COMPUTERS

Although computers became a pervasive part of daily life in the United States toward the end of the twentieth century, little has been written about the history of labor in the computer industry. More common are studies of technological innovation, the contributions of key individuals, and the consumption patterns for computers and related technologies. In most of these analyses, labor—particularly blue-collar labor—is an invisible or marginal factor.

Moreover, writing a labor history of the computer industry raises several difficulties. The sheer ubiquity of computers in the late twentieth and early twenty-first centuries in the United States and the broad scope of the industry make it difficult to categorize and draw general conclusions about the labor being performed. Computing includes work in microelectronics manufacture, telecommunications, software publishing, and many other areas. In a 1986 study, the National Research Council divided the computer industry into categories: engineers, computer specialists (including computer scientists, programmers, and software engineers), technicians, operators, and production workers. However, these categories do not account for the large numbers of nontechnical workers in the computer industry, such as those in sales and administration. Growth in online commerce has further diversified the computer industry and blurred the boundaries of traditional labor classification. Because much of our knowledge of computer history derives from the surviving corporate literature, which depicts events and practices from the perspective of management, certain forms of labor are more prevalent in the literature than others.

Early History

Objections to computerization have often framed computers as the enemy of workers, automating their work and performing with greater speed and efficiency the tasks previously undertaken by humans. However, before 1945, the term “computer” referred to a human being, usually a woman. Human computers performed the tedious calculations that filled mathematical tables used for astronomy, maritime navigation, advanced mathematics, ballistics, and other applications during the eighteenth and nineteenth centuries and the first part of the twentieth century.

In the nineteenth century, the mechanization of information processing paralleled industrialization. In 1821, the British mathematician and inventor Charles Babbage modeled his “difference engine,” a machine designed to automate the process of producing mathematical tables, on the division of labor advocated by Adam Smith in the Wealth of Nations and the intellectual division of labor found in the human table-making “factories” such as those in Napoleon’s France. However, Babbage was also an economist best known by his peers for the book On the Economy of Machinery and Manufactures (1832), which surveyed manufacturing processes of the period. Economics, manufacturing, and information processing came together in Babbage’s subsequent plans for a more general “analytic engine” (1856). Using the nineteenth-century textile mill as a model, Babbage expanded his design for the difference engine to create a more general machine that shared many characteristics found in modern computers, such as memory, the ability to accept programmed instructions, and a central processing unit that he aptly called a “mill.”

Across the Atlantic in the United States, Herman Hollerith, an engineer who had worked as a clerk for the U.S. Census Bureau, created the first tabulating machines to save census workers the daily drudgery of computing data by hand and to reduce the time needed to compile census results. With the introduction of tabulating machinery for the 1890 census, government clerks punched data for each U.S. resident onto a perforated card; Hollerith’s machinery then tabulated and sorted the information. Each clerk punched an average of seven hundred cards per day, and more than 80 clerks operated the tabulating and sorting machines, each clerk processing one thousand cards or more per hour. Hollerith’s Tabulating Machine Company (TMC), formed in 1896, was the forerunner of the computing giant International Business Machines (IBM).

Hollerith’s machines did not replace the use of human computers for more complicated projects, such as those directed by the U.S. military during the first part of the twentieth century. Human computers held a place of importance during World War II. Approximately two hundred women with university degrees in mathematics computed ballistics trajectories at the University of Pennsylvania’s Moore School as part of the war effort. When the Moore School finished building the first electronic computer, the ENIAC (electronic numerical integrator and computer), in 1945, many of these female computers became the first computer programmers.

In this period, computers, both human and machine, crunched numbers for scientific purposes. Computing was the exclusive domain of trained mathematicians, scientists, and engineers. This changed in the 1950s, when the computer became a data-processing machine marketed to and adopted by the business community.
J. Presper Eckert and John Mauchly, formerly of the Moore School faculty, formed one of the first computer businesses, Electronic Control Company, to sell the first commercial computer (UNIVAC), but IBM and about 30 other firms soon followed and developed their own machines for business applications. By the mid-1950s, IBM machines dominated the market.

The growth of commercial computing expanded the range of tasks performed by workers in the industry and changed the idea of what it meant to be a computer worker. IBM, for example, built a successful sales force based on sales quotas, commissions, and a strict dress code, which remained in place until the 1990s. All salesmen completed a comprehensive training program and were the cornerstone of IBM's marketing strategy. By the mid-1960s, IBM had nearly 250,000 employees, a figure that climbed to 400,000 by 1985. Not all were computer engineers. With a reputation for job security and a public image as a benevolently paternalistic company, IBM became a coveted place to work for white-collar, middle-class employees during the 1960s, 1970s, and 1980s. However, IBM also depended upon a large infrastructure of technicians, clerical workers, administrative staff, training staff, middle managers, and janitorial workers, among others.

