Cover Story

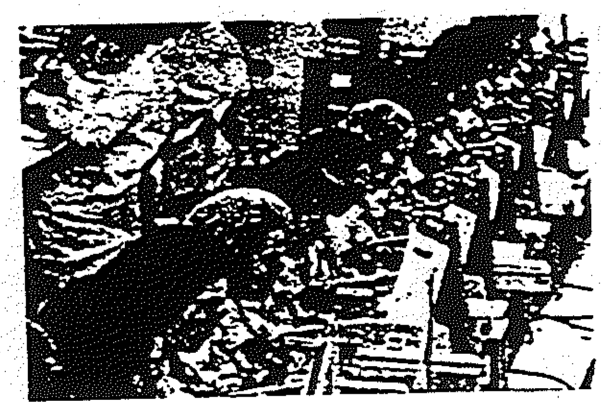
Bled Dry by the Cutting Edge

A Short History Silicon

The First of a Two-Part Series on Local History

by Chuck Carlson

Fifty years ago, Stanford alumnus William Shockley invented the transistor at Bell Labs in New Jersey. This, of course, has become part Stanford history as well as larger legend. As possibly the most important technological innovation of the 20th century, Shockley's invention gave birth to the modern electronics industry. Less well-known, but equally important to the development of the electronics industry, was the passage of the Taft-Hartley Act in the same year, 1947. Conceived in a conservative backlash toward the increasing militance of the labor movement, Taft-Hartley marked the end of a decade of unprecedented public and state support for American unions. These two seemingly unrelated events reflect the defining aspects of the electronics revolution: they brought into being an entirely new industry based on incessant technological innovation with an unyielding opposition to workers' organization of their workplace.



Hidden beneath the popular press's celebration of the industry's entrepreneurial spirit, technical genius, and dazzling new products is a very different story about environmental degradation, the export of jobs to overseas sweatshops, continuing industry dependence on military contracts, the exploitation of immigrants, ethnic minorities and women and the most intransigent group of anti-union corporate managers this country has ever produced. For good or ill, this story begins here on the Stanford campus.

The semiconductor industry is the child of the Cold War. Although the transistor, the forerunner to the printed circuit board or semiconductor, was invented by Shockley in 1947, the industry that grew up around it was not established until the early 1950s. Stanford engineering legend Frederick Terman lobbied both the Stanford administration and the U.S. government to promote research and production of electronics in the early cold war era. Terman was indefatigable in his efforts to establish an electronics research endeavor and, later, the Stanford Research Park as centers for the production and development of the new technology. As a true visionary, he foresaw the application of the semiconductor as the wave of the future for both military and consumer technology. The value of the semiconductor to emerging military technology was equally recognized by American cold war planners and, subsequently, Terman's efforts were richly rewarded by a continuous flow of military research and development grants throughout the 1950s. The consumer applications of electronic circuitry would lag well behind its military uses; as with penicillin, the airplane and the automatic assault rifle, the transfer of technology from the military to civilian uses was a trickle-down affair.

The early giants of the industry — Shockley, Bill Hewlett, David Packard and Bob Noyce — were all either Stanford alumni or located their industries in the Stanford Research Park, established through Terman's efforts in 1954. The long-term leases at the park, which charged nascent industries a pittance as an inducement to establish near Stanford, are still in force today. Throughout the 1950s, fueled by lavish defense contracts, the electronics industry began to spread out like spokes of wheel from the Stanford hub. The Cold War, the Korean War, and later the Vietnam War produced a huge demand for electronic technology. From 1954 to 1961, 80 percent of all new manufacturing jobs created in the Silicon Valley were related to defense projects. With a solid base in defense production, the nascent industry swiftly expanded into consumer commodities until, in the mid-1960s, consumer production surpassed defense-related contracts. Despite the industry's current success in consumer markets, a large portion of the annual defense budget is still dedicated to electronics procurement. About $30 billion for electronics contracts was included in this year's defense budget, a share expected to rise to $50 billion by the year 2000. Defense remains a significant cornerstone to the health of the industry as a whole.

