% more programmers would be needed by 1967.

It was an exciting time—the Mercury and Gemini programs sent humans into space and the Apollo program landed them on the Moon and returned them safely to Earth. The effort fulfilled President Kennedy's goal when he said that "no single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish."

With this kind of presidential mandate, there were free-flowing funds in collecting the workers, and there were no barriers to race, religion, political leanings, or gender. Just about anyone who could pass an aptitude test, believed in the mission, and loved challenges in logical thinking was brought on board. The work was centered around the computers and the control systems that launched astronauts into space, and not on ambition or power—it was amazing that so many people could be coordinated and committed so that each person felt he/she had a part in the work. That gave us all a sense of pride.

I was lucky enough to join the ranks in 1965, when the National Aeronautics and Space Administration (NASA) and its subcontractors were hiring a cast of thousands. The desperate need was primarily a call to arms due to the Cold War and the race for space—using a new technology only increased the challenge!

Of course, we must admit that there were hurdles as well as successes. Sadly, the struggles have not always been brought to light, nor have they resulted in learning experiences. Where I worked in 1965, men and women programmers and program designers sat together in offices (pre-cubicle), shared ideas, and acted as sounding boards for each other. We had comfortable and equal working conditions, supplies, and equipment. Following a design, we wrote—by hand—computer program instructions on large coding pads (80 columns per instruction, the same width as a Hollerith punched card). A courier

came by twice each day, picking up the coding pads and delivering yesterday's instructions that had been magically translated into a different physical medium—card decks. Put some paper on a cart one day and presto, the next day, a stack of $7\frac{3}{8}$ inch by $3\frac{1}{4}$ inch, stiff paper sheets with holes punched in them were delivered. These cards constituted the program, which was sent to the machine room where operators fed the decks through the card reader. (Remember, this was the mid-1960s.)

What I did not think about then was that the machine room, where the programs ended their journey, was cool (it had to be—the older mainframe computers put out a lot of heat), the operators had some authority, and they were male. By contrast, the "support" room in the basement housed the female keypunchers. It was hot and stuffy and filled with rows and rows of machines where the women sat in front of the card punch machines all day. Keypunching was mind-numbing, the breaks were seldom and short, and the data had no meaning to the keyboardists. (This is not to denigrate the job or the need for it—members of my close family were keypunch "girls.")

Unfortunately, these women were often blamed for errors in the deck, which then became errors in the program—it was easy for a programmer, any programmer, to shift the blame when necessary. This resulted in instituting a verification procedure where each punched card deck had to be rekeyed, using the exact same data, by another woman, making the reward system (based on volume) even less meaningful.

During this time period, I knew several male operators who, without a 4-year degree of any kind, were promoted into the ranks of programmer, seemingly because they were skillful at reading hardware signal lights, fanning card decks, hanging tapes, mounting disks, or even just putting printed output on delivery carts. These were important, necessary activities, carried out by some incredible young men. However, it isn't at all clear how those duties translated into a talent for programming. Keypunchers, who also performed mostly physical tasks, were rarely (never, in my experience) selected for aptitude tests or invited to an interview that could have led to an elevated position. I never knew of a single woman keypuncher who was promoted into any other rank, with the possible exception of women who were elevated to group supervisor, and then they had to stay in the same hot room. I wish I were relating only an individual experience and not the norm, but there is evidence that this situation was prevalent and has been recreated in many ways.

In 1969, the Data Processing Management Association (DPMA) awarded its very first "Computer Sciences Man of the Year" award to U.S. Navy Commander Grace Hopper, eventually to be Rear Admiral Hopper. She was already famous as the "inventor" of COBOL, a programming language that was close to natural speech (English)—for many years the most widely used language in computing. On three different occasions I drove for hours just to hear her captivating and motivating speech. Now she was a role model.

Women continued to enter the field of computing, not only as "keypunch girls" but also as professionals and educators who could employ their mathematical or engineering education or proclivities, in unprecedented numbers during the 1960s and 1970s. Many, maybe most, of them greatly enjoyed their experiences.

There were the pros and cons of being female in the computing field then, just as there are now. The disadvantages still exist, but they have morphed into different ones and are shifting the workforce culture in an unhealthy direction that threatens the future of a profession that still needs diverse participation and input to support our undisputed computer-reliant life.

