Chapter Three

Cyborganic Sources: Technocultures and Countercultures

A number of sub-cultures and cultural legacies came together in Cyborganic, providing the narrative frames, social, and cultural resources to imagine and realize the project. The histories of Silicon Valley as a high-technology zone of entrepreneurial innovation, of personal and networked computing, and of Bay Area bohemian countercultures are all, in the long view, branches of Cyborganic's genealogy. As Castells has noted, the history of the Internet's development is a "unique blending of military strategy, big science cooperation, and countercultural innovation" (1996:351) and that history is expressed in the Internet culture he describes as "characterized by a four-layer structure: the techno-meritocratic culture, the hacker culture, the virtual communitarian culture, and the entrepreneurial culture" (2001:37). This is an apt summation of the cultural tributaries to Cyborganic and understanding how this confluence of cultural layers came about is essential to understanding the role of communities of production and use in the development of networked social media. Many studies and histories of Silicon Valley have emphasized the role of the military-university-industrial complex in the development of the Internet (Abbate 1999) and region as a hub of technological innovation (Sturgeon 2000; Leslie 2000; Saxenian 1994; Hanson 1982) and these are paths through which the blending of cultural layers (i.e. sub-cultures) occurred. In addition, journalists (Hafner and Markhoff 1991; Markhoff 2005) and scholars (Turner 2005, 2006) and have traced the historical connections and social networks linking the countercultural substrates of Internet culture (hacker and virtual communitarian) and the institutionalized ones (techno-meritocratic, entrepreneurial) to one another and to the Bay Area. Drawing on this work, this chapter presents a historical account of the way these layers came together in the development of Silicon Valley, personal computing, and the Internet in order to trace the long legacy of producer/users and their communities of practice in these parallel endeavors.

Founding Narratives and Origin Myths

Two origin myths are associated with the birth of Silicon Valley in both popular lore and scholarly literature. First is the story of two Stanford graduate students, William R. Hewlett and David Packard, who founded the firm Hewlett Packard in 1939 with the help of their professor, Frederick Terman, in their garage at 367 Addison Avenue in Palo Alto (Hanson 1982; Rogers and Larsen 1984; Saxenian 1994). In 1989, California state landmark officials installed a plaque designating the Hewlett Packard garage "The Birthplace of Silicon Valley" (Sturgeon 2000; Darlin 2005). The heroic ideal of "the garage start-up" looms large in Silicon Valley and has since been pursued many times (with varying degrees of success) in companies from Apple (founded in a garage in Los Altos) to Google (started in a garage in Menlo Park) and thousands of lesser known ventures.

The second event often cited as seminal in the history of the Valley is the formation of Fairchild Semiconductors in 1958 (Casement 1984; Morgan and Sayer 1988; Scott and Angel 1987; Scott and Storper 1987; Storper and Walker 1989; Bahrami and Evans 1995). In the mid-1950s William Shockley, who with John Bardeen and Walter Brattain invented the first practical transistor at Bell Laboratories in 1947, moved back to his one time hometown, Palo Alto, to set up his own company. He recruited from the East Coast a team of eight scientists. This team "became the founding nucleus for the growing West Coast semiconductor industry" when they left *en masse* in 1957 and started their own company, Fairchild Semiconductor (Bahrami and Evans 1995:168). Over time, Fairchild founders and employees started many "spin-off" companies of their own in a pattern of new firm formation and collaboration that has come to typify Silicon Valley: "a genealogy of semiconductor start-ups through 1986 indicated that 124 start-ups could trace their roots to Fairchild" (Kenney and Von Burg 2000:231). Though the term "Silicon Valley" dates only to 1971[1], the origin story of Fairchild and its many "Fairchildren" was already being told in the pages of *The Economist* in 1979:

> [Shockley] recruited from the east coast [sic] a number of the most brilliant young electronics men around. Several of them were dissatisfied with Shockley's management style. They left and started a company of their own, Fairchild Semiconductor. Some of them then left Fairchild to start more companies. And so on. The process is still going on. The ancestry of most of the companies forming Silicon

[1] The term appeared in print in a 1971 article that Don C. Hoefler wrote for *Electronic News*, a weekly electronics industry paper. (Malone 2002:xix)

> Valley can be traced back to Shockley through his recruits to Palo Alto. It was one of his protégés who was co-inventor of the integrated circuit. (Casement 1984:17-18)

The protégé mentioned is Robert Noyce, who along with fellow Fairchild founder Gordon Moore, left to start Intel, the company that launched the microprocessor in 1971 and has dominated the semiconductor industry ever since. Advanced Micro Devices (AMD), National Semiconductor, and LSI Logic are other noted spin-offs of Fairchild Semiconductor.

The Hewlett Packard garage and Fairchild spin-offs are significant, both as historical events and origin myths that circulated among my Cyborganic informants, but like the term "Silicon Valley" itself, they take the semiconductor industry as the origin point for the region's unique blend of technical innovation and economic productivity. In doing do they privilege the role of entrepreneurial culture, giving only a nod to the techno-meritocratic in recognizing Terman's and Stanford's role in the founding of Hewlett Packard and Bell Labs' connection to Fairchild. This obscures the formative roles of the military, world history, and earlier communications technologies in the genesis of the region and its unique cultural hybrids in the thirty years before the founding of Hewlett Packard.

Before Silicon: Telegraph, Radio, Microwave Electronics

In 1909 Stanford graduate Cyrus Elwell founded Poulsen Wireless Telephone and Telegraph with $500 in venture capital from Stanford University President, David Starr Jordan. Initially named for the Poulsen arc transmitter it used, the firm soon became the Federal Telegraph Company (FTC, later bought by ITT). With investment from San Francisco financiers such as the Crocker family, FTC built a profitable business providing wireless telephone and telegraph services on the West Coast. The vacuum tube—which preceded the transistor and integrated circuit[2] as the basic component of the region's emerging radio, television, and military electronics industry—was perfected at the FTC laboratories in Palo Alto in 1912 by inventor Lee de Forest with funding from Stanford. FTC is also notable for the spin-off companies that came from it. The first, only a year after FTC's founding, was Magnavox in 1910, and later Litton Industries (1932) and Fisher Research Laboratories (1936). By 1917 Magnavox "had perfected the design that most loudspeakers are still based on today" (Sturgeon 2000:30). At the outset of World War I the Navy contracted FTC to provide shipboard transmitters for all the Liberty Ships and "probably all" battleships. The "war work at FTC culminated in installation of a pair of one-thousand-kilowatt transmitters at the Layfayette Radio Station, fourteen miles southwest of Bordeaux, France," and though the war ended before the project was finished, the French Government paid the company to complete it. (Sturgeon 2000:22-23)

The end of World War I brought cancelled orders and lean times for Bay Area electronics firms struggling to survive in an industry still dominated by Eastern

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[2] Each was a more miniature and efficient way to modify a signal by controlling the flow of electrons in an evacuated space which is the basis of both radio and electronic logic signals.

Laboratories and contentious battles over radio patents (Leslie 2000:52). Though none of the Bay Area companies became very large before the Second World War, the regional tradition of technical cooperation and innovation took shape in the period between the two World Wars. The region not only played a pioneering role in the development of the vacuum tube industry in the 1920s and 1930s, but also in the development of television when Philo Fransworth, backed by San Francisco financiers, made the first completely electronic transmission of a television image in San Francisco in 1927 (Sturgeon 2000:34-5). Ralph Heintz, pioneer in short-wave radio systems for aircraft, and inventor of the "gammatron" tube, together with his partner Jack Kaufmann, and their companies H&K, Heintz and Kaufmann, and Globe Wireless, also played a leading role in the Bay Area electronics industry of this period.

In his essay "How Silicon Valley Came to Be" (2000) Timothy J. Sturgeon describes the aggressive and litigious Radio Corporation of America (RCA) as an unwitting catalyst for Silicon Valley's culture of open standards and inter-firm cooperation. During World War I radio became so crucial that the federal government made it illegal for foreign companies to hold more than 20 percent interest in any U.S. based radio station. Thus, by government mandate General Electric (GE) acquired American Marconi in 1919 and the new company became RCA. With the rapid rise of commercial radio in the 1920s, RCA became a dominant force as electronics came to permeate more and more social arenas; and under the management of David Sarnoff, General Manager of the company from its founding until his retirement in 1970, RCA worked vigorously to protect its patent monopoly. In the mid-1920s, Westinghouse and GE refused to sell vacuum tubes to FTC because its parent company (Mackay) "was perceived as a threat to RCA's near monopoly on long-distance radio communications." FTC brought in Heintz and he reminded them that because Lee de Forest had made his discoveries while an employee of FTC, the company held "shop rights" under de Forest's patent to manufacture vacuum tubes for internal use without paying royalties (Sturgeon, 29). Besides FTC, Magnavox, Farnsworth, H&K, and a host of smaller companies had similar encounters with RCA lawyers. In this manner, RCA not only spurred the development of local tube production and the practice of using technical means to circumvent patent restrictions, but also shaped the regional economy and culture in other important ways. As Sturgeon argues:

> the early electronics industry in the San Francisco Bay Area labored under constant threat of RCA litigation…A few Bay Area companies were persistent thorns in the side of David Sarnoff, and some were able to beat him in court. Many others were small enough and far enough away to simply fly under RCA's radar. If the cooperative nature of Bay Area electronics companies during the 1920s, 1930s, and 1940s had any one source, it was opposition to the domination of the field by RCA. (Sturgeon 2000:28)

RCA's dominance also influenced the region's firms to specialize in instrumentation, electronic components, military electronics, and advanced communications: markets in which RCA had no interest and where their patents were less relevant. A similar pattern was seen again in the 1990s, with Mircosoft in the role of RCA as the opposition against which Valley firms cooperated and the open source movement coalesced.

The early history of the electronics industry is significant because it undermines the myth of “instant industrialization” showing that Silicon Valley is “entwined with the long history of industrialization and innovation in the larger San Francisco Bay Area” and that the characteristics for which the Valley is known today were already present more than thirty years before the founding of Hewlett Packard (Sturgeon 2000:47). Rather than instant industrialization, Sturgeon argues:

> what emerges instead is a portrait much more typical of studies in economic and historical geography: industrial development takes a long time to build up momentum, is profoundly structured by place and historical context, and acquires path-dependent characteristics that continue to influence outcomes far in to the future. (Sturgeon 2000:16)

From local venture capital and university-industry collaborations, to a culture of open protocols, inter-firm cooperation, “and a keen awareness of the region as existing largely outside the purview of the large, ponderous, bureaucratic electronics firms and financial institutions of the East Coast—all of these well-known characteristics of Silicon Valley were as much in evidence from 1910 through 1940 as they have been from the 1960s onward” (Sturgeon 2000:16-17).

