An Economic History of the Silicon Valley

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June 1999

"The Revolution in Technology which is in progress can open brilliant prospects for the West.... It is readily appreciated that as yet only a small beginning has been made in this direction and that immense and intriguing advances will continue to be made. What these advances can mean in terms of opportunity for investment by Western capital, enterprise for Western businessmen, and employment for Western workers is indicated only in part by war activity in the West."
Wendell Berge, 1946

"Silicon Valley is a symbol of innovation, growth, entrepreneurship, the prosperous future of high technology and the coming of the age of information."
Regis McKenna, 1984[1]

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Introduction

The rise of consumerism in the Information Age is almost entirely the result of developments in electronics research and the expansion of the electronics industry. The United States is currently in the midst of a new Industrial Revolution based upon the ability to use electrically powered tools that perform tasks at high speeds. The tools execute tasks that consumers would otherwise perform manually. Thus the tools reduce individual labor and produce newfound time for consumers. Such tools are also used to supplement human labor formally involved in processing and disseminating information. The widespread application of electricity has had a marked and under-appreciated impact on the industrialized world during this century.

The human who attains the ability to process information in a fashion deemed useful is the new skilled worker. Today, the business community often designates such skilled workers as "engineers." An engineer that creates a model for an idea and successfully replicates the model for sale and profit is the new entrepreneur. The entrepreneur is at once the owner, manager, and laborer. The entrepreneur owns the product of his/her imagination. The entrepreneur utilizes and directs the skills of other skilled workers to develop the product and uses unskilled workers to mass-produce the product in order to bring it to market. The entrepreneur also labors to develop new tools.

The attraction of investment to this new industrial organization produced the new Industrial Revolution. The industrialization of the late 19th century gathered many members of an industry into one corporation, and then diversified the corporation to perform all the processes of production necessary to bring a product to market in order

to maximize profits and minimize expenditures. Skilled workers in the new Industrial Revolution at first specialized in creating new electricity-manipulating devices to sell and reinvested profits into the expansion of production capacity. The minimized expenditures and maximized profit reinvestment combined with increased high-speed communication driven by the electronics industry inaugurated a new growth potential previously unequalled in industry. Unmatched rates of growth drew speculators, and then investors, until capital investment became concentrated in the new industries.

The history of the new industrial revolution is the history of the growth of electronics and its incorporation into mainstream commercial enterprise. Though the evolution in electronics theory has occurred more rapidly at varying times in various regions around the world, one region first dominated the creation of an electronics industry. The Silicon Valley is the model community of the new industrial era. Those who implemented new processes of mass-producing electrical equipment are to a large degree responsible for the rapid exchange of information, and thus the new worldwide communications revolution.

Only sixty years ago, the Santa Clara Valley was primarily a conglomerate of well-financed farms and orchards. Yet by the 1970s, the significant changes in the region warranted a new nickname: The Silicon Valley. Did the valley undergo a transformation during the war that laid the foundations of a new electronics-based industry? Did the change result from a rapid departure from the previous industrial organization in the United States, or was the growth incremental and continuous as in previous periods of industrial expansion? Finally, where did it all begin, what are the

roots of Silicon Valley, and why was it formed out of the orchards of the Santa Clara Valley?

In the pages ahead, I will address these issues by examining important trends in the Santa Clara Valley's economic planning and development. I propose that in the immediate postwar period, area leaders shifted the direction of growth in the Santa Clara Valley from an agri-business community to a small business community designed around technology, reorganizing the region into an industrial-based and highly growth-oriented economy. To begin, I will attempt to place the discussion in a historical context by describing current debates around the issue of growth in the west, a common topic of late in the area of historical research.

However, because of the continuous nature of growth in the region, early periods of significance cannot be discounted. The discussion will explore the importance of economic changes in the Bay Area during the first forty-five years of the twentieth century. I place the focus of the period prior to World War II on the ascendancy of Bank of America and the lending policy of its branch banking system. I propose that the bank's emphasis on small businesses and individual investors was a key factor in bringing World War II war production contracts to California, and particularly to the San Francisco Bay Area.

The short-term effect of the war was accelerated growth; the war brought many new workers and doubled industrial output. However, World War II war production actually had more significant long run effects, as it influenced the designs of postwar industrialization in the Santa Clara Valley. For the first time, federal policy makers gave attention to the needs of small businesses. The Smaller War Plants Corporation

provided war production contracts to smaller concerns, many of which were financed by the Federal Reserve Board's Regulation V loans from area banks. The success of these two programs was not great, especially considering the massive war production allotments to large corporation. Yet mandated subcontracting of portions of large contracts to smaller firms initiated a trend of specialization among small manufacturers.

War production brought substantial immediate growth to the San Francisco Bay Area region. Still, my argument emphasizes the major shift in the Santa Clara Valley that did not begin until after the war's end. The US military required considerable electronic technology to conduct the Cold War. However, the impact of federal spending on high technology devices and electrical equipment became minimal as commercial markets for these products opened. In an effort to retain both the pool of skilled labor that existed in the Santa Clara Valley owing to a strong electronics tradition and the influx of war workers, educational and industrial leaders attempted to establish a new industrial base centered on marketing innovations in electronics technology commercially.