In this book, the chapters provide a fresh and constructive look at potential reasons for the growing imbalance in gender, exploring the different reasons for the evolution of a profession that has become as male coded as the computing profession now is. While the first wave of programmers and analysts worked in a relatively unsegregated environment, the current computer workforce (across all sectors, including government employees, small business owners, entrepreneurs, chip designers, space-race programmers, and game developers) has become ordered and structured as primarily male.

While Thomas Misa and his colleagues search for answers, they assume no conspiracy theories. There is no diatribe against the male gender, nor does anyone fan the flames of the early feminist movement. It is simply a fact that the last 25 years have seen an increasing imbalance in gender in the computing profession. Most other science and technology sectors actually demonstrate steady growth in the number of female participants. Clearly, something odd happened in computing.

This book is, at times, brutally honest: women are practically absent from the historical literature on computing. They made significant contributions in all segments of the computer industry, yet they had to fight for respect and funding, and too often they lost.

This book gives voice to historians as well as practitioners—those who experienced the heyday, those who are trying to understand it, those who report it, and all those who are trying to change it. The book takes a fair look at this complex issue, is true to history, presents an international perspective, and without judgment explores the strange and unsettling phenomenon that we are now living with: only the male half of the population is working to achieve the potential of computing. And, with the diagnosis that computing's public image is radically out of step with computing's actual practices, the book presents a clear way of moving forward.

If I had had a crystal ball in 1965 and realized what 2009 would look like, it might have been easier, or more obviously important, that we should strive to preserve the culture of the "golden age" of women in computing, while helping it to mature and evolve to meet today's technical challenges. And, by all measures, to be fair.

LINDA SHAFER, CSDP
*IEEE Computer Society Press Chair*

# Preface

We don't normally think of academic publishing as a contact sport, but this volume was born with bruises on my arm. We were planning a workshop at the Charles Babbage Institute (CBI) and enjoying the process of framing a much-needed historical assessment of gender and computing. We knew it was a respectable topic. Scholars from many different backgrounds and traditions had in recent years put gender on the academic map. The exploration of gender and computing history was long overdue. After all, there must be something in the many hundreds of photographs we'd seen over the years showing "white guys with computers."

When introducing the CBI workshop to my colleagues in science and engineering, I explained how gender had become a useful category of analysis in the social sciences, and our aim for bringing gender analysis into the mainstream of computing history. Often, I didn't get more than two or three sentences into the spiel when a female colleague grabbed my arm and said: "no, you don't quite understand—what you are doing, gender and computing, is important, really important." My technical colleagues had gone through graduate school and started their careers in the midst of the women's movement, and many had struggled in their careers and institutions with its ambiguous successes. They wanted to *understand* gender and computing, but they also wanted to *change* the existing state of affairs. This volume took form with both these aims in mind.

We were fortunate to draw on a growing interest in the gendered aspects of computing. Educators, administrators, managers, and scholars share an interest in better understanding how computing has emerged and become part of contemporary culture. Computing educators are justifiably concerned about flagging computer science and engineering enrollments, while administrators and managers at all levels strive to recruit and retain a more gender-balanced workforce. Scholars in computer history can appreciate that gender is a useful category of analysis, and that gender studies of computing are urgently needed.

To identify promising themes and possible contributors, we formed a steering committee consisting of Janet Abbate (Virginia Tech), Veronika Oechtering (University of Bremen), Jeffrey Yost (Charles Babbage Institute), and myself.

Bringing these educators and scholars together for a weekend in May 2008 depended on material support from several sources. At the University of Minnesota, we are grateful for essential financial support from the Institute of Technology Dean's Office, the Computer Science and Engineering Department, the Electrical and Computer Engineering Department, and the Program for the History of Science, Technology and Medicine. International travel was funded by the University's Office of International Programs and the Deutsche Forschungsgemeinschaft (German Research Foundation). Everything we do at the Charles Babbage Institute represents a unique partnership between the founders of CBI, with their prescient vision of supporting a research center for the history of computing, and the longstanding institutional support from the University of Minnesota's Institute of Technology, the University Libraries, and the Program for History of Science, Technology and Medicine.

We are fortunate also for first-rate staff at CBI. R. Arvid Nelson, CBI's archivist, developed a special museum exhibit entitled "Gendered Bits: Identities, Practices, and Artifacts in Computing" in cooperation with in-house professional designer Darren Terpstra. These materials were physically installed in Andersen Library during the summer of 2008 and will be made available permanently via an online exhibit. (Images of the installed exhibit, as well as literature and background materials for the workshop, can be found at umn.edu/~tmisa/gender/.) Katie Charlet took charge of registration and played an essential role in preparing this volume for publication, including translations from the French (again!), while Jeffrey Yost and Stephanie Crowe assisted with preparations and logistics.