This earlier history is also important because it underscores the crucial role of the military in the formation of Silicon Valley, not only as a market for the Valley’s wares, but also as an agent that intentionally set bid requirements beyond known limits to spur technical development (Sturgeon 2000, Leslie 2000). As historian of science and technology Stuart Leslie has argued, Silicon Valley "owes its present configuration to patterns of federal spending, corporate strategies, industry-university relationships, and technological innovation shaped by the assumptions and priorities of Cold War defense policy" (2000:49). As the rest of this history will show, from FTC's World War I Navy contracts to the opening of Moffet Naval Airbase in Santa Clara county in 1933, and founding of dozens of local firms during and after World War II, the military has played a formative role. Throughout this history, *communications* has been the regional specialty, from telegraphy and radio to all manner of microelectronic transmission, reception, detection, countermeasures, and signal processing.

From Military-Industrial Complex to University-Technology Park

Most histories of Silicon Valley begin with Frederick Terman, professor of Electrical Engineering at Stanford University whose vision and leadership in fostering university-industry collaboration were central to the genesis of the region. Son of a Stanford psychology professor, Terman grew up on the campus and attended college there. A radio enthusiast since boyhood, he earned a degree in chemistry by the age of 20 and another in electrical engineering before heading off to MIT for a doctorate in 1922. He returned to teach at Stanford in 1925, bringing with him a philosophy of university-industry cooperation learned at MIT, evidenced in his practice of taking students on field trips to local radio and electronics firms, including Farnsworth's television lab in San Francisco. In 1927, Terman wrote in the journal *Science* of his vision for "a community of technical scholars…composed of industries using highly sophisticated technologies, together with a strong university that is sensitive to the creative activities of the surrounding industry" (Winner 1992:37). Terman built a pioneering program in radio engineering at Stanford and was full professor and head of the Department of Electrical Engineering by 1937 (Sharpe 1991). As previously noted, David Packard and William Hewlett studied with Terman and, though Packard took a job on the East Coast upon graduation, Terman persuaded him to take a leave of absence in 1938 and return to Palo Alto to participate in the "Wide Grid Tube Project" with Russell Varian and Charles Litton. The next year, Hewlett Packard started in Palo Alto's most famous garage, and "spurred by massive orders" from the military "for its line of electronic measuring instruments, jumped from nine employees and $37,000 in sales in 1940 to one hundred employees and $1 million in sales just three years later" (Leslie 2000:53).

In 1941, Vannevar Bush, Terman's mentor at MIT, was named director of the new Office of Scientific Research and Development (OSRD), the group that administered the Manhattan Project. Bush, who had been Dean of Engineering at MIT from 1932-1938, "revolutionized the relationship between science and government by funding universities rather than government labs to pursue basic military research" (Saxenian 1994:13). He tapped Terman to become director of the Harvard Radio Research Laboratory (RRL), in Cambridge, Massachusetts. Throughout the war, Terman not only developed radar jamming and countermeasures technology, but also taught companies like RCA, Western Electric, and General Electric how to manufacture the designs. When he returned to Stanford in 1946 as Dean of Engineering, he brought with him: 1) a team of RRL alumni; 2) the conviction that the collaboration of government, industry, and academia had won the War; and, 3) the vision of applying that formula to the development of a local electronics industry in Silicon Valley.

One case that illustrates this confluence of university, industry, and military interests is that of Russell and Sigurd Varian. In 1937 the Varian brothers, working with Stanford physicist William Hansen, invented the klystron tube under "an unusual contract with the university" in which they "were granted access to faculty, laboratory space, and modest funding for materials, in return for a half interest in any resulting patents" (Leslie 2000:52). The klystron was rapidly developed during the War for use in radar and aircraft navigation. Sperry Gyroscope Company came to produce the tubes under an agreement that provided substantial funding for klystron research at Stanford and "gave Sperry an exclusive license to make, use, and sell any microwave equipment developed in the university laboratory" (Leslie 2000:52). Sperry relocated the Stanford klystron group to their Long Island laboratories during World War II to bring it closer to manufacturing. However, after the War, group members returned to California with plans to set up a business of their own. In 1948, the Varian brothers founded Varian Associates to manufacture klystron tubes. With financing to extend manufacturing capacity from the Defense Production

Administration and the Air Force, and the demand created by the Korean War, “Varian’s sales climbed from $200,000 in 1949 to $1.5 million two years later, to $25 million by the end of the decade, with military tubes accounting for all but a small fraction” (Leslie 2000:55-6).

In 1951 Stanford University leased land to Varian and Hewlett Packard. Three years later, to extend and institutionalize university-industry cooperation, and corporate funding of academic research, university trustees decided to establish Stanford Industrial Park. In addition to Hewlett Packard and Varian, early tenants included General Electric, Admiral, Eastman Kodak, and Watkins-Johnson. Renamed Stanford Research Park, the site now occupies 655 acres on the Stanford campus “and leases space to some seventy technology-oriented firms” (Winner 1992:37). NASA (then NACA) opened the Ames Research Center at Moffet Field in 1939 and in the post-War period the nation’s major electronics firms followed the government’s lead: Xerox, IBM, Westinghouse, Philco-Ford, General Electric, Sylvania, ITT and Lockheed all opened research and development facilities in the region. Companies were drawn to the region’s concentration of technical talent and many located new facilities in and around Santa Clara County. When the Army Signal Corps contracted Sylvania to build and run a new lab for missile countermeasures in 1954, the company situated it in Sunnyvale, close to Stanford’s pool of faculty consultants and graduate students (Leslie 2000:59). Annalee Saxenian, who has studied the development of Silicon Valley closely, asserts: “Three institutional innovations during the 1950s reflect the relationships that Terman pioneered in the region." One was the development of Stanford Industrial Park. Another was the Honors Cooperative Program through which engineers at local companies were encouraged to take graduate classes, either "directly or through a specialized televised instructional network which brought Stanford courses into company classrooms." Third was the establishment of Stanford Research Institute (SRI) "to conduct defense-related research and to assist West Coast businesses." The importance of SRI will be discussed in connection with the later history of the personal computer and Internet. (Saxenian 1994:23)

Spawn of Sputnik: Transistors, Microchips, and Consumer Electronics

The launch of Sputnik in October 1957 is often cited as setting off the "space race," as the U.S. Government, alarmed by the technological capability of the Soviets, embarked on a major initiative to achieve superiority in space and missile technology. The Sputnik crisis led to the creation of NASA and the manned space program; educational programs in math and science to train a new generation of engineers; dramatic increases in funding for scientific research;[3] and the Polaris and Minuteman missile programs. The Cold War transformed the U.S. economy as the

[3] In 1959, Congress increased the National Science Foundation budget to $134 million, almost $100 million higher than the year before and by 1968 that budget was nearly $500 million (National Science Foundation, "An Overview of the First 50 years," http://www.nsf.gov/about/history/overview-50.jsp, accessed February 27, 2006).

federal government stimulated industrial development by funding high technology research at universities. MIT and Stanford were the chief recipients of defense and aerospace contracts that remade the regional economies around them in the 1950s and 1960s. By 1970, Route 128, near MIT, and Silicon Valley, near Stanford, had become the world centers of electronics research and production (Saxenian 1994). Between 1959 and 1979 Fairchild Semiconductor, celebrated as the original spin-off, "spawned fifty new companies" in the Valley "including Intel, National Semiconductor and Advanced Micro Devices (AMD)" (English-Lueck 2002:761). From a purely technical perspective, at the center of this massive growth lies the transistor, the small device that over the last fifty years has become more integral to our society the more it has dropped in price and size. Though the first patents on the transistor principle were made in Germany in the late 1920s, Shockley, Bardeen, and Brattain at Bell Labs were the first to make a practical transistor in 1947. In 1953, Bell began licensing its transistor technology to other companies. Among the first licensees were: General Electric, IBM, Raytheon, the newly formed Texas Instruments, and Tokyo Telecommunications Engineering, a small Japanese company that became Sony Corporation when it entered the U.S. market in the mid-1950s. Over the next twenty years, transistors replaced vacuum tubes in most electronics and made possible many new technologies, such as integrated circuits and personal computers.

Early transistors were expensive, but within seven years of their invention had fallen in price to less than a dollar each and were entering the mainstream of American industry. Hearing aids and radios were the first commercial products to incorporate the new technology. The first consumer transistor radio went on the market in time for Christmas in December 1954 and used transistors manufactured by Texas Instruments (TI). The announcement issued by the company for the occasion describes the product as a historic milestone.

> The introduction of this first mass production item to use the tiny transistor to replace the fragile vacuum tube leads the way for the long-predicted transistorization and miniaturization of many other mass production consumer devices. TIers can justly be proud of being the first to produce a high-gain transistor at a cost permitting its application to the high-volume commercial market. (Texas Instruments, October 18, 1954)

Though it is not unusual for announcements from technology companies to claim historic importance, this one is noteworthy because it describes consumer electronics as "long-predicted" and underscores *miniaturization* and *cost* as the key material conditions for its realization. However necessary, material conditions are insufficient and attention to the social conditions and construction of electronics technology sheds light on the apparent paradox that while mass consumer applications were widely anticipated in the 1950s, it was only in the late 1970s and 1980s that they became part of mainstream, everyday life in America. Despite the great expectancy surrounding transistors in the consumer market, the market itself did not drive research and development of ever smaller and more powerful electronic components.

While the Japanese took the lead in bringing mass-produced “transistorized” goods to consumers in the late 1950s and 1960s, Silicon Valley remained focused on developing increasingly sophisticated electronics for the defense industry. As Markoff so eloquently put it: “The shrinking silicon chip did not emerge in isolation…but grew out of the twin geopolitical challenges of placing a man on the moon and squeezing navigational circuitry into the nosecone of an ICBM” (2005:xi). Unlike the instant industrialization associated with men such as Edison, where inventions are rapidly turned into consumer products, microelectronics involved a longer period of research and development in which science was applied to technological objectives shaped by the Cold War.