As the role of the federal government decreased, Santa Clara Valley community planners wielded powers delegated by the state of California to further encourage industrial expansion. The governmental bodies instituted land policies favorable to start-up and relocating companies. The growth plans shifted the area away from agriculture and built an industrial network. The region's industrial base grew exponentially in the second half of the century because of innovative entrepreneurship leading to substantially increased capital investment. The Santa Clara Valley's

transformation made the unique area world renowned, and it has recently become a model for economic growth and community planning.

Historiography

Historian Gerald Nash argues that the California economy underwent a transformation during World War II. Before the war, the state was simply a raw material exploiting and agricultural economy. Nash states that the economy was colonial in nature before the war, in that its sole purpose was to serve eastern industrial enterprises. California relied on exports to drive the economy. Booms and busts related directly to international and domestic demand for raw materials and agricultural products. However, World War II brought the state a significant population boom and unprecedented industrial expansion that sparked a new diversification of its economy. The argument parallels economic historian W.W. Rostow's theory in *The Stages of Economic Development* that some outside force, in this case the immense award of war production contracts, incurs a "take-off" period of economic growth that might convert an underdeveloped economy into an independent and highly active economy.[2] To Nash, new industries formed based upon war induced innovations in science and technology.[3] This allowed the state to shed its colonial status and construct an independent, internally driven economy. In Nash's view, California businessmen viewed the war as the most important period of economic expansion in the 20th century, a second Gold Rush for the state.

Nash points to the significance of the shipbuilding and aircraft industries in spurring continued economic growth during and after the war. The shipbuilding industry, relying on thousands of subcontractors, stimulated many new service establishments and a range of related manufacturing industries that survived after the

war. The existing aircraft industry, Nash contends, was revamped by war needs to include new methods of production, which fueled the industry's rapid expansion. The most significant result was "the creation of a research and development establishment, which changed the nature of the industry and strengthened the military-industrial complex that was to play a central role in the economy during the next four decades."[4]

Central to Nash's theory is the development of small enterprises in the West during World War II. Nash argues that constituents from California and other Western states paid close attention to the needs of small businesses. They lobbied for the establishment of government agencies devoted to nurturing the growth of small business during and after the war:

> The West played a prominent role in the movement to bolster the role of small business in American society. Indeed, most westerners viewed the war as an unusual opportunity to throw off the shackles of economic dependence.... Between 1940 and 1946, therefore, western leaders actively promoted the cause of small business in the national as well as regional economy.[5]

Nash believes these leaders were responsible for the creation of the Smaller War Plants Corporation, which was closely linked to the War Production Board, and which eventually awarded more than $2 billion in prime contracts and $500 million in subcontracts to small businesses. The focus on small industries led to a decentralization of the economy and promotion of private enterprises. According to Nash, small business development in the West became one of the most significant planning movements in 20th century America and a key component in reshaping the West. The new increases in population, industry, and innovation were decisively sustained in the decades following the war.[6]

In August 1994 a group of economic historians published a critique in the *Pacific Historical Review* called "Fortress California at War: San Francisco, Los Angeles, Oakland, and San Diego, 1941-1945." The contributors to the *Pacific Historical Review* did not deny the major impact that the war had on California's economic growth. However, they called into question Nash's assumption that the war in itself was the crucial reason for California's rise to economic preeminence in the United States from its prewar status as a mere backward colony of the east.

These historians contend that Nash exaggerates the status of California as a "colonial fiefdom" to the eastern establishment and undervalues the economic progress of the state prior to World War II. Historian Roger Lotchin states that the three largest California cities, San Francisco, Los Angeles, and San Diego in fact underwent no revolutionary transformation during the war. Though there were ephemeral wartime changes, these were discontinued immediately following the war. Los Angeles and San Francisco both added fewer industrial jobs than many other eastern and midwestern cities. Furthermore, the West lagged behind the East in war plant and equipment spending.[7]

Economist Paul Rhode maintains that California was no backward economy by 1940. Rhode believes that California greatly increased its share of the national income between 1910 and 1940. During that time, the state attracted many new manufacturing companies and industrial workers. Industry was securely in place by the time that military mobilization began. He sees the growth of wartime shipbuilding and aircraft industries as rooted in prior economic achievements, and notes that the wartime boom was transitory and unbalanced and the postwar conversion period highly problematic.

When viewed in the short-run, California's economic growth between 1940 and 1945 looks substantial: 11.4% annual growth vs. the United States average of 8.5%. However, average annual growth in California also surpassed the U.S. average between 1933 and 1940 and between 1950 and 1955. In addition, when viewed over periods of ten years, California's annual rate of growth was actually larger between 1920 and 1929 (7.3%) than it was between 1940 and 1950 (6.3%). The construction boom, the growth of trade and services, and the inflow of nationwide manufacturing firm branches appears less significant than the development in California's economic environment in the 1920s.[8]

The *PHR* contributors remove the emphasis of economic growth during World War II and place it in different time periods during the century, specific to each author's focus of analysis. For instance, one examination of Oakland and the East Bay finds that though no lasting economic changes occurred because of the war, the social and political implications of the war were still significant. For example, the influx of white and black migrant workers from the South strengthened union organization and established an evangelical subculture still present in Oakland. One contributor assesses that the war did fundamentally change Los Angeles, propelling its emergence as the new leading city in the American West. Another contributor sees no wartime transformation in San Diego. Instead, the federal government's domination of the urban growth mechanisms controlled San Diego's growth cycles: there was a long-term prewar process that culminated in the war. These views reinforce Lotchin's and Rhodes' de-emphasis of California's economic growth during World War II. The general opinion of the *PHR* survey is that California's growth has been rather continuous

throughout the 20th century, with different regions experiencing more pronounced growth during different time periods.