Today, electronics is the largest manufacturing employer in the country; about 2.3 million people are employed in electronics-related production. In the Silicon Valley, 11 out of the top

# of Labor in the Valley

25 firms are in electronics; about one out of five workers are employed in micro-electronics, and 71 percent of all manufacturing jobs are related to electronics production. As an industry, electronics also can claim the dubious distinction of possessing the lowest rate of unionization in the nation. About 2.7 percent of all electronics employees operate under union contracts, most which are in "captive facilities" like GM and AT&T, in which workers fall under industry-wide collective bargaining agreements. Considering that only about 14.5 percent of workers in the United States belong to a union, this may not seem so astonishing, but it is striking when compared to the unionization of other large manufacturing industries like steel (56.2 percent), auto (54.6 percent), telecommunications (43.8 percent) and even construction (22 percent). The ability of the electronics industry to remain a bastion of non-union labor defies simple explanation, considering it was born in an era when unions were at the peak of their strength in the United States; almost 36 percent of all workers held union cards in the early 1950s. Some of the explanation lies in the competitive nature of the industry, the decentralized and internationalized nature of electronics production and the historical lack of interest in some of America's major unions in enlisting low wage, semi-skilled minority and women workers to their ranks. A major portion of the answer, however, lies in the ideology of the industry's movers and shakers, which was formulated, like the industry itself, during the early stages of a management backlash aimed at American unions in the early post-World War II era.

At the end of World War II, organized labor was at the peak of both its power in the workplace and its popularity in the public mind. Aided by the liberalization of labor laws and the creation of the National Labor Relations Board during the Great Depression, unprecedented numbers of Americans had joined unions and won contracts from every major manufacturing industry in the country. Organized labor's moment of triumph, however, was to be exceedingly brief. In the eyes of industrial and financial capitalists, labor had overstepped the acceptable boundaries of workers' control of production issues. About the same time as Shockley invented the transistor, the labor movement was about to be swept away by the convergence of a managerial counterrevolution and the emergence of the Cold War.

It was in this era that the future giants of the electronics industry, Packard (Hewlett-Packard), Noyce and Andy Grove (Fairchild Semiconductor and Intel) and Charles Sporck (Fairchild and National Semiconductor) were founding their companies and beginning their careers. The anti-union ideology and zeal for internationalizing production which dominates the industry today can be seen as a direct byproduct of the shifting attitudes towards unions and the corporate vision of a U.S.-dominated global economy developed in that early Cold War era. The intimate connections between electronics and the defense industry no doubt strengthened the ideological resistance to militant rank-and-file (worker controlled) unions like the United Electrical Workers.

If the early growth of the industry was dependent on the Cold War program of military buildup, it didn't stay that way for long. Beginning in the late 1950s, the application of electronics to consumer products expanded rapidly. Televisions, radios and a host of other consumer technologies employed the transistor and the semiconductor or printed circuit board enabling the establishment of an industry in mainframe computers. The U.S. electronics industry dominated both national and international markets for electronics goods until the late 1970s. By 1977, more than 6,000 electronics firms were registered in the United States, producing everything from digital watches and hand-held calculators to televisions and computers. U.S. firms also established numerous off-shore production plants, primarily in Southeast Asia. Fairchild Semiconductor was the first company to establish an overseas plant in Hong Kong in 1963, but the rising tide of both domestic and later Japanese competition produced a flood of new offshore plants throughout the 1960s and early 1970s. By 1971, there were more workers employed in American electronics plants overseas than within the United States.

The move offshore is blandly treated as an economic inevitability in most articles about the electronics industry, but its consequences to both American workers and international workers have been profound. As electronics production evolved, a strict ethnic and sexual division of labor evolved with it. Both inside and outside U.S. borders, women have constituted the majority of electronics production workers, particularly in the area of electronics assembly — the placing of electronics components (transistors, diodes, etc.) on printed circuit boards. In 1979, more than 200,000 Southeast Asian women were engaged in assembly, mostly in American owned plants. Inside the U.S., in 1990, more than 60 percent of electronics factory operatives were women and nearly 75 percent were drawn from the ranks of ethnic minorities. Whether in Hong Kong, Singapore, Malaysia, the Philippines or Israel — all significant centers of electronics production — the typical worker was and is female, a member of a local ethnic minority and chronically overworked and underpaid. In the intensely competitive atmosphere of today's market for electronics commodities, the exploitation of women and legal and illegal immigrant workers has become a key to remaining competitive.

The imperative of the industry to keep labor costs low grows out of the labor intensive nature of electronics work. Despite the automation of portions of the process of making printed circuit boards and semiconductors, much of the assembly and plating process still depends on careful and tedious hand and eye work which cannot be turned over to the machines which now dominate the assembly lines of other industries. The rapid expansion of the U.S. economy in the postwar era brought about a need for an expansion in the workforce. The postwar vision was that of free movement of raw materials and manufactured goods across international borders, and to accomplish this mobility of capital, the mobility of labor became an additional priority. Between 1952 and 1968, the United States relaxed immigration restrictions and 17 million immigrants entered the United States between 1952 and 1992. This influx of relatively cheap immigrant labor along with the concurrent exodus of U.S. production facilities overseas had serious consequences for the strength and viability of American unions.