By the start of the 1960s multiple transistors were being integrated on a single layer of semiconductor material to create integrated circuits (ICs) or microchips (chips). Though Jack Kilby of Texas Instruments was the first to demonstrate an IC in 1959, Noyce at Fairchild developed one independently at about the same time and held the key patent for the “planar” process of chip making. In hindsight, putting more and more components on a single chip leads fairly directly from the invention of the IC to the production of the first microprocessor in 1971, yet this evolution was neither automatic, nor inevitable. The first commercial ICs were more expensive and less versatile than transistors and were slow to catch on. Producing new chips was capital intensive and if 10% of an initial manufacturing run worked, that was considered good. Advances in industrial processes, such as photolithography and ion implantation, and in business processes, such as standardizing production on a few basic circuits (a tactic Silicon Valley has employed ever since), were key to the cost reductions that made microelectronics a transformative social phenomenon. (Casement 1984: 62)

With the exception of Motorola, RCA, and Texas Instruments, most of the semiconductor companies of the 1960s were in the Santa Clara Valley. While the ingenuity of the Valley's engineers and entrepreneurs was necessary, it alone was not sufficient to effect the spiraling reduction in cost of computing power that has been central to the microelectronics revolution, and the success of Silicon Valley. As many have noted (Sturgeon 2000; Leslie 2000; Saxenian 1994; Hanson 1982; Winner 1992), the U.S. government and military played a crucial role in the region's "start-up" phase, pushing technological limits, funding basic research, and creating a steady "cost plus" market for Silicon Valley's wares.

> New means of working with electricity usually have been forged in the crucible of military necessity. Often, however, the carrot held out by the military has not been so much in the form of direct funding, although there has been plenty of that, but in the form of a first market for untested, still-expensive devices considered too risky for the commercial market. For the computer, the transistor and the IC, the military served as first customer, followed by government bureaus, business, industry, and, finally a broad range of commercial and consumer applications. With the microprocessor, however, semiconductor developments began unfolding so rapidly that the military found it hard to keep up. (Hanson 1982:119)

Ever since the launch of the transistor in the early 1950s the complexity of electronic circuits has doubled every two years, while the cost has decreased several thousandfold. This phenomenon has come to be known as "Moore's Law." In 1965, when no more than fifty transistors could be fit on a chip, Intel co-founder Gordon Moore wrote, "by 1975 a chip would be built with as many as sixty-five thousand transistors" (Markhoff 2005:12-13) Both the press and the semiconductor industry seized on the statement and it was enshrined as a sort of law of technological development stating that the complexity of integrated circuits will double (and thus halve the price) approximately every 18 months. Though in practice, it turns out to be closer to 24 months, this rate of increase has held for the last thirty-five years, setting the pace of local life in the Valley as well as the material conditions for the more global economic and social transformations of the information age. Both Michael S. Malone (2002), said to be the country's first high-technology journalist, and anthropologist Jan English-Lueck (2000), have written insightfully about the ramifications of this continual acceleration on Silicon Valley life.

Though the U.S. government served as first customer or, as Stuart Leslie has put it, "the biggest 'angel' of them all"[4], innovation in semiconductors was also spurred by the high volume civilian market pioneered by the Japanese and Texas Instruments beginning in the late 1960s. In 1971, in response to an order from a group of Japanese desktop calculator manufacturers, Ted Hoff at Intel in Silicon Valley led development of the first microprocessor by putting all the required math

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[4] "Angel" is the term for venture capitalists that provide companies their first round of investment.

and logic circuitry on a single silicon chip. Hoff, working with chip designers Stan Mazor and Federico Faggin, was simply trying to fit within the size constraints set by the calculator makers, yet the microprocessor they created was a significant breakthrough. As Hoff insightfully noted, "The actual invention of the microprocessor wasn't as important as simply appreciating that there was a market for such a thing" (Hanson 198:118). But the invention was important because it brought about further economic efficiencies and broadened the range of functions that chips could perform.

With the microprocessor the semiconductor industry could build a standard chip with stored programs in memory to fit a range of applications, from pocket calculators to video ping-pong. The "computer on a chip" as it was somewhat inaccurately dubbed, came at a very good time for Silicon Valley and U.S. electronics companies. As the Vietnam War and defense spending waned in the early 1970s, the microprocessor opened many in the U.S. and abroad to new business and consumer applications of computing power. These provided Silicon Valley with new customers, markets, and businesses to offset the cut backs of their "first customer," the U.S. military:

> Military and aerospace markets accounted for a diminishing share of the semiconductor business as the growth of the computer industry fueled demand for transistors and integrated circuits. Government purchases, which had accounted for half of total semiconductor shipments during the 1960s, dropped to only 12 percent in 1972, and continued to fall throughout the decade. Silicon Valley…thus

> managed to achieve gradual transition to commercial production during the 1960s and 1970s. (Saxenian 1994:26)

In 1971, the year Silicon Valley got its name, the region was primarily in the semiconductor business, but ten years later it was the center of a vast computer industry, a hub in a network of related industries from minicomputers, databases, and software, to video games and personal computers. This transformation did not simply arise as a natural result of the falling cost of computing power. It was a cultural transformation.

In 1967 computer music researcher John Chowning developed a technique known as frequency modulation synthesis that made it possible for electronic components to approximate the sound of orchestral instruments. "Four years later, he handed the technology to Stanford's Office of Technology Licensing, which in turn approached a number of American instrument makers. None of them were interested and it was Yamaha [of Japan] that ultimately licensed Chowning's invention" (Markhoff 2005:100). I note this turn of events to point out how industry in Silicon Valley was not yet oriented toward the civilian market. As Hoff indicated, that was something to be discovered and developed, not simply an effect of technology. During the 1970s the primary costs of computing lay in hardware and processing power, but by the 1980s these had fallen to the commodity level and software represented the major cost. That transition, from hardware to software, marks an important departure from industrial to post-industrial. It was a sort of socio-economic phase change akin to the way increasing miniaturization of the circuit brings chip design into the realm of quantum mechanics. Silicon Valley's approach lay not so much in exploiting commercial applications of the microprocessor[5], as in driving and adapting to this transition: First by developing the technology and manufacturing that made computing power so *micro* in terms of cost, size, and heat/electrical power; and second by building on its regional tradition of inter-firm cooperation to create a "network-based industrial system that promotes collective learning and flexible adjustment among specialist producers of a complex of related technologies" (Saxenian 1994:2). As many scholars have noted (Saxenian 1991a, 1991b, 1993, 1994; Castells and Hall 1994; Bahrami and Evans 1995; Cohen and Fields 1999; Kenney, 2000), it is this second development that distinguished the region as a hub of technical innovation and economic dynamism as it emerged from the economic crises of the 1970s engaged in a host of new enterprises known today as the computer industry. While the region's industrial system may have enabled its nimble transition, the computer industry did not arise whole cloth from the semiconductor and electronics industries of the 1960s. Rather, a number of different tributaries came together to produce it. Consideration of these sources will serve to further highlight the cultural and conceptual changes that coalesced in Silicon Valley starting in the 1970s in the production of personal computing.

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[5] Commercial applications were certainly pursued in a wave of consumer electronics that appeared in the 1970s (e.g. digital watches, Pong™, Speak and Spell™). However, as Hanson shows these markets quickly stagnated as chip-makers found, for example, that selling watches required knowledge of the jewelry and fashion business, and was unlike the semiconductor business in other significant ways.

From Mainframes to Networked Personal Computers: A Fractal Path

In his book on innovation and economic growth in nineteenth century America and Britain, Paul David (1975) questions the practice historians of technology have adopted of separating "the history of inventions" from "the history of common practices" and studying these independently. Noting David's distinction, James Boyle argues that "the fixation on authors, inventors, and entrepreneurs tends to obscure the importance of continuity, indebtedness, and evolution and to overemphasize that of transformation, originality, and revolution" (Boyle 1996:207). Structured thus far by the narratives of technical invention and mass production, this account could be seen as perpetuating the fixation Boyle critiques. Yet, it has also worked to underscore the long gestation preceding Silicon Valley's christening in 1971 and the role of the state, military, and U.S. taxpayers, in the genesis of what became, in the words of venture capitalist John Doerr, "the largest legal accumulation of capital in the twentieth century: the PC industry" (Markhoff 2005:197). Langdon Winner argues the importance of this role in his critical examination of Silicon Valley as a "model of what a postindustrial society might look like" (1992:32).

> Without the military's enormous subsidies throughout 1950s and 1960s, the microelectronics industry would certainly have developed more slowly, for there was no socially pressing need for its semiconductors, no significant domestic market. The government in effect absorbed the burden of risk of a number of highly uncertain enterprises—a point usually ignored in media and industry folklore. As silicon chips began to enter video games, microwave ovens,

> personal computers, and other consumer goods in the late 1970s, credit for the industry's success was showered on entrepreneurs…and their venture capitalist counterparts… The true long-term risk-takers, overlooked by *Fortune* and *Business Week*, were ordinary American taxpayers. (Winner 1992:42-43)

Because the Valley's myths of heroic entrepreneurialism and technical innovation are themselves an object of study, I have organized this account in terms of the technical evolution from vacuum tubes to microprocessors, loosely following conventional history, but also highlighting the role of the military and Cold War. While this approach risks the artifactual bias of a "history of inventions," it also enables me to show that, even among those most closely involved in the creation of these technologies, the evolution of common practice was more gradual, multiplex, and sometimes surprising, than conventional accounts indicate.

The PC industry did not spring from the microprocessor *ipso facto*, the inevitable result of the invention itself; and Silicon Valley did not transform overnight into a global hub of information society. The region is defined by almost one hundred years of development as a high-technology zone, by the countercultural social movements of the 1960s and 70s, and by the separate histories of the personal computer and computer networking. What we understand today as the Internet represents the confluence of a number of distinct forces, some of which are contradictory, many of which are redundant (e.g. multiple, independent instances of similar technologies), and most of which involve the gradual improvement of process and technique through the ideas and energies of many thousands of people applied over many decades.