Gender studies of technology and science have an active interdisciplinary journal literature in *Signs*, *Women's Studies*, *Gender and Society*, and *Social Studies of Science*, *Technology & Culture*, as well as key books, including those by Roger Horowitz (editor), *Boys and Their Toys?* (New York: Routledge, 2001); Donna J. Haraway, *Simians, Cyborgs and Women* (New York: Routledge, 1991); Donna J. Haraway, *Modest_Witness@Second_Millennium* (New York: Routledge, 1997); Nina E. Lerman, Ruth Oldenziel, and Arwen Mohun (editors), *Gender and Technology* (Baltimore: Johns Hopkins University Press, 2003); Ruth Oldenziel, *Making Technology Masculine* (Amsterdam: Amsterdam University Press, 2004); and Roger Horowitz and Arwen Mohun (editors), *His and Hers* (Charlottesville: University of Virginia Press, 1998). For computer history, see the special issue introduced by Janet Abbate, "Women and Gender in the History of Computing," *IEEE Annals of the History of Computing*, Vol. 25, No. 4 (2003): 4–8. Our gender and computing bibliography can be found at www.umn.edu/~tmisa/gender/literature.html.

THOMAS J. MISA

*Minneapolis, Minnesota*
*March 2010*

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# Tools for Understanding

I

# Gender Codes
## Defining the Problem

# 1

THOMAS J. MISA

Women have passionately programmed computers for many decades. Ada Lovelace wrote abstract programs for calculating Bernoulli numbers on Charles Babbage's mechanical computer, and six women mathematicians, known as human "computers," created working programs for the ENIAC computer during the Second World War. In the 1950s the pioneering generation of computer science featured a surprising number of prominent women who led research teams, defined computer languages, and even pioneered the history of computing. The annual Grace Hopper celebration, named for the most prominent of these pioneering women computer scientists, offers "a four-day technical conference designed to bring the research and career interests of women in computing to the forefront"[1]. More recently, Elizabeth "Jake" Feinler defined the top-level domain names—.com, .gov, .org—for the Internet. In 2006, Fran Allen, already the first female IBM Fellow, was the first woman to win the prestigious Turing Award from the Association for Computing Machinery, for her work in optimizing computer code. Two years later, Barbara Liskov was awarded the Turing Award for her foundational work on programming languages. The list of notable women in computing is sizable and expanding. It's strange anyone would think that women don't like computing.

Since the 1970s women have made impressive gains in professional life, but these gains did not extend evenly into the fields of engineering and the physical sciences. Greater gender parity has typified most professions in the past two decades or so, with women making up half or more of all graduate or professional students: this is true for law schools and medical schools as well as most fields in the social and biological sciences. Engineering and physical

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sciences started with rather few women, at all levels, and have been making slow if steady progress in enrolling more women students and hiring more women faculty and scientists. Retaining women scientists and engineers at mid-career remains a challenge. But when you look at the college enrollments and workforce figures for computing, a strikingly different picture emerges.

There's no way of putting it except to say that computing is unique among all the professional fields. You can see this most clearly when looking at the "big picture" across the last 40 years and identifying which of the technical professions women opted to enter and when they did so. The first distinction for computing was an early upside in women's participation. Beginning in the mid-1960s, women entered the emerging computing profession and eventually did so in unusually large numbers (Fig. 1.1). In the United States, women went from being roughly one in ten in the undergraduate computing cohort to being nearly four in ten. At the peak in the mid-1980s women earned 37% of all U.S. bachelor degrees in computing, and across these decades women entered the computing workforce in large numbers. In the late 1980s, women constituted fully 38% of the U.S. white-collar computing workforce. This was a significant success for computing and for the women's movement. Chapters in this volume describe why, for roughly two decades, computing attracted so many women.


Figure 1.1. Woman studying linear programming. For recruiting, Honeywell created a positive image of women programmers in 1969. Women, such as Christine Johnson, composed one-third of the opening class of 40 at Honeywell's Wellesley Hills, Massachusetts, education center. (Courtesy of Charles Babbage Institute.)