Changes in the computer market paralleled changes in the technology and manufacture of a computer's component parts. The first computers used vacuum tubes. Later models used transistors and, eventually, integrated circuits. The manufacture of a reliable component often required a separate set of techniques, tools, and environmental controls than those that led to the initial laboratory prototype. Bell Laboratories announced the invention of the transistor in 1948, but it was 1951 before the first transistors rolled off its assembly line at a Western Electric plant in Allentown, Pennsylvania.

Because new developments within the industry occurred so rapidly, factories often doubled as laboratories for companies that wanted to be innovative and to manufacture these complex component technologies on a large scale. Western Electric, the manufacturing arm of Bell Laboratories, was a pioneer and employed a team of Bell Labs engineers charged with transforming laboratory inventions into reliable mass-produced goods. In this context, the historian Stuart W. Leslie observes, such “plants should be considered a new kind of laboratory, one devoted to process rather than product.” Workers followed strict rules concerning clothing, hair, makeup, and the cleanliness of their workspace. In 1960, workers at the Allentown plant assembled transistors largely by hand, and women outnumbered men on the assembly line by a ratio of 7 to 1.

As a branch of Bell Labs, Western Electric sold transistors for telecommunications systems, not computers. However, its manufacturing practices set the standard for the growing semiconductor industry, which supplied the computer industry. Fairchild Semiconductor was one of several companies that adopted Western Electric's techniques, including clean room practices. Located on the San Francisco Peninsula, the area that would become known as Silicon Valley, Fairchild became a major source of silicon components for computers in the late 1950s, selling to IBM, among others. Fairchild pioneered new methods of manufacture such as photolithography, which improved transistor performance and reliability and later made possible the manufacture of integrated circuits. Like the Western Electric work force, Fairchild's consisted of semiskilled female workers as well as groups of engineers charged with increasing factory production capacities. Fairchild raised the standards for its clean rooms, dust-proofing and air-conditioning all assembly and processing areas and prohibiting employees from smoking on company premises. The firm also required workers to adhere to a strict set of manufacturing procedures outlined in lengthy company manuals.

In the mid-1960s, Fairchild cut its labor costs by moving the testing and assembly of its transistors and integrated circuits to Hong Kong, where unskilled laborers were paid 25 cents an hour instead of the $2.80 per hour that Bay Area factory workers commanded. Other semiconductor firms, including Motorola, Texas Instruments, Pacific Semiconductor, and Hoffman Electronics, soon also sent work to Southeast Asia.

From 1960 to 1970, the semiconductor industry witnessed a period of dramatic growth, fueled in part by rising demand from the computer industry. In 1960, Fairchild had 1,400 employees on its payroll. Ten years later, it and its Bay Area spin-off companies employed about 12,000 people. Growing computer sales helped the semiconductor industry to thrive. One thousand computers were shipped in 1957, compared with sales of 18,700 computers in 1967, and many machines contained more than half a million transistors. In 1968, the year that two Fairchild founders, Robert Noyce and Gordon Moore, left to form Intel, Fairchild commanded 80% of the market for integrated circuits for computers. Its victory was short-lived. Intel's introduction of the microprocessor in the 1970s secured its supremacy into the twenty-first century.

The U.S. computer industry enjoyed continued growth throughout the 1970s and 1980s. In 1970, the U.S. Census Bureau estimated that nearly 1.17 million people worked in the computer industry, a
Software and Labor

Despite the eventual disparities in pay and promotion for men and women in the computer industry, early computing machines created new areas and opportunities for female labor. Occupations such as computer programmer lacked a gender precedent, and women could fill such positions without challenging gender stereotypes. Programming was often considered an extension of clerical work, which made such jobs logical for female hires. However, the gender composition of the programming work force saw a significant shift during the 1950s. Men conducted the majority of programming work in the United States from then on. The historians Nathan Ensmenger and William Aspray link this demographic shift to the rise of business computing and the increased demand for programmers in industry, which quickly depleted the available pool of mathematically trained female computers and computer programmers.