Ideas of personal computing and computer networking preceded microelectronics and both have long pre-digital histories that span a variety of technologies such as the telegraph and amateur radio. Desktop and even portable calculating machines existed in the first half of the twentieth century. Vannevar Bush, who had been Terman's mentor at MIT, wrote in a 1945 article for *Atlantic Monthly* of his idea for the "memex," a "device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility" (Bush 1945). The article, "As We May Think," predicted many kinds of technology, from hypertext, speech recognition, and personal computers, to the Internet and World Wide Web, and influenced such computer pioneers as Douglas Engelbart and Ted Nelson. Yet despite the long history and wide influence of these ideas, neither the PC nor the Internet emerged along an expected path. For those acquainted with its history, the puzzle of personal computers is why they took so long to arrive. As Ted Nelson, who coined the term "hypertext" in his 1965 proposal for a memex-like system called *Xanadu*, wrote in 1977: "The question is not why have home computers come? The question is what held them back?" (Nelson 1977) One obstacle Nelson and others (Freiberger and Swaine 2000; Markhoff 2005) point to was a "high priesthood" in government and corporate bureaucracies that kept computers large, remote, and locked away from users in air-conditioned rooms. In the last twenty years scholars in science and technology studies (STS) have called attention to the role of users in the social construction of technology (e.g. Bijker et al. 1987). Though they are typically viewed as consumers acting through the market only after, in the language of social constructivism, "closure of debate about the emerging technical (and cultural) artifact is in sight" and specific practices have coalesced into a new medium (Feenberg and Bakardjieva 2004:41), STS scholarship has worked to counter this approach. In terms of the personal computer and the Internet, recent accounts by veteran journalists of Silicon Valley (Freiberger and Swaine 2000; Markhoff, 2005), STS and other scholars of the Internet (Abbate 1999; Castells 2001), have emphasized the direct involvement of producer/users in creating these technologies. The account that follows of the shift from defense and semiconductors that characterized early phases of Silicon Valley's development, to the PC and Internet industries that followed, draws on all these works to highlight the importance of recognizing the close, symbiotic, and cybernetic connection between the history of invention and the history of common practice in the social construction of these technologies. Several good chronicles tell of the development of the personal computer (Hanson 1982; Freiberger and Swaine 2000; Roy 2001; Waldropp 2001; Markhoff 2005) and I will not present a comprehensive overview here, but will focus instead on the vital role of users and the symbiosis between their communities of practice and the development of the personal computer industry after 1975.

In the thirty years following World War II, IBM dominated the U.S. computer industry and centered it firmly within the East Coast research-military-industrial complex that Terman had sought to transplant to Silicon Valley. Through most of the 1960s IBM remained the largest of eight major computer companies (with UNIVAC, Burroughs, Scientific Data Systems, Control Data Corporation, General Electric, RCA, and Honeywell). These were known in the business world as "IBM and the seven dwarfs" (Kidder 1981:11), given IBM's much greater size and influence. Scientific Data Systems was a Santa Monica, California company later sold to Xerox, but all the others were in the Northeastern U.S. IBM, itself a large, corporate, bureaucracy, fostered the "high priesthood" approach to computers, where giant, costly machines were leased to users, serviced by expert consultants and technicians, and sold by zealous salesmen in white shirts. IBM, and therefore everybody else, saw computers as serious tools for serious people and focused on making mainframes for government, military, and corporate customers, not individual consumers.

As transistor and core memory technology developed in the late 1950s, smaller "minicomputers," the size of a few filing cabinets rather than a room, became possible. "Like other important postwar technologies, the minicomputer was developed through the combined efforts of federal military funding and university research" (Saxenian 1994:18). Ken Olsen, a researcher at MIT's Lincoln Laboratory who had been working on ways to make a smaller, more general-purpose computer, left academia in 1957 to found Digital Equipment Corporation (DEC), the first and largest of the minicomputer companies of the late 1950s and 1960s. By the early 1970s, the computer industry consisted essentially of two types of companies: those that sold room-sized mainframes that "were designed by an entire generation of engineers, cost hundreds of thousands of dollars, and were often custom-built one at a time;" and those that sold cheaper, more compact, minicomputers, built in larger quantities and sold primarily to businesses and scientific laboratories (Freiberger and Swaine 2000:24). IBM and the dwarfs were in the first business, while companies such as DEC, Hewlett Packard, Wang, Data General, and Prime, were in the second. Though minicomputer companies were known for an aggressive, fast-paced, high-risk corporate culture that differed from the button-down world of IBM[6], they did not essentially challenge the high priest approach to computing. As veteran computer industry journalists Paul Freiberger and Michael Swaine have observed, despite having means and motive, neither group of computer makers brought the personal computer to market.

> The mainframe and minicomputer companies had the money, expertise, and unequaled opportunity to place computers in the hands of nearly everyone. It didn't take a visionary to see a personal-sized computer that could fit on a desktop or in a briefcase or in a shirt pocket at the end of the path toward increasing miniaturization. In the late 1960s and early 1970s, the major players among mainframe and minicomputer companies seemed the most logical candidates for producing a personal computer…It was only logical, but it didn't

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[6] For example, see Tracy Kidder's account of Data General Corporation in *The Soul of a New Machine* (1981).

> happen that way. *Every one of the existing computer companies passed up on the chance to bring computers into the home and on top of every work desk*. The next generation of computers, the microcomputer, was created entirely by individual entrepreneurs working outside the established corporations. It wasn't that the idea of a personal computer had never occurred to the decision makers at the major computer companies. Eager engineers at some of those firms offered detailed proposals for building microcomputers and even working prototypes, but the proposals were rejected and the prototypes shelved. In some cases, work actually commenced on personal computer projects, but eventually they, too, were allowed to wither and die. The mainframe computer companies apparently thought that no market existed for low-cost, personal computers, and even if there were such a market, they figured it was the minicomputer companies who would exploit it. They were wrong. (Freiberger and Swaine 2000:25)

Minicomputer makers DEC and Hewlett Packard both had engineers leave after squelching their proposals to market computers for individuals. PC magazine pioneer David Ahl, left DEC in the mid-1970s when, after seeing his plan to market personal computers, company founder, Olsen, is reported to have "said that he could see no reason why anyone would want a home computer" (Freiberger and Swaine 2000:28). Apple Computer co-founder Stephen Wozniak began building personal computers while employed as an engineer at Hewlett Packard. After several unsuccessful attempts to interest his employer in a microcomputer project, he asked the company if they would sign a release so he could pursue the work on his own and they did. (Segaller 1998:153)

The computer companies were not the only firms in a position to develop and market personal computers. Semi-conductor firms developed microcomputer expertise in the course of designing microprocessors and making them useful. As general-purpose, programmable chips, microprocessors needed programs and were useless without them. In order to write those programs, chipmakers had to build what were essentially microcomputers around their chips. Such development systems also involved writing the first microcomputer programming languages and operating systems. Intel was in the forefront with such technology; many of those who started PC companies in the 1980s (Mike Markkula, Gary Kildall, Adam Osbourne, Fredrico Faggin), honed their microcomputer knowledge working at Intel in the 1970s; and the first personal computers were built around off-the-shelf Intel processors[7]. However, Intel, too, passed up the opportunity to get into the personal computer business. There were several reasons for this beyond the perception noted earlier that computers were industrial products that had no consumer market. First, Intel's primary business had always been computer memory chips and it was not until the mid-1980s that microprocessors took the lead. Intel co-founder Noyce had also guided the company not to compete with its customers, to supply components, but leave the tasks of marketing and supporting whatever products might be made with them to other firms. When Hoff and his team developed their first microprocessors (the 4004 and 8008) as custom orders for corporate clients (Japanese calculator maker Busicom), Intel did not retain the right to sell the chips to other customers. When they eventually did secure the rights, as Freiberger and Swaine note, they were reluctant to release the chips to "the general engineering

[7] The Scelbi and Mark-8 on the 8008, and the Altair on the 8080.

public" because they were not set up for that kind of business. Memory chips "were easy to use and were sold in volume like razor blades." Microprocessors, however, required that customers learn how to use them, how to program them, and how to make them interface with other chips and devices. Providing that type of documentation and customer support is difficult and costly. Within Intel, Hoff had to evangelize the virtues of selling microprocessors as off-the-shelf components persistently before the company finally hired an advertising manager—Regis McKenna, who later handled Apple's advertising—to promote their microprocessor "in a fall 1971 issue of *Electronics News*" as "a microprogrammable computer on a chip." At about the same time, Texas Instruments released and filed a patent for what it called "a single chip computer." With these developments microprocessors became available to individual engineers and hobbyists. By the early 1970s, those who were aware of the advances in computing technology chaffed against the strictures of time-sharing on mainframe and minicomputers and many began to experiment with building microcomputers of their own. (Freiberger and Swaine 2000:17-20)

As, Freiberger and Swaine point out in their history, *Fire in the Valley: The Making of The Personal Computer* (2000), "Intel's marketing department had been right about the amount of customer support the microprocessors demanded," even when the customers were engineers building their own devices (2000:20). The magnitude and type of support required to bring to market a computer that would be useful to people who were not computer experts is difficult to imagine, let alone calculate, even in hindsight. Thus, the resistance of established firms and industries to developing the PC cannot be explained simply, as yet another example of big organizations failing to harness the technologies created within them.[8] Deciding not to develop and market PCs seems entirely reasonable when one takes a moment to consider all the various kinds of cultural supports, not to mention personal investments of time and effort, required to make these machines useful, even today, let alone in the early 1970s. As historians of technology have argued, many inventions require complementary inventions before they can be usefully deployed (Rosenberg 1994:143) and *all* technologies require a cultural milieu to support their meaningful application (i.e. are socially constructed). In the case of the PC, a host of complementary inventions in hardware and software came together around the microprocessor, but the social and cultural infrastructure, the support, required for these developments did not, and arguably could not, come from the mainframe, minicomputer, or semiconductor companies. Instead, Freiberger and Swaine contend, it emerged through "a grassroots movement of hobbyists fully conscious that they were ushering in not just a technological revolution, but a social one as well" (2000:xx). Their book is valuable, not only for drawing attention to the many different types of support and complementary invention involved in the development of the PC, but also for its insight into the vital role of three social practices that came

[8] For example, Xerox's famous "fumbling of the future" described inter alia in Smith and Alexander (1988) and Brown and Duguid (2000).

together around personal computing in the 1970s: (1) The publishing and reading of popular periodicals about microelectronics among engineers and hobbyists; (2) the formation of clubs and user groups, and hosting of conferences and "faires" among PC makers, users, entrepreneurs, and enthusiasts; and (3) the first store-front retailers who sold and proselytized PC products, and also provided hand-holding and local sites of dissemination and community building. Freiberger and Swaine summarize their insight into these three distinct (though overlapping and mutually reinforcing) social realms, writing:

> It's perfectly accurate to say that computer magazines, user groups, shows, and stores were crucial to the development of the personal computer. But saying this creates a misleading impression unless one explains that the magazines, shows, and stores of the early days of the personal computer revolution were very different from magazines, shows, and stores today. The essence of the difference is that, whatever the motives of the editors, organizers, or storekeepers, the magazines, shows, and stores were primarily about community building. They all helped to create a culture in which computers for individuals could be imagined, built, understood, and, almost incidentally, bought and sold. (2000:213)

One need not accept the contention that buying and selling were incidental to the evolution of the personal computer to appreciate the value of Freiberger and Swaine's insight into importance of communities of practice in making the PC "thinkable" and "doable." By looking briefly at the role of PC magazines, clubs and conferences, and shops, I seek to give some sense of the tight interconnection of producers and users in the evolution of PC technology. I adopt "producers/users" from Castells who employs it in his analysis of the Internet culture to "refer to those whose practice of the Internet feeds directly back into the technological system; while consumers/users are those recipients of applications and systems who do not interact directly with the development of the Internet, although their uses certainly have an aggregate effect on the evolution of the system" (2001:36). My proposition is that understanding the role of the three social practices that Freiberger and Swaine highlight shows how the term "producers/users" is also useful and applicable in the context of the development of the PC.