We need to better understand why women elected to study *computing* in such large numbers. Why not chemistry or physics or engineering or one of the other technical professions? Men through the 1960s soundly dominated all of these fields. In this book we explore why large numbers of women experienced programming and other computer-related jobs to be more congenial than working in science labs or in engineering offices. We show that women worked

as programmers, as systems analysts, as managers, and as computer executives. In the mid-1980s, while women flooded into computing education and from there into the computing workforce, there were proportionately more women in computing than anywhere else in the engineering world. Medical school was to a large degree still a boy's club, with sizable increases in women medical students just beginning. (Only psychology and certain of the social sciences had equal numbers of women and men; and, of course, the professions of nursing, teaching, librarianship, and social work were, from their origins earlier in the 20th century, distinctively hospitable to women.) This book tells the stories of women computing professionals, including accounts of their struggles and celebrations of their successes. The chapters also give visibility to the many women who worked in lower-status and lower-pay computer occupations, such as operators and data-entry clerks (Fig. 1.2).

Despite these early successes, something unprecedented in the history of the professions hit computing in the mid-1980s: not merely did women stop entering computing in large numbers, but the proportion of women studying computing actually began falling—and it has continued to fall, steadily, all the way through to the present. No other professional field has ever experienced such a decline in the proportion of women in its ranks. The latest figures from the National Science Foundation (NSF), the Computing Research Association,

Figure 1.2. Women as computer operators. Publicity images often used attractive women models to sell computer systems. But many women actually worked as computer operators, here on an OCR data-entry system, a decided step up from data-entry work (compare Fig. 1.6). (Courtesy of Charles Babbage Institute.)

the Department of Education, and the Bureau of Labor Statistics using various measures and methodologies all tell the same story: women are staying away from computing education and the computing workforce. The most recent NSF figures suggest that women may account for just one in seven undergraduate computing students, or around 15%: a catastrophic drop from the peak of 37%. The Taulbee survey of top-ranked North American computer science and engineering programs puts the recent figures even lower [2]. A minuscule 0.4% of first-year women college students list computer science as a probable major, while as recently as the early 1980s it was fully ten times higher. Even when combining computer science with information science, which has more women students, the trend is unmistakable—and it is down [3].

We initially thought this drop was "only" a problem for academic computer science, but closer inspection of the data indicates there has been a gender-specific tail-off in the computing workforce as well. Recent figures from 2005 indicate that women composed just 29% of the white-collar computing workforce, down nearly 10 percentage points from the 1980s. Clearly, this is not merely an academic problem. Of course, not all practicing programmers have computer science degrees, and indeed only around two-thirds of working programmers and systems analysts have 4-year college degrees of any sort. A large number of computer professionals enter the workforce with associate degrees or other vocational training. (Gender statistics for these vocational programs are not carefully scrutinized by national policymaking bodies; the same goes for proprietary courses offered by Microsoft, Oracle, and other companies.)

A recent report from the Harvard Business School anatomizes the sharp falloff of women in science, engineering, and other technical companies. Most women continue work in these technical fields, including computing, for approximately 10 years—and then fully half of them leave the workforce. This mid-career exodus is not the result of women's "choices" or "preferences" (as some commentators suggest) because, after all, these women actually chose those professions. Rather, "more than half of these women [working in science and technology fields] drop out—pushed and shoved by macho work environments, serious isolation, and extreme job pressures" [4]. This loss of women's talent is alarming. Figures that we obtained from the U.S. Bureau of Labor Statistics indicate that women's presence in the computing workforce is falling off as well. Worse, the falloff in workforce closely follows the downturn in undergraduate computer science graduates—with perhaps as little as a 3-year "lag." If women were leaving the computing workforce after 10 years, that would be bad enough. It appears that the fall in enrollments, number of graduates, and computing workforce numbers are closely related. Indeed, we suspect that the educational and workforce tail-offs together actually reflect some broader, as-yet-unrecognized social or cultural shift. If the employment figures continue to fall as abruptly as the enrollment figures might forecast, then the computing workforce will soon become one of the most gender-segregated professional environments. Computing might return to its gender composition of the 1960s, but the rest of the world has moved forward.

A pressing question that this book addresses, and for the first time with historical data and analysis, is how and when and why women's participation

in computing fell so dramatically. This lopsided change in computing's gender balance in the past two decades is entirely without historical precedent. Some of the technical professions appear historically to be resistant to women's entry, such as surgery or civil engineering; yet no other profession has seen the upswing and downturn of women that is strikingly evident in computing. There have been wide swings in the enrollments and employment of varied branches of engineering, as one field or another comes into fashion or falls from favor; these swings are not accompanied by any similar long-term decline in women.