According to Ensmenger and Aspray, U.S. companies began expressing fears of a programmer shortage as early as 1954, and this anxiety continued throughout the 1960s. At the same time, programmers experienced a professional identity crisis. Industry trade publications debated the skills, education, and abilities required to become a professional programmer. This was before the advent of most university computer science departments, so college-educated students who learned how to program in the 1960s did so informally, usually in a scientific setting. In most cases, these students wrote programs with little regard for their eventual application or the deadline for their completion, considerations at the heart of industry practice. Early programmers often described software writing as more art than science. This frustrated managers, who hoped to standardize programmers’ qualifications and abilities and to structure the process of writing software.

As the 1960s progressed, professional computer societies formed and helped to professionalize those involved in software development. Hierarchies of work emerged within the software industry. University-educated systems analysts became the elite of the profession, with the greatest opportunities for advancing to management. Programmers, or “coders,” received fewer opportunities for promotion, and their job descriptions required that they possess a technical degree. Software workers, like other white-collar members of the computer industry, did not organize or join unions.

In the 1970s, management focused on controlling the behavior of programmers rather than increasing their output or efficiency. In his 1977 book *Programmers and Managers*, the sociologist Philip Kraft wrote that management practices such as structured programming, modular programming, and the use of prepackaged software programs allowed companies to cut their labor costs by standardizing the work. By dividing software production into a set of smaller steps connected by a routine set of relationships, managers could make software workers interchangeable. These practices transformed programming into a less-skilled form of work and reduced the level of intellectual control that programmers had over software development. Kraft’s Marxist-inspired conclusions are not universally accepted, but his work stands as one of the most thorough studies of the programming profession during the 1970s.

Men continued to hold most of the better-paid jobs in the software industry, including those in engineering and systems analysis. Women gravitated toward less-skilled keypunch and data-entry positions. According to the 1980 U.S. Census, women held 92% of all data-entry jobs, but only 22% of all computer scientists and 31% of all computer programmers were female. The percentage of women enrolled in U.S. university computer science programs declined after the 1980s, a phenomenon that social scientists, educators, and computer professionals cannot fully explain. Moreover, corporate practices of sending programming work to other countries negatively affected the employment prospects for U.S. programmers and contributed to an overall decline in computer science enrollments in the first part of the twenty-first century. In 2005, the U.S. Labor Department predicted the employment of U.S. programmers would continue to grow at around the same average rate as other occupations through the year 2012, with most growth occurring in the area of software publishing. However, in areas such as computer manufacturing, the U.S. Labor Department expects a 23.4% drop in the number of U.S. programmers needed through 2012, the second-largest projected decrease in the sector,
behind only electrical and electronic equipment assemblers.

The High-Tech Boom

The late 1970s and early 1980s witnessed a radical change in the computer industry. The personal computer, or PC, brought computers into the house as well as the office and made computer technology accessible to lay users, not just hobbyists or experts. This increased the number of workers in the industry and expanded computer industry work to include sales, tech support, product development, and administrative resources for these new markets.

Advances in electronic manufacturing technology also changed the character of labor in the computer industry during the 1980s. Some sectors, such as circuit board assembly, became automated. Demand for U.S. assemblers dropped dramatically, and companies sent most remaining work involving production and assembly of their circuit boards to foreign countries. Subcontractors handled the remaining circuit board assembly work in the United States and paid minimum wage to semiskilled production workers, many of whom were women, minorities, and illegal immigrants who faced routine exposure to hazardous chemicals and fumes.

The commercialization of the Internet in the mid-1990s connected computers in homes and businesses throughout the world and transformed them into a vast global network. This opened new options for work and commerce and fueled an Internet startup, or dot-com, boom in the late 1990s. According to the social theorist Manuel Castells, the 1990s marked the beginning of an information age defined by flexible labor, the individualization of work, and weaker labor movements. His critics argue that this assertion overemphasizes the impact of technology on labor and ignores labor’s role in shaping technological change. However, the rapidity of change required workers to master new skills continuously in an industry also marked by high turnover and a lack of job security. Workers throughout the industry did not organize, and unions reported difficulties building membership because workers regularly change jobs, work is often outsourced, and there is no history of organized labor.

In Silicon Valley, the center of the high-tech boom, the numbers of temporary or subcontracted workers increased dramatically, as did the number of intermediary organizations such as temporary help firms, employment agencies, recruiters, and labor contractors. In California’s Santa Clara County, home of Silicon Valley, temporary workers rose from 1.6% to 3.5% of the area’s total work force from 1984 to 1998. The geographer Chris Benner cites more telling statistics in *Work in the New Economy*. He writes that while overall employment in Santa Clara County declined by 2% between 1990 and 1994, employment with temporary agencies grew by 30%. Most workers employed by these agencies lacked union representation, although some temporary workers did secure victories against U.S. computer companies. In 2000, long-term temporary workers, or “permaments,” at Microsoft won a $97 million federal lawsuit because the company excluded them from receiving benefits. A number of guilds emerged in the Silicon Valley area during the 1990s, but most acted as training or professional organizations and exerted little power over company regulations or working conditions.