Once microprocessors became generally available, the growing interest in single-user microcomputers was both showcased and fanned in the pages of hobbyist electronics magazines that featured designs for home computers and news of the latest products and technologies. Computer enthusiasts relied on these popular periodicals to keep up with the latest developments; read tutorials and product reviews; connect to others like themselves; buy and sell; and engage in a variety of educational, economic, and social practices centered around the PC. "The magazines defined a market, spread important news, and helped bring hobbyists together" (Freiberger and Swaine 2000:217). Between 1974 and 1977 several different personal computers were marketed, most as kits that required customer assembly, in the pages of such periodicals as *Popular Science*, *Radio-Electronics*, and *QST* magazine, a publication of the American Radio Relay League (ARRL). Computer hobbyist magazines emerged from earlier practices of radio enthusiasts and ham operators. The first kit computer, called the Scelbi, was advertised in the March 1974 issue of *QST* and the second, the Mark-8, was featured a few months later in the July issue of *Radio Electronics*. The first commercially successful PC, the Altair, often cited as launching the PC industry, was announced in a *Popular Electronics* cover story in January 1975. The Altair

> was an instant hit with amateur computer enthusiasts, who placed thousands of orders during the first few months it was advertised. Suddenly, a technology that had been restricted to authority figures in academia, business, and government was in the hands of teenage hobbyists. Members of a new hacker subculture quickly made improvements to the Altair and began devising more user-friendly machines, and by the late 1970s there was a thriving market for personal computers. (Abbate 1999:137-138)

Though "Altair" is the name by which it became famous, Freiberger and Swaine report that the machine was originally dubbed the PE-8, for *Popular Electronics*, reflecting the involvement of the magazine in the development of the technology. *Popular Electronics* editors, Les Solomon and Arthur Salzberg, actively sought good designs for a personal computer about which they could run a story. Judging the initial submissions to the magazine inferior, Solomon contacted several talented engineers asking them to submit designs; traveling to meet them; and facilitating their business collaborations. He also shaped and set the pace of the Altair's development by holding out a cover story as the prize for a prototype that met the magazine's deadlines and requirements. One requirement: Salzberg insisted that *Popular Electronics* "had to offer its readers more than just instructions on building the device. [They] also had to offer one solid application, a practical purpose for the Altair that could be demonstrated right away" (Freiberger and Swaine 2000:46).

Though Solomon initially had no idea what that application might be, he contributed to its development by introducing Roger Melen and Harry Garland, two Stanford graduate students who had created a digital camera called the Cyclops, to Ed Roberts, whose company MITS made the Altair. As Freiberger and Swaine report:

> Soon after the meeting between Melen and Roberts, Solomon wrote to Garland and Melen suggesting a television adapter for the Cyclops. They replied that it would be prohibitively expensive, and instead described their plan to link the Cyclops device to the Altair for use as a security camera. Solomon was gleeful. The security camera was the practical application that Art Salzberg had wanted. He incorporated the idea into Garland and Melen's article on the Cyclops. (2000:49)

This is a vivid illustration of the tight interconnections linking the popular electronics periodicals (the community of practice of publishers and readers) and the producers/users of personal computers during this period. Garland and Melon went on to found Cromemco, an early and successful Silicon Valley computer company that began making video camera and supporting cards on the strength of the symbiosis between their Cyclops camera and the Altair. The Sol Terminal computer[9], the first PC packaged with a built-in video display, and also one of the first with ROM memory that eliminated the need to enter programs by flipping switches, came out in 1977 from Processor Technology in San Francisco's East Bay. The name Sol is a reference to *Popular Electronics* editor Solomon, another indication of the productive feedback relationships between the magazines, engineers, and entrepreneurs in the emerging PC industry. A variety of successful personal

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[9] The computer featured in the film *War Games* (1983) a Net generation classic.

computing magazines were started in the mid-1970s, such as *Byte*, founded in 1975, which had a subscription of 50,000 by January 1977; *Kilobaud,* founded in 1977; and *Dr. Dobb's Journal*, the first software magazine, launched in 1976 by the People's Computer Company, a Silicon Valley non-profit created to promote the personal use of computers. As PCs became big business in the 1980s, so, too, did computer publishing and every new development—networking, gaming, desktop publishing, and the Internet—has spawned a complementary development in print media around the technology, its production, use, and marketing.

As the magazines circumscribed a national community[10], personal computer clubs, users groups, conferences and fairs provided local and face-to-face venues for the creation and expression of that community. Within such groups and events, new computer hardware and software—and knowledge and information thereof—was demonstrated, discussed, troubleshot, and exchanged. As Freiberger and Swaine point out, the clubs provided day-to-day support for computer hobbyists, while the fairs "were technology spectacles" where a "carnival atmosphere ignited each attendee's enthusiasm for the growing field" and "gave hobbyists the opportunity to try out the latest novelties with their own hands." The Altair is a milestone in PC history, not simply because a significant number were sold, but because of the newsletters, clubs, and conferences that formed around it. The Homebrew Computer Club, probably the most famous hobbyist group in PC history, started in Menlo Park

[10] That is, in Benedict Anderson's sense of "imagined community (1991)."

(Silicon Valley) in 1975 in the excitement surrounding the newly released Altair. Demand far outstripped expectations and early customers faced long waits for their Altairs, so those who had machines brought them to club meetings for show and tell. The first large PC conference, held in early 1976, was a single-company event hosted by MITS, makers of the Altair, in Albuquerque, New Mexico. But soon thereafter, as Freiberger and Swaine (2000) report, computer clubs and conferences were started all over the U.S. In 1976 the Amateur Computer Group of New Jersey (ACGNJ) organized the Trenton Computer Festival that "pioneered the idea of an open computer conference that wasn't tied to a single manufacturer." Other early PC users' groups include the Boston Computer Society (BCS), which "eventually developed…into a 7,000-member organization with 22…committees;" and the Midwest Area Computer Club, which drew nearly 4,000 attendees to its first conference in June 1976. In April 1977, Dr. Dobb's editor Jim Warren organized California's first PC conference in San Francisco, which he called "the West Coast Computer Faire," in reference to the popular Renaissance faires where attendees dressed in Elizabethan garb. With nearly 13,000 attendees, the West Coast fair was three or four times larger than any previous computer conference and became an annual Bay Area event that played a significant role in the development of the PC industry. (Freiberger and Swaine 2000:224-230)

In addition to user initiated clubs, MITS itself sought to facilitate support for the Altair through a newsletter, user conference, and a rather unusual marketing tactic that involved driving a motor home, known as the "MITSmobile" or "Blue Goose," around the country, to promote microcomputing and get people to start computer clubs. "One of the clubs it helped initiate was the Southern California Computer Society, which in turn published an early influential microcomputer magazine, the *SCCS Interface"* (Freiberger and Swaine 2000:59). Started with two members in September 1975, the SCCS had grown to 20,000 members just one year later (Endelso 2001). As Freiberger and Swaine explain, there were many good reasons to start a computer club at the time.

> The equipment in these early days didn't always work or work properly, and software was often unusable or nonexistent. Although buyers were typically engineering hobbyists, few of them had all the skills necessary to fully understand a microcomputer. The clubs encouraged a synergistic sharing of knowledge among the sophisticated but stymied users of the machines. Without this interaction and mutual aid, the industry would not have blossomed as it did. (Freiberger and Swaine 2000:59)

In addition to providing technical support, and creating local communities of practice, clubs and users' groups also played an important consumer advocacy role in the fledgling days of the PC industry. Freiberger and Swaine argue that these groups "worked to protect computer buyers to an extent that was unprecedented for any American industry."

> The clubs fostered a spirit of voluntarism and adherence to consumer advocacy that was carried over into the users' groups…Committees worked diligently against shoddiness in manufacturing and deception in advertising. The clubs were responsible for directing the efforts of the free-spirited microcomputer manufacturers of the day. Without the feedback from the clubs, the early hobbyist-oriented microcomputers

> might never have developed into the useful personal computer of today. (Freiberger and Swaine 2000:225-6)

Given the great number of microcomputer makers who were themselves members of such clubs—the most well known being Apple Computer, a company started in the context of The Homebrew Computer Club—the feedback that took place through these social forms clearly went beyond consumer advocacy, blurring conventional boundaries of producers and users. Reviews in club newsletters could make or break new products and many industry entrepreneurs began by selling their wares (hardware, software, computer books) at club meetings. In the context of cultural freedom, hybrids multiply.

As interest in personal computing grew along with demand for products such as the Altair, and the many complementary devices (storage, memory boards, software) required to make it practically useful, a number of business-minded hobbyists saw an opportunity to open store-front outlets where people could try and buy computers. Though they were commercial enterprises oriented to market exchange, early computer stores served the same range of economic, educational, technical support, and social functions as PC magazines and clubs, though, of course, in different ways to different degrees. For example, Dick Heiser, who opened a computer store in West Los Angeles in 1975, quickly found that, though he was making a steady profit selling computers, most of his employees' time "was spent explaining the technology, repairing machines, setting up systems, and reassuring customers. Hand-holding, community building, proselytizing" (Freiberger and

Swaine 2000:233). Clearly the relationships between the first computer retailers and their customers were more multi-stranded than simple market exchange of goods at prices determined by the law of supply and demand. Another early computer outlet, the Byte Shop, which opened its first store in the center of Silicon Valley (Mountain View) in December 1975, took its name from the leading hobbyist magazine (*Byte*). Founded by a Homebrew member who, when the store expanded, "insisted that Byte Shop managers in the Northern California area attend meetings of the Homebrew Club," (Freiberger and Swaine 2000:236) the Byte Shop is an excellent example of the synergistic interconnection of the magazines, clubs, and stores in creating the cultural milieu that shaped and supported the development of personal computing in this period. In 1977 several new manufacturers released successful personal computers that established the market: Commodore International began selling the PET computer; Radio Shack came out with the TRS-80; and Apple Computer, incorporated that year, released the Apple II. Thus, 1977 marks a turning point from the hobbyist-oriented development of the PC to its development within the market-oriented context of corporate capitalism. By the 1980s large regional and national retailers had mostly supplanted the computer stores and franchises founded by hobbyist entrepreneurs in the 1970s. However, without such nodes of exchange, the PC and PC industry would not have developed as and when they did in the U.S.