This is a delicate and complicated subject. Too often immigrant workers and the transfer of production facilities overseas have been approached by U.S. labor in xenophobic and racist terms. Just as often, defenders of U.S. economic policy and defenders of immigration and immigrants have cast off criticism of policies as simple racism or colloquial nationalism. The toughest fact to confront is that U.S. workers have had their wages and employment opportunities at least indirectly diminished by both trends and that U.S. industries have used immigrant labor to both depress wages and break unions. Capitalism depends on some level of residual unemployment to keep wages from rising; one need only note the negative reaction of the stock markets to reports of unemployment dropping below six percent to witness this trend. The point here is not to criticize immigrants or immigration policy, but to note the exploitation of these policies by the electronics industry, and explore the reaction of the industry to the initiatives of both immigrant workers and unions to organize electronics shops.

Plating is only the first step of the production of circuit boards and has traditionally been an almost exclusively male domain, but the other end of the process — the assembling of electronic components onto printed circuit boards — has largely been dominated by the employment of immigrant or minority women. The idea that women's domestic work follows them into the workplace, in other words that women are channeled into professions which demand patient, meticulous work, is still an operative concept in electronics. One woman assembler put it this way: "Women make the best workers at this kind of thing because you have to be patient, you have to be good with your hands and the work is so tedious. Isn't raising children and doing housework tedious? I mean women are good at this. And, I guess, women are hired mainly because the labor is cheap, and you don't have to have a good education behind you to get a start." Women made up more than 60 percent of the assembly line workers and 80 percent of the clerical workers in the industry, but less than 25 percent of the managerial, professional and technical workers as of 1990.

This strict division of labor, along with a reliance on immigrant and minority labor is a keystone of the industry which serves to depress wages and keep production costs as well as consumer prices low. The hiring of different ethnic minorities and legal and illegal immigrants by Silicon Valley plants has also erected barriers for unions attempting to organize electronics workers. As many as five or six languages may be spoken within a single production plant, and while this does not hinder production (as long as supervisors are bilingual or multilingual), it does effectively hinder organization by erecting language barriers between workers and between organizers and workers.

Given this overview of the demography of the electronics industry, what is the nature of the work that it requires? I worked in a small semiconductor plating shop in the mid-1970s under conditions that could, at best, be described as primitive. As a copper plater, I moved racks of recently drilled circuit boards — at that point in the process, simply thin squares of fiberglass with copper sheeting laminated on both sides — through a double line of chemical filled barrels to plate the holes, creating conductivity from one side of the board to the other. The boards were later silk-screened (by hand), etched by a caustic ammonia solution to remove the excess copper and create the "pathways" or "traces" between holes and then plated with a tin-lead solution to protect the copper traces. Most of the boards we plated would go into calculators, early digital watches or missile-guidance systems (claims that U.S. nukes could strike within 100 feet of their Soviet targets usually brought on a good laugh; we used to bet if they could land in the correct hemisphere). The plating process was tedious, and the plating shop was a witch's brew of formaldehyde, acids, ammonia and smoke from superheated oil. On cold days, the chemicals would condense and create a fine mist which hung like an early morning fog off nearby Monterey Bay.

Working under conditions of high toxicity and interminable boredom for ten cents over minimum wage quickly divested us of any previous notions that the electronics industry was the "clean, space age" industry its boosters proclaimed it to be. Underneath the glitz of the advertising and boosterism was a production process which resembled a cross between the industrial environment of a steel mill and the repetitive hand-eye motions of a Guess Jeans sweat shop. The idea that it was either clean or modern, was a laughable proposition for those of us on the production line. That we were part of dedicated production team was even more ludicrous. Without exception, our goal was to get through the day with enough energy left to go home and crash in front of the tube for a few hours. We coped with our working conditions in a number of both time-honored and innovative ways.

Once on the line, we quickly learned to control the pace of our work. In the 19th century this practice was called "the stint," the process of learning how, when and where a worker can apply their knowledge of production to keep the process moving at a reasonable pace. On my line, this meant knowing how long I could keep the racks of boards in certain chemical vats to either speed-up or slow-down production. On swing shift, this was easy. Without a supervisor around, we could crank out most of our quotas in five or six hours and spend a couple of hours of our shift talking, visiting friends in other departments or sneaking into the office and reading the latest batch of "how to stifle the union drive" literature our bosses got from the Western Electronics Manufacturing Association (the only way we knew that "the union" was out there). On day shifts, employing and enforcing the stint involved sleight of hand; adjusting the work flow communally to appear to maintain a smooth production flow while concealing the potential for what we actually could produce from the bosses.