The high-tech boom boosted employment in the computer and information technology sector, and unemployment rates for Silicon Valley were well below the national average from 1995 to 2000. Average payroll figures for salaried and hourly Silicon Valley workers were 84% higher than the national averages in 2000, which drastically inflated living costs in the Bay Area. However, there is some speculation that reported earnings in the industry were artificially inflated because so many of the lowest-paying jobs no longer existed in the United States. Also, the high salaries were offset by the long hours demanded by an industry in which 80-hour weeks were common and celebrated.

During the boom years, the dominant industry culture changed and promoted an image of young entrepreneurialism, quick wealth, and informality. Dress codes relaxed. Many companies strove to create a fun and flexible atmosphere for their employees that also encouraged them to work longer hours. Internet startups and well-established computer companies offered lucrative salaries to attract and retain highly educated engineers and computer scientists. Newspapers regularly ran stories about young employees in the high-tech sector who accrued millions of dollars in stock options before turning 30. Such stories sustained the mythology of the high-tech boom, but accounts of white-collar employees who held service and lower-level administrative and technical positions spoke of long hours, oppressive management, limited family time, deskilled work, and salaries incommensurate with the cost of living in Silicon Valley and other high-tech areas. When combined with criticism of environmental practices of high-tech processing plants during the 1980s and 1990s, which led to such problems as leaks of hazardous substances from underground storage tanks, the dumping of toxic sewage, and the regular exposure of blue-collar plant workers
to dangerous chemicals, the picture was much less than ideal. Although some white-collar professionals made significant sums during the high-tech boom, the distribution of wealth was far from equal, with white and Japanese-American men enjoying the highest salaries. One 1996 study of 33 high-tech firms in Silicon Valley found that whites composed 81% of managers. Only 6% of managers working in these firms were black or Hispanic.

After 2000, the industry experienced a downturn when the “dot-com bubble” burst. Many startup companies went bankrupt, venture capital monies dried up, stocks in high-tech companies lost part (if not all) of their value, and workers paid in stock options saw their net worth plummet. The end of the high-tech boom and increased offshore manufacturing, programming, and engineering exacerbated employment instability for workers in the U.S. computer industry.

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**References and Further Reading**


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**CONFERENCE FOR PROGRESSIVE POLITICAL ACTION**

The Conference for Progressive Political Action (CPPA) was intended to form a broad political alliance of socialists, unions, and progressives. It was officially founded at a meeting held in Chicago in February 1922, though the idea of building such an alliance had been originally broached by the National Executive Committee of the Socialist Party in September 1921. This initial conference was called by the Railroad Brotherhoods and was attended by other unions, farmers’ organizations, and Progressive political organizations. It worked to promote the election of pro labor candidates to public office. It laid the seeds for the Progressive political party that arose most notably around the candidacy of Robert M. La Follette for president in 1924.

The central problem facing the CPPA was whether to act as a third political party. Many of its constituents envisioned the CPPA as an organization that would support pro labor or progressive candidates from the major parties, while others, especially from the Workers Party of America (a precursor to the Communist Party), pushed the CPPA to form a third party. Between its founding and 1924, the Conference for Progressive Political Action provided the administrative machinery and energy to try and build a pro labor political alliance that would include the AFL unions, socialists, and upper-middle-class progressives, and in doing so it built the skeleton of a third party without actually forming one.

This debate and attempts by the Workers Party to enter the organization led to early internal conflicts. At the CPPA’s second convention in Cleveland in December 1922, a number of Workers Party members who attempted to attend the conference were denied the right to do so on the grounds that their organization stood in opposition to the goals and ideas of the CPPA. Soon after, the Workers Party focused its energies on the Farmer Labor Party, and even organized the 1924 convention of the Farmer Labor Party to coincide with that of the CPPA. The Workers Party’s attacks on the CPPA as an organization that claimed sympathy for a labor party but did not actually want to build one did not prevent the CPPA from being attacked on the right by politicians who denounced it as a Communist front.

In September 1924, the CPPA met in Cleveland with the intention of endorsing either the Republican or the Democratic nominee for president. However, because the Democratic Party convention was so contentious, no Democratic candidate had yet been nominated. When the Wisconsin Republican Senator Robert M. La Follette offered to run, the Conference