## FRAMING THE GENDER GAP

The dramatic falloff of women in computing is hardly a secret. In 1991 Ellen Spertus, then an MIT graduate student, wrote a paper asking, "Why Are There So Few Female Computer Scientists?" The problem was not so much formal discrimination or overt barriers to women, but rather gender biases encoded in professional culture. Among her findings, Spertus reported a professor introducing robotics to a graduate artificial-intelligence class by telling this would-be joke: "Pretty soon we'll have robots that are sophisticated enough to wander around in shopping malls and pick up girls." Unsurprisingly, the female graduate student who related the episode hardly heard the rest of the lecture. In the years since Spertus's report, the situation has not gotten better. "What Has Driven Women Out of Computer Science?" was one recent headline. "Lack of Women in Computing Has Educators Worried," goes another. The *IEEE Spectrum* [5] warns that the "gender gap is widening."

The gender gap in computing now concerns professionals in the field as well as educators concerned about the composition of their classrooms. Women's absence has contributed to a sharp contraction in U.S. computing enrollments: in 2001 there were 400 majors in each computer science (CS) department, while today there are just over 200. In recent years, the National Science Foundation has put around $20 million annually into various research and demonstration efforts aimed at increasing the participation of women in computing and other science and engineering fields [6]. Educators from K-12 through graduate school encourage young women to study math and science as well as to major in engineering fields, including computer science and electrical engineering. Professional associations mobilize high-level committees of educators and practitioners. Some researchers examine gender as an important variable in designing software and human–computer interfaces, addressing a gender bias broadly similar to medical researchers' past assumption that men's bodies were the normal ones [7]. And science museums, science-fair mentors, Girl Scout leaders, and many others present positive views of science and technical fields as approachable, exciting, and relevant to young women as they plan careers. It's difficult to assess their impact, but it's a safe bet that absent these wide-ranging efforts the worrisome figures on women in computing might be even worse.

We believe that there is some "missing piece" to this picture. Our book is aimed—in three distinct ways—at assisting these reform efforts and, we hope, changing the culture of computing. First, we offer forceful *historical data* documenting the gender gap in computing. It's very clear that smart people have

devised many intervention strategies, based on intuitively plausible models of the underlying problem [8]. Yet, surprisingly, not enough is known about how and when and why the gendered culture of computing emerged. This book addresses these very questions. We hope historical insight can improve the outcomes for the wide-ranging efforts at change. Richly textured case studies of women's struggles as well as their own strategies for success, in gaining computing education as well as working for and even running computing companies, can help evaluate and refine these intervention strategies. While we know that women flooded into the computing professions in the 1960s and 1970s, we know all too little about why they did so and what they found there. Women's experiences in the computing workforce are similarly underdocumented and poorly understood [9]. In this book we present fresh evidence of women's striking successes as computer scientists and as entrepreneurs in the computer services industry. This book also documents women's exclusion from high-level computing positions and marginalization within the computing professions. These stories, too, give a more complete picture of the problem.

A second contribution of this book is to offer *tools for grasping the dynamics* of the gender gap. The computing profession changed dramatically across the past three or four decades. We need to record the stories but we also need tools for understanding what was going on, what might have gone wrong, and, for those early decades, what clearly went right with women in computing. Historians, by our disciplinary training, are ideally equipped to understand complexity and change across time. Historians study social processes as well as cultural dynamics; as a profession we deal centrally with language, representations, cultural forms, institutional practices, social and political processes—and power. "The study of computer science education can be seen as a microcosm of how a realm of power can be claimed by one group of people, relegating others to outsiders," as Margolis and Fisher argue in *Unlocking the Clubhouse*. There are "weighty influences that steal women's interest in computer science away from them" [10]. Historians' contributions frequently involve not merely accurately reporting the facts, but also unpacking complex terms at play. Here, it is certain that we need to unpack the terms "women" and "men" and "computing" and to set these into a dynamic framework. Women faced different expectations about gender roles and career paths in the 1960s compared with the 1980s, while computing during these decades was transformed from large mainframe-based installations to the profusion of personal computers. It is worth noting that women flooded into computing during the mainframe era as well as that the sea change in gender occurred during the rise of personal computers in the 1980s.