The Internet: Built by ARPA, Transformed by Users

The origins of the Internet in ARPANET, a computer network set up by the Advanced Research Project Agency (ARPA) in the U.S. Department of Defense, have been examined in many popular (Hafner and Lyon 1996; Segaller, 1998) and scholarly (Naughton 1999; Abbate 1999; Castells 2001) books. Created in February 1958, in response to the launch of Sputnik, ARPA took on the "task of mobilizing research resources, particularly from the university world, toward building technological military superiority over the Soviet Union" (Castells 2001:10). ARPANET, which emerged out of the Agency's Information Processing Technology Office (IPTO), was only a minor program, but through a confluence of technical, organizational, and political factors it became "a large-scale, long-lived, and highly visible example of the 'success' of packet-switching" networks (Abbate 1999:219). When it was launched in September 1969, ARPANET was a single network connecting four research centers (at UCLA; Stanford Research Institute; UCSB; and the University of Utah), but within a decade it had been transformed into a network of networks—the Internet—with protocols that made it "capable of almost indefinite expansion" (Abbate 1999:113). As Janet Abbate has argued in *Inventing the Internet* (2000), this development was neither inevitable, nor spontaneous.

> The history of the Internet holds a number of surprises and confounds some common assumptions. The Internet is not a recent phenomenon; it represents decades of development. The U.S. military played a greater part in creating the system than many people realize, defining and promoting the Internet technology to serve its interests. Network

> projects and experts outside the United States also made significant contributions to the system that are rarely recognized. Above all, the very notion of what the Internet is—its structure, its uses, and its value—has changed radically over the course of its existence. The network was not originally to be a medium for interpersonal communication; it was intended to allow scientists to overcome the difficulties of running programs on remote computers. The current commercially run, communications-oriented Internet emerged only after a long process of technical, organizational, and political restructuring. (Abbate 1999:2)

Though Abbate examines the important ways military priorities and concerns shaped the Internet, she also illustrates that "military shaping is only part of the story. The Internet approach would not have been so influential had it not served the needs and interests of a diverse networking community" (Abbate 1999:144).

Abbate focuses on the social and cultural processes through which the APRANET was transformed into the contemporary Internet. Her analysis reveals a number of ways in which the Internet, like the PC, was characterized by informal, decentralized, user-driven development carried out by "a self-selected group of experts" building tools for their own use (Abbate 1999:127). The patterns and processes of development she describes for the Internet share much in common with those of the PC. In both cases:

- Significant time and support were required to transform experimental technologies into media of everyday use.
- Voluntary social forums and communities of use/practice/interest provided much of this support. These served as sites of development, deployment, and

testing, that is, contexts within which the social construction of the technologies took place.

- Users shaped the technology to such an extent that they are more accurately described as “producers/users” (a term Castells proposes in his analysis of Internet history and that I have extended to the PC above).

Having discussed these patterns in the context of the PC in the previous section, let me give a brief illustration of them in regard to the Internet, then turn to their relevance as cultural sources of Cyborganic.

In the early 1970s, as Abbate (1999) observes, using the ARPANET was difficult:

> the support systems were inadequate, and there was little opportunity to interact with other users….One challenge in making the ARPANET user friendly lay in translating activities that build community—sharing of information, support, recreation—to the network environment. In taking these steps for the first time, early users of the ARPANET laid the groundwork for future virtual communities. (1999:84)

Interpersonal communication and community building practices were as significant in shaping the Internet as they were in shaping the PC. Abbate’s account is valuable for its recognition that “building a sense of community among ARPA’s researchers” was “both a means to facilitate network development and an end in itself” (1999:69). Lawrence Roberts, ARPANET’s first program director, coordinated the project “through a variety of informal mechanisms aimed at creating and reinforcing common values and goals” (Abbate 1999:69). In addition to maintaining personal contact through frequent site visits, those working on the ARPANET met in annual retreats for Principal Investigators (PIs), or at similar meetings for graduate students. "By bringing researchers from around the United States together to work on pressing technical problems of mutual interest, PI retreats and graduate student meetings helped the social networks of computer scientists to become national rather than merely local" (Abbate 1999:69). Abbate draws attention to the efforts of ARPANET's managers in "[C]ultivating existing social networks, creating new management mechanisms to promote system-wide ties, and insisting on collaboration among groups," arguing that these all aided in the "social and technical integration of the system" (Abbate 1999:73). That is, building a computer network entailed building social networks in the process. This pattern of technological development and deployment began with the initial ARPANET project and only intensified as the network came to reach more and more users outside those directly involved in its creation.

Abbate's overarching argument in her history is that "the ARPANET was not a finished product" at the end of its first phase of development (around 1972), and that "users were responsible for transforming [it] from an experimental system with limited appeal to an operational service whose existence could be justified and even celebrated" (1999:111). Those who planned the network saw it as a means to share access to large, centralized computing systems and other resources among remote host sites. Abbate shows how this original "computer utility" view was supplanted by users who turned the network to interpersonal communication. For example, ARPANET was designed to connect distant computer centers (nodes) at universities and research labs across the country. However, soon after each node was connected, users would begin to use the network for local, intra-node communication. "No one had envisioned such a use of the ARPANET," notes Abbate (1999:93-4), and the network monitors at Bolt, Beranek and Newman (BBN), the firm contracted to build the ARPANET, were surprised when they first noticed heavy intra-node traffic, that is, great flow in segments of the network that had little flow over outgoing lines. "By 1975 almost 30 percent of ARPANET traffic was intra-node. A spontaneous innovation by users had contributed substantially to the use of the ARPANET and hence to its perceived value" (Abbate 1999:94).

Electronic mail is another example of the way users shaped development of the network. This application had not been part of the original ARPA project, but mainframe and mini-computer users had been sending intra-system mail for years and in 1971 Ray Tomlinson, a BBN programmer, modified the mail program he had written for the company's operating system to transfer files between machines over the network. Electronic mail "quickly became the network's most popular and influential service" and "eclipsed all other network applications in volume of traffic" (Abbate 1999:107). By 1973 it accounted for 75 percent of ARPANET traffic. Abbate underscores the importance of this user innovation, writing:

> Had the ARPANET's only value been as a tool for resource sharing, the network might be remembered today as a minor failure rather than a spectacular success. But the network's users unexpectedly came up with a new focus for network activity: electronic mail. (Abbate 1999:106)

Electronic mail and intra-node communication are but two of the many illustrations Abbate gives to support her contention that the network's users were directly involved in its development in its first decade of operation and that their activities contributed to the perceived success of the system (Abbate 1999:83).

PC Culture, Network Culture, Counterculture

Despite different origins and trajectories, by the early 1990s the cultures of personal computing and internetworking had converged and propagated in a new generation of producers/users to which the Cyborganic community I studied belonged. As noted at the outset, this generation inherited the Internet culture composed of techno-meritocratic, hacker, virtual communitarian, and entrepreneurial strains (Castells 2001: 37). While the histories of the development of Silicon Valley, the microprocessor, PC, and Internet illustrate the confluence of techno-meritocratic, hacker, and entrepreneurial cultures as a legacy of the military-university-industrial complex, little has been said yet about the communitarian legacy of the counterculture. The U.S. counterculture of the 1960s and 1970s is important for having brought technology, entrepreneurialism, sociality, and social action together in new relationships, thereby contributing to the synthesis of a number of Silicon Valley's legacies into a new set of values and practices. The countercultural strands are especially significant to the undertaking of this chapter because they not only connect PC and Internet culture, but also situate the resulting mix regionally in the San Francisco Bay Area. Therefore, let me briefly consider their role in the social construction of networked, personal computing before turning to explain how the various cultural legacies came together in Cyborganic in the 1990s.

The connections linking personal computing, networking, and the counterculture have been well documented in a variety of contexts. In his book *From Satori to Silicon Valley* (1986), cultural historian Theodore Roszak traces the rise of the PC industry to the countercultural values of the 1960s and 1970s. *Whole Earth Catalog* creator Stewart Brand has argued that "the counterculture's scorn for centralized authority provided the philosophical foundations of not only the leaderless Internet but also the entire personal-computer revolution" (Brand 1995). Freiberger and Swaine (2000), Abbate (1999), and Castells (2001), whose work I have drawn on in this chapter, have all noted countercultural influences as integral to the social construction of networked, personal computing, as have a number of other less known works (e.g. Vallee 1982, 2003). More recently, two authors have focused directly on the role of the counterculture in shaping, in one case the personal computer industry (Markhoff 2005), and in the other, the new economy of the information age (Turner 2005, 2007). By looking briefly at their arguments I seek to show how the counterculture contributed to the synthesis of Internet culture and to making the Bay Area the region in which the various technical possibilities and cultural histories of networked computing came together most productively in the last thirty years of the twentieth century.

In *What the Dormouse Said: How the 60s Counterculture Shaped the Personal Computer Industry* (2005), veteran computer culture journalist, John Markhoff, makes the case that the thriving counterculture of the Bay Area and Midpeninsula (the area between San Francisco and San Jose) played a significant role in creating "a new set of computing paradigms" in the 1970s (2005:xiv). Structured around the life histories of researchers at two government-funded Stanford University labs—Douglas Engelbart at Stanford Research Institute (SRI) and John McCarthy at the Stanford Artificial Intelligence Laboratory (SAIL)—Markhoff's book connects the military-university-industrial complex to the personal computer hobbyists, and situates them within the wider political and cultural context of the era.