Continuity and departures in California's economic growth underlie this study, which focuses on the particular region of the Silicon Valley and attempts to determine whether transformation occurred there during the war, or whether the area's economic roots were established in other periods. Federal policy during the Second World War caused short-term economic growth in the Santa Clara Valley. A policy encouraging subcontracting and small business participation in war procurement had the most significant long-term consequences. However, the war did not cause an immediate transformation. Rather, it contributed to and accelerated the new Industrial Revolution in the United States. The diffused location of industry designed to deter the threat of a long-range missile attack on the industrial northeast, together with the need for new electronic devices to direct an increasingly automated armed forces, were essential elements of the coming changes in the agricultural Santa Clara Valley.

Branch Banking and World War II

Bank of America, Branch Banking, and Bay Area Small Business

Before investigating the war and the postwar era I wish to explore the institution that played an indirect, yet important role in the postwar changes in the Santa Clara Valley. The history of Bank of America, the premier financial and lending institution in Northern California and Western America during the 20th century, suggests that both Nash and the economic historians who responded to his argument are in some ways correct. Supporting Nash's critics is an examination of the bank's growth and lending practices that makes apparent, at least financially, that California broke free from eastern economic domination prior to the war.

In 1869, only a few months after the golden spike was driven into the ground at Promontory Point, Utah, a transcontinental railroad station opened in San José. Expanded markets gave the valley the economic opportunity to establish an agricultural producing industry. As early as 1875, non-irrigated fruit growing was introduced in Los Gatos, just southwest of San José. The year round warm climate made the valley a choice location for specialty crops, namely apricot, prune, and pear orchards, which commanded a premium in the marketplace.[9]

The liberal loan policies of the Bank of Italy, which promoted California businesses in the 1920s and 1930s, also aided the young agricultural community and canning industry in the Santa Clara Valley. The branch banking system, developed by A.P. Giannini and his Bank of Italy by 1920, inaugurated the foundation of the modern economy of the San Francisco Bay Area. Giannini, particularly concerned with his hometown of San Jose, introduced the nation's first branch bank. The bank

inaugurated smaller interest financing and lower interest rates to isolated farming communities throughout the state. The benevolent lending policy operated by extending capital to areas of greater need at different times. The bank played a key role in financing the accelerated growth in California during the 1920s and lessened the traumatic experience of the Great Depression.

Visiting Canada in 1908, Giannini learned about the strengths of a branch banking system. Home branches in large cities made assets available to small frontier communities via small branches sometimes thousands of miles outside the major populated areas. Giannini implemented a similar system for California's varied yet abundant agricultural community. A farm upbringing in San José made Giannini familiar with farmers' financial needs. Independent small town banks in the San Juaquín and Sacramento Valleys held monopolies over local credit, hindering the expanding Northern California economy. Banks charged premium interest rates because many farming communities had few banks and sometimes only one area lending institution. In addition, limited resources in many of the isolated towns restricted the ability of these institutions to give loans. California's seasonal agricultural production caused widely fluctuating demand. Farmers in one region would require loans in the same seasons because of similar climates and crop rotations. In order to meet lending demands, local independent banks were forced to make an unsafe number of loans in seasons of greater need. After 1909 state legislation officially permitted branch banking and Giannini's branch system expanded. With superior resources centered in San Francisco, Bank of Italy transferred money from communities with less demand for loans to communities needing loans. Giannini's foresight paid off as farm production

more than doubled in California between 1900 and 1920. By 1920, California supplied two-thirds of the nation's fruits and vegetables, much of which came from the agricultural output of Northern California.

The Santa Clara Valley benefited greatly from the strong and growing San Francisco based financial institution. The bank offered loans to local farmers at reduced interest rates that enabled valley orchards to expand operations. By 1930, the world famous orchards covered 65% of Santa Clara County cropland. 83% of the region's nearly five thousand farms produced 55% of the world's prunes.. 11% of more than 160,000 acres of county cropland was devoted to apricots, most of which were canned and sold nationwide. In addition, the persistent warm weather of Alviso and Agnew, two towns adjacent to the south end of the San Francisco Bay, contained the nation's second greatest number of pear trees.

The agricultural production influenced the growth of San José's industry. A lack of coal deposits handicapped the growth of manufacturing in much of California before World War II. It was agriculturally related industries that provided employment to area residents. Canning and food processing predominated non-agricultural employment, followed by food machinery, can and box makers, and food chemical companies. Golden Gate Packing Company was established in 1875 to can peaches and the Food Machinery and Chemical Company was founded in 1883 to sell orchard sprays.