Now, for those of you who plan to go into management this may seem dishonest or sleazy, but one thing we learned quickly was that if you actually did speed production to rush out a special order, the bosses immediately assumed you could work that fast all the time. The work was exhausting enough at the pace we enforced; cranking it up a notch meant we went home, ate, went to sleep and then dreamt about work all night. No boss is going to pay you overtime for dreaming about the job.

The second major way of coping with conditions was a product of the times. We fought toxics with toxics and worked stoned, drunk or otherwise altered. This wasn't difficult to get away with. The chemical fog in the plating room always produced irritated, red eyes; the bosses had no way of knowing we were blitzed and didn't really care, as long as the production quotas were met. This method of resisting was a decidedly double-edged sword. While altered consciousness led to some creative coping activities — one guy used to work out new guitar licks while running the ammonia etcher, while I used to compose musicals based on a plating shop theme in my head — getting high took the urgency out of a more direct forms of resistance like forming a union. In our shop, working-class consciousness was altered consciousness. The former never had a chance at overcoming the latter, given that one could substantially ameliorate the pain and drudgery by effectively removing their mind from the workplace.

The ultimate method of resisting was quitting. In the Seventies there were literally dozens of small plating shops under contract to the large companies like Intel, Fairchild or National Semiconductor. If you didn't like your pay or conditions, you could simply quit and find another shop — in boom times, anyway. The turnover rate in electronics manufacturing is about 30 percent in any given year; in our shop, it was closer to half. I personally quit twice and was hired back a few months after my departure. Even though the bosses knew I would likely be a short-timer, they preferred hiring someone they didn't have to train rather than take a 50-50 chance on hiring someone new who would probably quit anyway. They knew and I knew that nobody looks at plating as a career.

The larger AFL-CIO unions which have tried to organize workers in Silicon Valley have been handicapped by their traditional emphasis on skilled white workers as their constituency. Progressive minority-oriented unions like United Electrical Workers (UE) have also been handicapped, however, by the lack of resources to hire and train organizers who are fluent in, say, Spanish, Chinese, Tagalog and Vietnamese. This has not prevented them from trying. In the early 1970s and into the 1980s, UE launched organizing drives throughout Silicon Valley. As a relatively small union which charges minimal membership dues, UE has limited financial resources to put into organizing drives. Typically, they will enlist a few workers to form an "organizing committee," and the workers will actually conduct the enlistment of their co-workers into the union. The Electronics Organizing Committee was founded at several shops (National Semiconductor the largest) in 1973 and 1974. The campaign was driven by the demand for a cost-of-living adjustment, known in union parlance as a COLA, and better working conditions. Workers at two small plating shops actually voted to join UE. The industry's reaction was swift and incredibly heavy handed. The Western Electronics Manufacturing Association (WEMA) offered help to the shops' management to combat the union. A union-busting consultant firm was hired, negotiations with the union were dragged out, and when the workers went out on strike in response, the shops simply closed their doors and went out of business. By 1978, the campaign was forced underground.

The myth of the hygienic workplace, a product not so much of modernized production but of Silicon Valley PR, eventually began to crack. The public was kept in the dark about the toxicity of Silicon Valley's purportedly "clean" industry until the contamination of the south Santa Clara Valley water table by Fairchild and IBM hit the headlines in 1980. A study revealed that the neighborhoods around these industries had three times the national occurrence of birth defects and miscarriages. Semiconductor plants use up to 5,000 toxic chemical compounds and require large amounts of water in the production process. The revelation that IBM and Fairchild had legally and illegally dumped huge amounts of chemicals and chemically contaminated water hit the community like a bomb.

The industry response was predictable: obfuscation, facile compliance with the EPA, protracted legal maneuvers, and aggressive public relations campaigns. One of the ways the industry promoted its "clean" nature was through publicizing the sterile and somewhat clinical operation of the clean room in the plating process. The operations of the clean room were held up as an example of the industry's attention to both environment, health, and quality. The following description reveals, however, that their function was dedicated only to the latter: "Clean rooms are sealed work areas in which particulate matter as small as a speck of dust or dead skin is filtered from the air to prevent contaminating the chips during the manufacturing process. Chemical fumes, however, which do not affect chip performance, are not of comparable concern. Clean room workers wear special protective clothing which covers them from head to foot and gives them the appearance of large white rabbits. The clothing is designed to protect the chip from contamination by the worker, not to protect the worker from the chemicals used to produce the chip."