> The civil rights, psychedelic, women's rights, ecology, and antiwar movements all contributed to the emergence of a counterculture that rejected many of America's cherished postwar ideals. The computer technologies that we take for granted today owe their shape to this unruly period, which was defined by protest, experimentation with drugs, countercultural community, and a general sense of anarchic idealism. (Markhoff 2005:xii)

Markhoff argues that the strength of the counterculture in the region is one reason development of the personal computer industry was centered in the San Francisco

Bay Area. Altair-maker MITS and their collaborator Microsoft[11] were located in New Mexico; and the possibility for personal computing existed in other places in the U.S. and abroad[12], most especially on the East Coast in the high-technology corridor of Route 128 adjacent to MIT. So why, Markhoff asks rhetorically, did the PC industry emerge where it did? The answer he provides is that the counterculture contributed to a new vision and understanding of computer technology that enabled the socially meaningful construction of new technologies, products, and media.

> What separated the isolated experiments with small computers from the full-blown birth of personal computing was the West Coast realization that computing was a new medium, like books, records, movies, radios, and television. The personal computer had the ability to encompass all of the media that had come before it and had the additional benefit of appearing at a time and place where all the old rules were being questioned. Personal computers that were designed for and belonged to single individuals would emerge initially in concert with a counterculture that rejected authority and believed the human spirit would triumph over corporate technology, not be subject to it. The East Coast computing culture didn't get it. The old computing world was hierarchical and conservative. (Markhoff 2005:xv)

Markhoff connects Engelbart's group at SRI, one of APRANET's original nodes, where the computer mouse, windowing, and online conferencing were pioneered, to the hacker culture of SAIL, the "Acid Tests" of Ken Kesey and "The Merry

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[11] Started by Bill Gates and Paul Allen in 1975, Microsoft moved from Albuquerque, New Mexico, to its current home in Bellevue, Washington in January 1979.

[12] For example, in 1973, Truong Trong Thi, a Frenchman of Vietnamese descent, came out with a commercial microcomputer system, the Micral, built around the Intel 8008 processor.

Pranksters," the politics of the Free Speech movement, and the hippie culture of Steward Brand's Trips Festival and *Whole Earth Catalog*. The Trips Festival, Markhoff writes, "gave rise to the Grateful Dead and helped create the San Francisco music scene, which in turn contributed to the creation of a national counterculture" (2005:111). SRI researchers' use of LSD and New Age *est* seminars as experimental techniques to advance their work; and the active role of SAIL Director John McCarthy in the Free University founded "to further aims of the Free Speech Movement" are just a few of the many examples Markhoff presents to illustrate the transformative role of the counterculture in "the lives of many of the young men who were to pioneer the ideas underlying the personal computer" (2005:111). He traces the countercultural legacy to Xerox's Palo Alto Research Center (PARC), legendary in the computing world as the birthplace of the Graphical User Interface (GUI), Ethernet, and laser printing; and to Apple Computer which released the first PC with a graphical user interface in 1983.

Beyond the local color that the countercultural ideology of freedom, with its practices of sex, drugs, and rock and roll, provided, it also provided the conditions within which the computer was re-imagined as a tool of individual expression and liberation. Markhoff observes that there existed a divide in the counterculture between "modern-day Luddites" whose back-to-nature attitude renounced high technology and "technophiles" who embraced it. Fred Turner describes exactly the same divide. In "Where the Counterculture Met the New Economy: The WELL and the Origins of Virtual Community" (2005), Turner shows the connections that link 1960s counterculture to contemporary cyberculture. He situates the WELL, an influential Bay Area computer conferencing system started in 1985 by Stewart Brand and Larry Brilliant, "and the increasingly important form of technologically mediated sociability it represents," within the wider technological, organizational, and cultural transformations of network society by tracing its legacy, through Brand's *Whole Earth Catalog,* to the American counterculture of the 1960s (Turner 2005:489). "As its name suggests," The WELL, or Whole Earth 'Lectronic Link, "took shape within a network of individuals and publications that first came together…with the publication of the *Whole Earth Catalog*" in 1968 (Turner 2005:487). Turner argues that, though the *Catalog* preceded the rise of digital computing, it can be seen as a "network forum" "within which information exchange, community building, and economic activity took place simultaneously" (Turner 2005:491). The distinction Turner draws within the counterculture between the New Left and a movement he identifies as "the New Communalists" is particularly valuable to understanding the synthesis of communitarian ideals, entrepreneurialism and information technology that came together in and with the networked personal computer.

> Both the New Left and the counterculture hoped to transform the technocratic bureaucracies that, in their view, had brought Americans the cold war and the conflict in Vietnam. Both also hoped to return Americans to a more emotionally authentic and community-based way of life. The New Left, led by the Students for a Democratic

> Society, pursued these goals as insurgent political movements always have: they wrote statements, formed parties, chose leaders, held news conferences. Many members of the counterculture however, *stepped away from agonistic politics and sought instead to change the world by establishing new, exemplary communities* from which a corrupt mainstream might draw inspiration. For this group, whom I will call the New Communalists, as for many others in the counterculture, the key to social transformation lay not in changing a political regime but in changing the consciousness of individuals. (Turner 2005:493, emphasis mine)

In the late 1960s and early 1970s, the *Whole Earth Catalog* combined "the tribal, anti-hierarchical politics of the New Communalist movement" with "the technophilia common to both the acidheads of the Trips Festival and the managers of America's nuclear arsenal" (Turner 2005:495). In the 1980s, the WELL took that synthesis online and, Turner argues, "the virtual community that emerged…not only modeled the interactive possibilities of computer-mediated-communication but also translated a countercultural vision of the proper relationship between technology and sociability into a resource for imagining and managing life in the network economy" (2005:491).

Turner's overarching argument is that, despite the suggestion by some new media scholars that the "peer-to-peer culture of the Internet emerged out of the New Left's critique of American political institutions," it "was the New Communalists of the *Whole Earth Catalog* and not the New Left for whom the building of a better society required stepping outside politics and turning instead toward information, technology, and commerce" (Turner 2005:511). Further, he argues that as the WELL built on the *Catalog's* network forum for information exchange, commerce, and community, dramatic shifts in technology and the organization of labor transformed the nature and value of these exchanges (Turner 2005:491). While the *Catalog* had come out twice a year, the WELL offered real-time communication twenty-four hours a day. While both united a geographically dispersed group of people, it was the WELL around which a dense, local community formed in the Bay Area. While both aggregated cultural information and member contributions in a non-hierarchical and collaborative system, the WELL "tended to push value out to its users, to distribute and increase value throughout the system" (Turner 2005:507). These differences, Turner shows, were not simply the result of the technology, but much more complexly the result of the global rise of the network form of organization that had occurred in the twenty-five years since the *Catalog* had first been published. As firms, industries, and nations began to downsize, adopt decentralized management structures, and reorganize "as project-oriented networks," this led to shifts in the organization of labor, which, in turn, shaped the development of the WELL (Turner 2005:504-505).

> In the late 1970s and 1980s, the professional communities of the Bay Area from which the WELL drew, and especially those associated with digital technology, witnessed an extraordinary rise in networked forms of economic organization and freelance patterns of employment. For the Bay Area's engineers and symbolic analysts, the WELL became a place to exchange the information and build the social networks on which their future employment depended. In this new climate, notions of virtuality, community, and the socially transformative possibilities of technology associated with the counterculture became key tools with which WELL users managed their economic lives. (Turner 2005:491)

The WELL was in this sense a successful realization of the New Communalist vision of a non-hierarchical community linked through information technology and a shared ethos. However, Turner contends, “at another level the WELL marks the failure of the New Communalist movement to escape the pull of America’s technological and economic centers of gravity” because the “new relationship of information, technology, and community” it developed “would ultimately facilitate the integration of computing technology and associated work styles into the mainstream of American life” (Turner 2005:511-512). Thus, the project of pursuing social transformation in everyday life came to contribute to the very systems of power and wealth whose technocratic rationality it had purported to counter.

Markhoff and Turner both illustrate the apparent paradox that in the Bay Area countercultural values and practices were integral to the development, first of the PC industry; then of the Internet industry and, most significantly, of the social and economic integration of networked computing associated with “the new economy” (Turner, Castells 2001). Together they give a sense of the role of the hippie counterculture in the convergence of communications and computing that took place in the decades between the rise of ARPANET (early 1970s) and the rise of the World Wide Web (early 1990s). During this period, dominant understandings of the computer as a specialist technology of calculation were transformed: the computer became a communication device and spilled out from its institutional and industrial seedbed into the everyday lives of individuals. The technological visions that such men as Vannevar Bush, Buckminster Fuller, and J.C.R. Licklider, had advanced within the context of the university-military-industrial complex, were taken up in segments of the counterculture (Turner's New Communalists) and put into practice in new forms of techno-sociality. The hobbyists and entrepreneurs of the personal computer "faires," Stanford and U.C. Berkeley hackers, engineers and researchers of SRI, Xerox PARC, and labs such as NASA Ames, were connected in the countercultural milieu that pervaded the San Francisco Bay Area in the 1960s and 1970s. The anti-East Coast establishment attitudes and open practices of information sharing of early Silicon Valley electronics firms, do-it-yourself ethos of radio hobbyists, and decentralized design and development of the ARPANET, all found mirrors in the counterculture. Within this matrix the cultures of personal computing and networking came together and, by the early 1990s, had converged and propagated in a new generation of producers/users that included the members of Cyborganic. This discussion of the counterculture has aimed to illustrate that convergence and situate it in the cultural history of the region because, as both Markhoff and Turner argue, the strength of the counterculture in the Bay Area was one reason the PC and Internet industries first developed there.

Gathering Together: Internet Culture, Techno-sociality, and Community

This account of the post-Sputnik confluence of computing, communications, and counterculture in the Bay Area serves as background for understanding Manuel Castells's analysis of Internet culture, "the culture of the creators of the Internet."