The Bank of Italy also applied the stable branch system to make more loans to small businesses and individuals. The Bank extended lines of credit to the canneries, allowing them to import fruits from other regions during World War I, when canned goods were in great demand. By 1920, following numerous mergers, 35 large

canneries existed in the Santa Clara Valley. By 1925, the agricultural producing and packaging valley was fully integrated with the national marketplace as Santa Clara County became a resource based and export driven economy. Small printing, furniture, and metal-extracting industries developed to support the agricultural base. 84,400 residents entered the county between 1900 and 1930, more than doubling the population, and another 29,800 settled there the following decade. In 1940, 23% of workers in the county were employed by agri-business and only 8% of total workers were employed in non-agricultural manufacturing.[10]

Giannini reinvested the returns into expanding his branch system. A tactic of horizontal integration kept Bank of Italy's interest rates lower than its competitors'. Giannini bought failing banks and converted them into Bank of Italy branches. The booming economy created a huge demand for credit and better services. Therefore, businessmen and industrialists seeking to expand did not stand in Giannini's way.[11] By 1921, Bank of Italy was comprised of 41 branches in 30 California towns and cities. Total deposits of $100 million made the institution the third largest west of Chicago.[12]

Diversification of investors and borrowers played a role in the bank's success. Diversifying its deposits among many small investors reduced the bank's risk of large-scale withdrawals during a panic. A bank catering to only large accounts stood to lose a great deal if only a few of the largest clients left or failed, but a broad base of loyal working class savers made Bank of Italy safe. Over $100 million was diversified among over 400,000 individuals (an average account balance of only $250), more than any other bank in the country.[13] The focus on small investors was unprecedented. The

growth rate continued at a pace of 40% a year until 1939. At that point, 353 branches and $1.1 billion in capital embodied the newly renamed "Bank of America" family.[14]

The bank's more than $2.5 billion in deposits by 1942 was fourth largest in the entire United States at that time. The large deposit base made it possible for the bank to make many loans. Though only fourth in deposits, the bank became first in money loaned in 1939. That year, the ratio of loans to deposits was 48% for Bank of America, as opposed to a nationwide average of only 32.5%. Again, the bank spread its loans among small businesses and individuals.[15] By 1945, Bank of America lent over $1 billion for 426,000 loans.[16] The average loan of little more than $2300 was less than two year's wages earned by the average Californian.[17] The forty-year period of financial growth and stabilization of small businesses under a strong banking network put California in a primary position to safely finance the large production orders and the company facility conversions that were necessary to meet the military demands of total warfare.

The growth of branch banking on the West Coast is one of the important changes in the San Francisco Bay Area during the prewar period. The growth of the San Francisco financial industry and its expanded lending capacity spurred sustained economic growth in the San Francisco Bay Area prior to World War II. Other San Francisco banks, such as Wells Fargo, Crocker First National, and Bank of California, expanded their branch banking structures as well. Growth in existing local industries, such as the canning industry and orchards of the Santa Clara Valley, benefited from increased lending competition among large banks. The ability of the Bay Area to handle

its own investment and lending needs, without East Coast intervention, established a foundation for a number of companies expanding their operations.

The financial structure was essential for effecting war production in the region during World War II. In addition, banks developed internal departments that invested in the industrial growth that would take place in the Santa Clara Valley following the war. As will be shown, a few key companies established prior to the war began a new trend of industrialization for war production in the region.

A Favorable War for California

California's prewar growth encouraged the federal government to bring large war production contracts to the state in the 1940s. The procurement agencies looked favorably on the state as federal policy diffused the location of industry from the Rustbelt to the Sunbelt. The war spawned an economic boom in California that caused significant short run changes. The war brought 500,000 workers to the state, many of which remained there following the war.[18] A large number of them settled in the region between San Francisco and San José. Furthermore, as pointed out by Rhode, California sustained the economic growth. This was due, as Nash observes, to the focus of Western leaders on small business prior to, during, and immediately after the war. One of these leaders was A.P. Giannini. By the beginning of World War II, Bank of America's 493 branches were handling nearly half of the state's financial needs. For example, in 1941 Californians gave the bank 40% of the state's total deposits as one in three individuals kept his/her savings with Bank of America.

Because the government focused on the large contracts, Mario Giannini, AP Giannini's son and president of the bank during the war, maintained that small contracts should be federally guaranteed. At his suggestion in 1942, Donald Nelson, chairman of the War Production Board (WPB), endorsed the creation of the Smaller War Plants Corporation (SWPC). The SWPC worked closely with the Reconstruction Finance Corporation and its subsidiary the Defense Plant Corporation to provide subcontractors with work. 90% of the subcontracts approved by the SWPC went to companies with fewer than 100 employees.[19] Established in the wake of the Small Business Act of 1942, the SWPC was one of the federal government's first attempts to assist the growth of American small business by promoting war contracting by subcontracting parts of large contracts to small businesses. The Smaller War Plants Corporation secured loans to companies and found financing to facilitate the necessary expansion of small business operations in order to encourage timely completion of the contracts.[20]

Moreover, Bank of America and other Bay Area banks further expanded their loans to new and smaller enterprises in the Santa Clara Valley with contract or conversion financing and extended lines of credit. With the necessary capital, many firms competed with the east, luring large war production contracts to the west. The companies secured loans to revamp their operations and the SWPC rewarded them with contracts.