This book profiles the astonishing diversity of women's experiences in the "computing profession" as well: they worked as highly paid programmers and systems analysts and managers, as well as lower-status operators, data-entry clerks, and maintenance workers. Some of these women, especially ones with managerial or executive responsibilities, are at the upper scale of white-collar work, while the lower-status jobs are squarely blue-collar ones. A key process that we document and analyze is the "feminization" of work as well as the "masculinization" of the professions. This book highlights how computing is understood in gendered terms and how it is represented in popular culture.


Figure 1.3. "Computing = Development" for Ivory Coast women. Ivory Coast stamp from 1972 surrounds a woman with computer images, including an IBM mainframe, punch cards, and core memory. In French, *informatique* can be either computing or the discipline of computer science. (Courtesy of Charles Babbage Institute.)

It is probably happenstance that the movie "Revenge of the Nerds" (1984) appeared just as women's enrollments in computer science were peaking, but there is some relationship between popular culture and the computing culture. We believe it is no coincidence that the sea change in gender of the 1980s closely paralleled the emergence of male nerds in popular culture as well as the rise of distinctly gendered computer gaming, now a multibillion dollar industry (see below). All the same, the mass media's amplified masculine image of computing is clearly a misleading one. Media images of computing are even less gender balanced than the actual practices of computing (see Chapter 12).

Finally, this book frames the problem of gender and computing in *international and comparative terms* (Fig. 1.3). Much thinking about the gender gap so far has taken the United States to be the normative case. Certainly, in the global economy of today, any uniquely national perspective is increasingly irrelevant. A recent CRA-Taulbee survey indicates that students from outside North America make up 59% of entering Ph.D. students in computing at North American universities. Computing professionals increasingly work in thoroughly international and multicultural environments, whether for large multinational companies or even in smaller entrepreneurial start-ups. We need to know how divergent perceptions and expectations regarding gender interact in this multicultural environment: this is the daily work experience for thousands of computing professionals today. This book presents historical cases and contributions

that begin a much-needed international and comparative analysis of gender and computing. The chapters include substantial material on Britain, Germany, Greece, Norway, and the United States as well as briefer comparative reflections on other countries. It's a modest step to a more thoroughly global picture [11].

## STRATEGIES FOR REFORM

Before turning to the detailed contributions of this book, we should give an overview of the reform efforts underway today. The favored intervention strategies aim at increasing the number of women in the computing professions, at both the undergraduate and graduate levels as well as in the ranks of faculty and in the wider workforce. The results of reform are not always easy to determine, especially with the persistent, long-term decline of women in computing. Social scientists and educators have identified five "explanatory factors" that underpin most existing interventions and experiments [12]. First, who feels welcome in the computing classroom or workplace—and who feels out of place—is shaped by experiences and even more strongly by entry barriers. When undergraduate computer science programs began requiring prior programming experience for introductory level classes, they did not intend to send a negative message to women but all the same that is exactly what occurred. It so happened that young men interested in computing had frequently done extensive after-hours programming at school or at home, but relatively few young women interested in computing had done so. The requirement of prior programming experience constituted a gender-selecting entry barrier. Indeed, recognizing this problem, some computer science programs have restructured introductory courses to focus less on programming prowess and more on conceptual issues.

Second, the topics treated in a computing curriculum as well as the examples used to illustrate them can be more or less gender-specific. For years, programming assignments did computations with professional football scores or baseball statistics. At one high school a woman student using football statistics in a programming exercise "was ridiculed because she used the name of a baseball team instead of a football team" [13]. (Some have suggested knitting diagrams as an alternate way of studying algorithmic thinking [14].) Some recent research suggests that women as well as men respond positively to course assignments that show how computing can make a difference in the wider world (Fig. 1.4). "Their motivation for learning computer science very much hung on the purpose that computing was going to be used for," suggests Jane Margolis, co-author of *Unlocking the Clubhouse: Women in Computing*, about women computer science students at Carnegie Mellon. "It wasn't just hacking for hacking's sake. There was a real social context that gave them motivation and meaning" [15]. Students transferring into computing majors from other disciplines, such as the sciences, also may require computing programs to offer catch-up courses.

While for years computer science programs were notoriously "hard"—frequently a large lecture class functioned as a wash-out course to thin the ranks [16]—it's become apparent that women were disproportionately hit by such treatment. Computer science programs are now actively looking for ways to