> The Internet culture is characterized by a four-layer structure: the techno-meritocratic culture, the hacker culture, the virtual communitarian culture, and the entrepreneurial culture. Together they contribute to an ideology of freedom that is widespread in the Internet world. However, this ideology is not the founding culture because it does not interact directly with the development of the technological system: freedom has many uses. These cultural layers are hierarchically disposed: the techno-meritocratic culture becomes specified as a hacker culture by building rules and customs into networks of cooperation aimed at technological projects. The virtual communitarian culture adds a social dimension to technological sharing, by making the Internet a medium of selective social interaction and symbolic belonging. The entrepreneurial culture works on top of the hacker culture, and on the communitarian culture, to diffuse Internet practices in all domains of society by way of money-making. (Castells 2001: 37)

The techno-meritocratic culture Castells locates at the base is a legacy of the university and government funded context within which the technology emerged. The hacker culture is a legacy of the MIT model railroad club, passed on through the Stanford Artificial Intelligence Lab (SAIL) and the use of Unix. The virtual communitarian culture is an inheritance of the counterculture epitomized by the WELL and a host of earlier endeavors, such as The People's Computer Company, and Community Memory, "a Berkeley computerized information network" (Markhoff 2005:199) Finally, the entrepreneurial culture—a mainstay of American life even before the electric age of inventor-entrepreneurs such as Marconi, Edison, and Bell—was also a regional legacy passed down from the World War I era, through Fredrick Terman (who brought another strand of it from MIT), to the semi-conductor (1960s), PC (1970s), workstation and computer networking (1980s), and Internet (1990s) industries that have distinguished the region as a hub of extraordinary technical and economic productivity. The entire history presented herein illustrates the convergence of these legacies and gives a sense of the lived social relations that brought them together in the Internet culture that Castells describes. While Castells's "hierarchically disposed" model of these layers is analytically valuable, I propose, in the figure below, another arrangement of the material to situate Internet culture within the context of individualization as a technological, economic, and social force.

	Technological	**Economic**	**Social**
Institutional	Techno-meritocratic	Corporate	New Left
Individual	Hacker	Entrepreneurial	New Communalists (Turner), Virtual Communitarian (Castells)

Figure 3.1: Rethinking Castells' four-layer structure of Internet culture

The overarching goal of this history of the development of Silicon Valley and the networked personal computer has been to emphasize the activity of producers/users and the role of social forms and forums—such as conferences, clubs, magazines, newsletters, games, and hobbies—in providing contexts and processes for the social and economic integration of the technology. Rather than viewing this integration hierarchically, I have worked to show how the linkages afforded by these social forums tend to cut across all kinds of boundaries to connect diverse domains (commercial, social, techno-scientific). This is precisely what makes them powerful as social networks. In this observation I draw on Mark Granovetter's much cited article “The strength of weak ties” (1973), a sociological study which found that it is not a person’s close relationships that are most useful in finding a job, but rather his or her weaker ties. This is because strong ties connect you to others with high degrees of similarity likely to know of the same opportunities you do. However, your weak ties link you to individuals who are members of other groups, and these are the ties that connect to wider networks of opportunity and information. Granovetter’s work has become a fixture of contemporary discourse on social networks and online community (e.g. Kavanaugh, et. al. 2005) largely because the Internet has turned out to be extremely effective for the maintenance of weak ties and diffuse social networks. While the cultural history presented here substantiates the productivity of such “weak tie” social forms as magazines and computer expos—through which a national community of PC enthusiasts was imagined and brought into being—my focus has been on the importance of local communities with stronger ties of practice and belonging.

Abbate has argued that “the needs and interests of a diverse networking community” shaped the Internet (1999:144); and many have cited Silicon Valley's cross-linked and overlapping communities of technical, economic, and social practice as the key to its superior economic performance over regions with comparable technological and economic bases, such as Massachusetts Route 128, but lacking such a cultural milieu (Saxenian 1993, 1994). Similarly, Markhoff (2005), Castells (2001), and Turner (2005), all argue the importance of communities of "selective social interaction and symbolic belonging" (Castells 2001:37) in the construction of the technologies they examine. From the radio aficionados of the early twentieth century, to the hobbyists and hackers of the PC and Internet, and the contemporary open source movement, producers/users and their communities have been crucial to shaping the vision and practices underlying "the long transformation" from telegraph to computer that began "with the first application of electricity to communication" (Marvin 1988:1). The Linux operating system that was developed in the 1990s, like the Altair in the 1970s, was important for the communities that formed around it, more than for the technology itself. Just as electronic mail transformed the Internet into a medium of interpersonal communication, "community applications" such as groupware (e.g. wikis, chat); peer-to-peer (e.g. Napster, Grokster) and social networking (e.g. Friendster, Myspace, Linked-In); blogging; and gaming (e.g. massively, multiplayer, online games, MMOGs), are transforming it yet again in the early twenty-first century.

My goal in this chapter has been to trace the role of communities of production and use in the development of the Bay Area as a hub of global Internet culture. In doing so I have worked to emphasize the symbiotic relationship between the activity of producers/users and their communities of practice in the development of the networked personal computer; and to illustrate the ways in which these technologies were shaped by the social contexts through which they developed. Implicit in the concept of community as it has figured in this account is another symbiosis between the face-to-face (offline or onground) and computer-mediated (online). University office parks housing Terman's "community of technical scholars," the high volume of intra-node traffic that surprised APRANET's network monitors, the local computer clubs and stores—all testify to the vital role of face-to-face community in the innovation and development of new technologies and industries.

Community Online and Off: The Reconfigured Importance of Place

Throughout this chapter I have framed the culture region of my Cyborganic fieldwork variously as "Silicon Valley", "the Bay Area", and "the Internet" a move that takes online and off-line together as inextricably intertwined and mutually constituted. In this I draw on: (1) the history of telecommunities as localized phenomena discussed in this chapter and (2) the growing body of scholarship, discussed in chapter 1, framing Internet research in terms of online communities and recognizing that online and offline phenomena are inextricably intertwined (e.g., Shields 1996; Jones 1995, 1997, 1998; Kitchin 1998; Wellman and Gulia 1999; Miller and Slater 2000; Hine 2000; Feenberg and Bakardjieva 2004). Turner credits Rheingold's book about the WELL, *The Virtual Community* (1993), for bringing about a focus on community in new media scholarship: "In the wake of Rheingold's book, researchers tended to adopt many of its core assumptions, including the notions that Americans needed new communities and that those communities could be established with technology" (Turner 2005:486, note 4). Beyond influencing

Internet research Rheingold's notion of the virtual community shaped popular understandings at a time when the Web was bringing networked communication to new populations and into new domains of social life.

In addition to his writing, Rheingold himself was mentor to the Cyborganic project and colleague to Cyborganic members working at *Hotwired* and Electric Minds (a San Francisco Web start-up founded by Rheingold). Just as the Internet researchers Turner describes, Cyborganic members adopted the assumptions that contemporary life requires new communities and technology can help build and sustain them. In this sense, Cyborganic is a direct descendant of the WELL and the New Communalist vision Turner describes. Cyborganic was a self-conscious project to build a hybrid community both online via the Internet and offline via face-to-face interaction in a shared, physical place. It was an exemplary community to demonstrate the possibility of applying the computer technologies and media with which its members had grown up, and the entrepreneurial idealism of an earlier generation (e.g. the WELL and counterculture), to the business of making a living and making a life in the 1990s. However, Cyborganic and the wider geek culture of 1990s San Francisco also have other important ancestors which this cultural history has sought to recount and trace. Let me close this consideration of Cyborganic's historical and cultural sources by briefly recapping the regional legacies that continued to bear fruit at the time of my Cyborganic fieldwork in San Francisco's South of Market district (SOMA) from 1993 to 1999.

At the links to the WELL might suggest, the legacy of the hacker and hippie countercultures was prominent in Cyborganic and the wider community of technologists, artists, “ravers”, students, and entrepreneurs within which it formed. While the anti-establishment ethos characteristic of the group’s Internet and open source culture owes much to 1960s counterculture, it also echoes the early days of the radio and electronics industries in the Bay Area where a regional identity was developed in opposition to the East Coast technology-government (knowledge/power) establishment. Though Silicon Valley sought to emulate this establishment in reproducing the productive synergies of the university-military-industrial complex, and developing its own venture capital and financial institutions, the region simultaneously developed its identity in opposition to that establishment in several ways. The regional culture of inter-firm cooperation, expectation of high professional mobility, and entrepreneurial spin-off ventures emerged in Silicon Valley’s earliest period in direct reaction against the large, bureaucratic, institutions of the East Coast. At the time of my fieldwork, this oppositional identity was expressed, not only in relation to the East Coast, as a bastion of old, broadcast media, but also in relation to Silicon Valley which was cast as an old-school, suburban, and corporate backwater in contrast to San Francisco’s hip, urban, SOMA district. During the 1990s this area of San Francisco emerged as “a new Silicon Valley” where small, emerging businesses grew and outposts of larger enterprises were established in proximity to “foster dynamically evolving networks of relationships, ‘a kind of fishnet organization’” (IFTF 1997b:2).

The tradition of open standards and loose regulation of patents and other intellectual property that dates from the region’s radio days also carried over to Cyborganic and SOMA in the 1990s. In the 1920s and 1930s RCA’s aggressive protection of its patent monopoly forged a culture of inter-firm cooperation in the Bay Area. In subsequent eras, AT&T’s, IBM’s, and Microsoft’s monopoly positions touched off similar responses around which the Unix, free and open source software communities coalesced, all of which are part of the larger (self-described) “geek” community that Cyborganic represents. The motto: “Information wants to be free;” was a touchstone for everyone who was part of the Bay Area Internet community in the early 1990s. Libertarians and traditional liberal democrats alike rallied around this idea, fighting back early government regulation, such as the Clipper Chip and Communications Decency Act of 1996, and creating a supportive climate for the development of new technologies and media. Cyborganic members participated in these mobilizations, but more significantly, as an exemplary community started to spread the word of the network revolution, the group itself literalized and embodied the region’s long tradition of open standards and information sharing.

Finally, from Terman’s “community of technical scholars” through Turner’s “New Communalists;” Castells’s “culture of the creators of the Internet;” Freiberger, Swaine, and Markhoff’s PC pioneers; and Abbate's inventive users, runs the activity of producer/users and their communities of interest and practice. Though I believe this provides an accurate conceptualization of regional and technological history narrated herein, other framings of the material are obviously possible and there is no doubt that my choices reflect my own fieldwork among people for whom the production and use of new technology, media, and forms of community were a matter of everyday life. In this regard, the culture of SOMA in the 1990s has served as the *telos* of my account. However, the focus on communities of production and use is not a simple consequence of my field study. It has also served three analytic and rhetorical purposes central to this chapter: (1) to situate the region within the wider context of the capitalist political economy; (2) to highlight the productive synergies of the military-university-industrial complex; and (3) to demonstrate how complexly entwined the histories of invention and common practice have been to Silicon Valley, the personal computer, and the Internet—and to the distinct social forms and multi-layered culture within which they developed and which developed them.