Some firms in the Bay Area found creative ways to secure war production contracts. To lobby for contracts, the South Bay's young electronics firms combined efforts with some electronics manufacturers in southern California to form the Western Electronics Manufacturers Association. David Packard was instrumental in forming the

group, which in 1943 went to Washington to inform the Pentagon that there was a living electronics industry that was not working to capacity.[21] Bank of America set up its own lobby in Washington, called the Office of Defense Information, which secured contracts and subcontracts for small industries in California. In its first three months of existence, the operation landed nineteen hundred contracts to small business worth over $42 million.[22] The bank loaned over $570,000 to a conglomerate of Santa Clara Manufacturers that formed a joint venture called the San Jose Manufacturers, Inc. to compete with large firms.

Once the contracts were secured, the Federal Reserve Board's Regulation V loan program federally guaranteed the loans made by commercial banks for the contracts. Most subcontracts called for small companies to produce prefabricated parts for large ships and aircraft that were then sent to the large manufacturers who built the vehicle infrastructures. Regulation V loans made war work irresistible to small companies because of a 5% maximum interest rate. Banks, ever willing to make federally guaranteed loans, pushed rates as low as 1.5%. Urgency was the logic behind Regulation V. After Pearl Harbor, new contracts needed to be approved expeditiously if the U.S. were to engage the Japanese before they possessed the entire Pacific. Banks made loans of unusual magnitude, often 80 to 90% guaranteed by the federal government, since small firms needed to make abnormal expansion of their facilities.[23] Bank of America increased its volume of approved loans every year during the war. Though Bank of America participated in many large contract loans, one-half of its Regulation V loans were for less than $100,000, mainly because loans under

$100,000 were approved and executed in the field without prior consent from Washington, DC.[24]

A Transformation in Ideology

As it became clear that the United States was going to win the war, Bay Area businessmen expressed a need to plan for future growth in the Bay Area. A consensus surfaced that the Bay Area should expand its industrial base. J. Hugh Jackson, the Dean of the Stanford Graduate School of Business, stated that the Bay Area's location as the gateway to an increasingly important expanding markets of the Pacific Rim would be an instrumental factor in the development of the region's industrial base. The Bay area, he argued, had amassed an abundance of skilled workers who could be incorporated into an expanded industrial network. In addition, there was plenty of space to grow south of San Francisco, and untapped local raw materials to exploit.[25] As early as 1943, the businessmen shared a sentiment that increases in industrial production, if sustained following the war, afforded the Bay Area an opportunity to meet this new goal of continued industrial growth and full employment. As Almon E. Roth, President of the San Francisco Employers Council put it, the Bay Area might enter "an era of great expansion in industrial and commercial enterprise to serve the needs of the new West and a new Orient."[26] A belief ensued that the same factors that led the United States Armed Forces to choose the Bay Area for war production—a strong financial system and focus on small business development—would propel such an era of industrialization. Concurrently, in the Santa Clara Valley, business leaders mobilized local government to prepare for the changes.

In effect, what occurred was a transformation in the minds of politicians and executives of both local and national firms that the Bay Area really was the future of commercial enterprise. The sharp increase in shipping and shipbuilding because of the war gave the illusion that the region had finally undergone its industrial revolution. Bay Area industrialists were in no way shy about promoting such an ideal. One Oakland executive exclaimed, "The war has brought a nation-wide realization that the area is the logical industrial center of the West!"[27] Many other area business executives followed suit, expressing optimistic assessments of the Bay Area's current state that concurrently served as self-promotion. W.W. Crocker of Crocker First National Bank proclaimed, for example, that San Francisco was the financial capital of the west with 6 of the 50 largest U.S. banks. J.B. Black, the president of PG&E, called the war "a major milestone in California's path of progress...[to become] more self-sufficient and more productive than ever before." Many others echoed these and similar sentiments, including A.T. Mercier, president of Southern Pacific Co., Colbert Coldwell of Coldwell, Banker & Co., and H.D. Collier, president of Standard Oil Company of California.[28]

Nevertheless, behind the optimism was concern. These industrialists were interested in prolonging the existence of a young industrial network. There was an opportunity for genuine expansion and it had to be handled correctly. Successful reconversion would soon be a challenge. In reality, no one really knew what was going to happen after military spending declined and people began to lose their jobs. Dean Witter laid the challenge on the shoulders of Bay Area industry. He argued that if industry stood to gain the most from post-war industrialization, than industry itself would have to be responsible for making it happen. The key, he contended, was to gainfully

employ the people in higher level jobs that would increase the overall standard of living in the Bay Area. In addition, businesses needed access to capital necessary for plant reconversion, new research, and market building. "To supply these jobs along with the necessary tools and markets, corporations need venture capital." According to Witter, it was pooling large amounts of capital that built America's economic strength and accelerated growth rates. By investing in the industry, the region would be able to maintain a large percentage of the 500,000 wartime workers who had moved to California. By increasing the standards of living throughout the area, purchasing power and consumption would increase, leading to demands for increased production and thereby benefiting industry.[29]

In retrospect, Dean Witter's assessment seems to have been the most accurate. Nevertheless, even he did not know to what extent venture capital would become commonplace terminology in the South Bay, and to what ends. Yet each of these businessmen was aware of the potential for economic growth that lay ahead. They recognized the abundance of raw materials and skilled labor, they recognized the potential of expanding both industry and its markets, but they did not perceive the industrial revolution already emerging in their community.