By the late 1980s, worker compensation statistics revealed that half of all occupational illnesses of semiconductor workers resulted from "systemic poisonings" brought on by exposure to toxic chemicals. Given that cancers related to toxic exposure can take up to 20 years to manifest, those statistics will likely turn out to be the tip of a very large iceberg. A former United Electrical Workers organizer has called the semiconductor workers of the 1970s "canaries in a coal mine," a reference to the 19th-century practice of placing canaries in coal mines that would keel over dead when workers hit otherwise undetectable gas pockets. While the industry has been forced to tighten their handling and disposal of toxic chemicals, they have only addressed these conditions when forced and have fought tighter regulations — as well as attempts at worker organization — every step of the way.

In 1981, with the revelation of the ground water pollution at IBM and Fairchild, UE felt the time was again ripe to go public. The second campaign also proposed a COLA, but also addressed issues of race and gender discrimination, workplace safety, and toxic pollution. Working with the Silicon Valley Toxics Coalition — a local grass-roots, neighborhood environmental group — they brought the issue of toxics before the public and won new regulations on toxics storage and disposal. National Semiconductor was the company targeted for the union drive and several hundred workers signed UE membership cards. Once again, the industry response was immediate. NSC granted another 35-percent raise to workers, and fired the key organizers. When a large group of Filipino workers walked out to protest the firing, the management issued a blanket demand that all workers present green cards within 72 hours. One can only assume that these were not demanded upon hiring. Within a few weeks NSC had fired or laid off about 1,000 workers as a result of the anti-union campaign. They claimed that these were necessary or planned reductions.

With the breaking of the second organizing drive, UE had exhausted its resources. They filed several lawsuits and grievances to the National Labor Relations Board to get shop employees who had worked as organizers reinstated and won a few of them, but the costs of the proceedings, the mass layoffs and the fear that pervaded the workplace effectively derailed UE's ability to sustain the campaign. Several other unions, including the United Auto Workers and the International Brotherhood of Electrical Workers also attempted organizing drives at targeted plants around this time, but they met the same response and fate of UE efforts. The cessation of efforts in 1983 effectively ended efforts at unionizing Silicon Valley Electronics for over a decade. It was not until the Justice for Janitors campaign of recent years that unionization would threaten any portion of the industry's employees. The success of Justice for Janitors, which seeks to compel electronics firms to contract only unionized janitorial services, has sparked renewed interest in unionizing the industry, and the AFL-CIO is currently beginning to approach Silicon Valley engineers with union proposals.

Highly educated, solidly middle-class engineers may seem to be unlikely candidates for unionization, but the AFL-CIO's new strategy is a product of the times. The ongoing shift of production overseas and retention of research and development in the valley has reversed the proportion of production to technical workers in recent years. The constant restructuring, mergers, and down-sizing of many electronics firms has commensurately raised the consciousness of many white collar workers to the tenuousness of their job security. If a new unionization effort arises, it will likely be among white collar professionals this time around. While the AFL-CIO sees this as a promising strategy, it would seem to be fraught with difficulties. Higher-paid employees who have traditionally been loyal and even enthusiastic about their companies, steeped in corporate cultures, and fairly satisfied with working conditions would not seem to make ideal targets for signing the union card. Additionally, to some this approach may seem to abandon the low paid women and minority production workers to their fates. If, however, a pincer movement does evolve, unionizing the janitors at the bottom and engineers at the top, an industry-wide union consciousness may evolve. Time will tell.

The electronics industry, in the meantime, will continue its current trends. Intel has recently committed a half-billion dollars to the building of a new industrial park outside of Manila in the Philippines, where it can operate without the cumbersome restrictions of complying with industry regulations and providing a living wage for its employees. And Apple just announced plans to lay off another 3,000 workers. The industry is on a roll, and for American production workers, immigrant and otherwise, that means jobs will continue to roll out of Silicon Valley. The workers that remain will continue to work and live at the whim of management under the vicissitudes of a boom-and-bust industry on the cutting edge of technological development. If there's a moral to this story, it's that when you go out and but that new 200Mhz MMX or that new Performa, keep in mind that the cutting edge cuts two ways.

Chuck Carlson is a doctoral student in history. Much of the information in this essay is drawn from the work of former UE labor organizer Michael Eisencher.