Industrial Organization

The effects of a strong economy prior to and during the war played a fundamental role in the development of a unique electronics industry in and around Palo Alto, CA. However, the most significant impact of the war was the marked expansion of a few small businesses. The ability to found independent electronics businesses near Stanford University was essential to keeping electrical engineers in the region after graduation. Postwar innovation and entrepreneurship in the Santa Clara Valley propelled expansion of the high technology industry. The story of two successful electronics firms illustrates the importance of World War II war production in augmenting small business growth.

Radio Research at Stanford University

Since the turn of the century, the San Francisco Bay Area has been an intellectual center for radio enthusiasts. As early as the 1920s, Stanford University's electrical engineering department produced innovators in radio technology (as electronics used to be known). The region had a history of electronics innovation beginning in 1902 with fourteen-year old Francis McCarty's invention of the wireless telephone in San Francisco. Though McCarty died four years later in a horse cart accident, his firm became the successful Federal Telegraph Company (FTC). Lee de Forest contributed substantially to the success of FTC. The Palo Alto native invented the first vacuum tube in 1906, and in 1912, while working for FTC in Palo Alto, de Forest amplified the sound of a watch ticking using the electrical signal from a vacuum tube.

Essentially, the amplification quality of the vacuum tube made long distance radio, radar, telephone, and television communication possible. For instance, in 1909 Dr. Charles Herrold established the nation's first radio station as "FN" in San José, which later became KCBS in San Francisco and could now be heard without headphones. Up the peninsula in San Francisco in 1927, Philo Farnsworth applied the vacuum tube model to invent the cathode-ray tube. Farnsworth demonstrated the first successful television transmission by spraying the controlled, amplified signal against the top of the tube. In the 1930s a different form of the vacuum tube, called the klystron, emitted microwave signals with enough power to make radar effective.[30]

Although individuals started firms at various places in California during the 1920s and 1930s, many eventually moved to Chicago, where large radio firms were located or, like Federal Telegraph Company in 1932 they moved to the industrial belt of the northeast. The Manufacturing Belt dominated industrial employment before the Second World War. The West had no electronics company comparable in size to RCA or Bell Laboratories, and no comparable employment packages. As is still often the case in many areas of the U.S., the educational system and industry lacked a working relationship. University research in the United States has rarely been funded by any significant contributions from industry.[31] Thus there was little incentive for radio researchers to remain in the Bay Area even though a local community of electronics innovators already existed.

However, one of Silicon Valley's founders, Fred Terman, decided to stay in Palo Alto with an idea to create an industrial-university relationship. Terman grew up living on the campus of Stanford—his father was a Stanford psychology professor

instrumental in the creation of the Stanford-Binet IQ test—where he acquired a fascination for ham radio. After receiving his doctorate at MIT in 1924, Terman returned to Stanford to head the new radio lab and taught electrical engineering. He helped graduates find either local employment or financing for electronics business ventures. With Terman's insight, key students would create a network of small electronics firms that eventually replaced Palo Alto's large orchards. They established a community of independent companies that specialized in building vacuum tubes, transistors, and then integrated circuits. With the help of World War II, two of Terman's apprentices opened the Santa Clara Valley's first world renowned electronics manufacturing company.[32]

Terman's protégés during his tenure were David Packard and William Hewlett, whom he believed had the capability to pioneer an electronics network in Palo Alto. He encouraged the two to go into business together after they graduated from Stanford. That plan soon became reality. In 1939, with Terman's assistance, Packard was awarded a $500 a year fellowship that brought him back to Palo Alto from General Electric in Schenectady, NY.[33] Packard and Hewlett signed a partnership in the garage of their rented apartment and the two began manufacturing their first product.

The audio oscillator, a device that generates high-quality audio frequencies, is used in communications, geophysics, medicine, and the defense industry. In their first year, the partners made a profit of $1563, which they used to rent a small building on Page Mill Road in Palo Alto for expanded production capability. The old, rickety wooden shack, now a California State Historical Monument, situated the small business to take on a large unforeseen project that surfaced when the war in Europe broke out.[34]

In 1940, Hewlett Packard was offered its first war production subcontract by International Telephone and Telegraph (ITT). ITT received over $124 million in army prime supply contracts between June 1940 and September 1944, of which it was obliged by the government to subcontract out as much as possible in order to increase efficiency and expediency.[35] HP could produce the fixed-frequency oscillators for aircraft landing systems at an unbeatable price and won the bid. The company needed working capital, but incidentally rejected a loan of $500 from the Bank of America, because the bank wished that the loan be signed over to the business's accounts receivable. HP decided instead to approach the president of the local Palo Alto National Bank, who took on the risk with the backing of his associate bank, Wells Fargo.

After Pearl Harbor, Bill Hewlett's reserve unit was called to duty, and Hewlett spent the duration of the war in the Army Signal Corp. Packard managed the business alone and handled the continual flow of war production projects. Profits were invested in capital improvements, which led to larger contracts. Early in the war, some of the profits were diverted to research and development, with the assistance of the Naval Research Laboratory. HP benefited from Professor Terman's involvement with the "Leopard Project" that used microwave technology to jam enemy radar. The company assisted in spawning the new field of microwave technology and sold microwave signal generators to the navy. By the end of the war, Hewlett Packard was supplying the army with wave and distortion analyzers, vacuum-tube voltmeters, and audio-signal generators. Nonetheless, the company kept its focus on electronics production, which eased reconversion after the war's conclusion in 1945.

When Hewlett returned from service, the company he helped to found was worth over $200 million. Because Packard reinvested the profits from the contracts into the business, the company grew at an astounding rate of 100 percent each year of the war.[36] Due to conversion loans secured by the Smaller War Plants Corporation, Hewlett also returned to HP's first wholly owned facility at 395 Page Mill Road.[37] HP's expansion exemplifies how rapidly electronics firms grew during the war. Upon conclusion of the war, Fred Terman recognized that the need for electronics devices was only going to increase. Because of the war, his first significant business experiment had been a success. HP illustrated that individuals could found electronics companies with low overhead and specialize in producing components of electrical machinery and equipment.

Varian and Radar

A second wartime success story of significance in the Santa Clara Valley, Varian Associates is also connected to Stanford University. At the university, Dr. William Webster Hansen's physics lab complimented Professor Terman's radio lab. Two interesting brothers made a name for the physics lab in the 1930s developing a key component of radar.

The development of radar is often attributed solely to the British, who effectively unveiled radar technology against the German Luftwaffe in the Battle of Britain. However, by 1939 the U.S., France, and Germany were each working secretly and independently on developing radar technology. In 1886 Heinrich Hertz, who discovered radio waves, proved that the waves reflect off solid objects. Officers at the Naval

Research Laboratory discovered in 1922 that if signals were sent from one ship to another, any vessel that passed in between the two could be detected.[38] However, until the late thirties, no country had an effective means of producing enough energy to cover a large enough area to detect nearing objects.

Driven and self-taught, Sigurd and Russell Varian were two physicists who helped make the radar work. Russell Varian had a learning disability and did not graduate high school until age 21, when he learned to memorize texts on his first read. That same year, 1919, Russ was accepted at Stanford and decided to attend. Russell left for Stanford—on foot (a 280-mile walk from Southern California). His brother Sigurd, who graduated in his older brother's class, decided he would rather teach himself how to fly than continue his education, and he bought a cheap World War I airplane. Sigurd quickly became an excellent pilot. He attained recognition for his skills by opening his own airplane school and was eventually employed as a pilot with Pan Am. While Sigurd was flying through Mexico and South America, Russell was working in the physics lab at Stanford directed by his roommate and new close friend, Hansen. Varian received his master's degree in 1927 and entered the workforce where he spent four years helping Philo Farnsworth develop the television in San Francisco.

Sigurd Varian returned from his Latin American adventures in 1935. That same year his older brother Russell decided to return to Stanford to continue his physics research. With their younger brother, Eric, the Varian brothers approached Hansen, now a professor of physics, about a project inspired by Sigurd during his flights. During his journeys, Sigurd realized that ground forces were essentially helpless when an army attacked from the sky at night. He wondered if there were any way that ground forces

could defend themselves without seeing the aircraft. The group was allowed to work as "research assistants" at the Stanford lab with no pay. The project attracted attention all around campus. A graduate student named Bill Hewlett worked on the project for awhile and Terman was also observant of the research. By 1937, the group invented, developed, and produced the Klystron. The device emitted microwaves over a large and controlled area and reflected back an "echo" of any solid object in range onto a detector screen. It utilized the vacuum tube technology to amplify the signal, which Russell learned about while working on the television.

In 1939, the university introduced the invention to the public. Sperry Gyroscope hired the team to start producing the products in New York during the war. The Klystron was the main component of the military's radar. The U.S. learned that the British had independently developed their own version of radar through a different technology called the magnetron. The magnetron gave the British an important edge over the German Luftwaffe in the Battle of Britain. Yet the devise was very heavy and could not be mounted in aircraft. The Klystron was incorporated onto RAF aircraft for nighttime radar in the battle when the Luftwaffe switched to night bombing. It was also used to spot U-boats when they surfaced in the dark. The klystron has been called a decisive innovation in the allied victory[39]

After the war the brothers Varian decided to return to the Bay Area to exploit new industrial and military markets in microwave technology that Hewlett Packard was already tapping. In 1948, they opened Varian Associates in San Carlos. The South Bay was a prime location for them because they shared a patent for their invention with Stanford, and could work there to further develop it. They wanted to benefit from the

progress of Stanford's scientific programs and also attract graduates to work at Varian. As the company began to prosper, it contributed to Stanford's research programs, illustrating the mutual benefits that an industrial/academic relationship could have.

Route 128

Frederick Terman was president of the Institute for Radio Engineers (IRE) in 1941. Because northeastern engineers dominated the IRE, Terman gained repute on the East Coast. The publicity compounded by his proximity to the klystron project at Stanford in the thirties made Terman a prime candidate to direct the Radio Research Laboratory at Harvard for the National Defense Research Committee (NDRC). Lee DuBridge, a physicist and director of the NDRC Radiation Laboratory at MIT, asked Terman to come east in late December 1941 to head a team, largely of Terman's choosing, to develop a system of radar obstruction.[40]

While at the Radio Research Laboratory at Harvard, Terman learned about the value of a relationship between military spending and university research. Developments in electronics research similar to those at Stanford took place at MIT before World War II. A community-oriented network of universities created an entrepreneurial environment for researchers to enter into industry. Boston College, Boston University, Harvard, and MIT all readily shared innovations that might help America win the war. Terman noted that the schools focused on developing an invention until it was marketable to a manufacturer. "The standard procedure...was that we would build a few models ourselves...We would then get the air force or navy or

somebody interested in them."[41] After the military made the product a requirement, the schools lined up a company to mass-produce it.

The universities opened their research facilities for use by students and faculty to create electronic devices. The schools then encouraged students to sell those products commercially or to the Department of Defense. In one example, George Hatsopoulos, who was a faculty member at MIT in the 1940s, decided to start his own company. He approached the Dean of MIT and asked if he could buy back the patents on his inventions that the university owned. The dean refused, but instead *gave* the patents to Hatsopoulos free of charge, noting that the donations to MIT after the new company's success would exceed anything the professor could currently pay for the patents. The dean allowed Hatsopoulos to remain on faculty and pursue his private venture on university property.[42]

Universities produced an entrepreneurial and innovative culture by giving engineering students freedom to use facilities and by creating avenues for students to pursue personal business goals. Many companies, which built small, device-oriented products, needed little initial funding. John S. Anderegg, Jr., former president of Dynamics Research Corporation in Wilmington, MA, states that he started his company with $600 in 1945. It grew to several hundred employees before going public ten years later. Most investment at the time of Terman's Massachusetts experience came from the defense department's need to develop radar technology. The MIT radiation laboratory was one major product of federal funds. Wartime radar research helped fledgling companies in the Boston area like Raytheon, General Radio, and National Radio succeed.

The semi-circular Route 128 on the fringes of metropolitan Boston eventually became the home of Massachusetts's technology industry. Route 128 was built in the 1950s to allow individuals from the north shore to reach the cape without going through Boston, by taking drivers through the countryside. This eased the city's growing traffic burden. However, when commuters discovered the hinterland, a paradise without the congestion of the urban areas, people moved there. The federal government subsidized Sylvania's move out to 128 from Boston to help disperse a particular radar industry that was concentrated in the city. It was felt that because the only manufacturers of a particular microwave devise were concentrated in a small geographical area of Boston, they were susceptible to Soviet nuclear attack. Spin-offs and start-ups continued to move to the loop until an intricate network of electronics and technology firms hugged the stretch of highway. The entrepreneurial spirit attracted investors and venture capitalists to the region to finance such companies as Teradyne, which was founded in 1960 with $25,000 from the founders, $100,000 from ten private investors, and $250,000 from the venture capital firm American Research and Development.[43] Like the Silicon Valley, the roots of the Route 128 community lie in the radio research tradition of the region.

Stanford Industrial Park

Terman returned to Stanford in 1945 and started a fellowship program with Hewlett Packard whereby HP hired Stanford engineering graduate students to research and design new products. In 1954, the Honors Cooperation Program allowed qualified HP engineers to earn advanced degrees at Stanford and San José State University

while working at HP. This put Palo Alto in a position to attract some of the nation's brightest electrical engineers.

As the workers came, Terman developed the Stanford Industrial Park to house their talent. The University donated almost 600 acres adjacent to the campus on which it constructed attractive sites for research labs, offices, and manufacturing facilities. New companies could also lease part of the land and construct their own buildings. This concept was the first of its kind in the United States.[44]

Terman believed that the university could strengthen itself by performing research for the government. He also saw the benefits of incorporating industry around a university committed to technological innovations and development of the regional economy. Pointing to the uncertainties of the world order immediately following the war Terman lobbied for government involvement in research and development. He explained to university officials that engineering graduates were going back east to find jobs. In order to keep the talent local, the university would have to encourage growth of local business. The university and the government accepted Terman's plan and in 1951 the Stanford Industrial Park arranged its first lease. Varian Associates prepaid $4,000 per acre for a 4 acre, 99-year lease.[45] Like Terman, Varian was also interested in convincing area engineers to stay local. In October 1949, Russell approached the university about leasing a parcel of land for an electronics manufacturing and research building. It took two years before Stanford officials were ready to begin the Industrial Park plan.

In 1951, after signing the long-term lease, Varian initiated a trend of high-standards in facility design. They hired Erich Mendelsohn, a distinguished German

architect, to produce a high-quality design that would heighten productivity and differentiate the Park from other industrial regions. He designed long, two story buildings—the concept eventually became the legal height limit in Palo Alto—that blended into the hills and allowed Palo Alto to keep its suburban look. There were no smokestacks, loud noises, or emissions that might offend nearby homeowners. Prospective employees would find a sizable nearby community. Many of the residents in Palo Alto at first did not even realize that the new employment center existed. Varian expanded quickly to several structures on ten acres by the early 1950s. By the mid-1950s, Klystron sales made Varian a multi-million dollar company.

The company's success made the Stanford Industrial Park famous. The adjacent area developed rapidly into new neighborhoods. Nationwide firm Eastman Kodak became the second tenant, opening a film processing plant in 1952. General Electric opened with a microwave-research laboratory on the premises as GE executives felt that an association with Stanford would help the company win defense contracts. These two companies brought national reputations to the Industrial Park and Hewlett-Packard completed a 3000 employee headquarters there in 1957.[46]

Industrial Expansion

The effects of the Industrial Park were immediate and substantial. Other business parks sprouted in the Santa Clara Valley as growing national companies were lured by the success in Palo Alto. IBM opened a research facility in South San José in 1952 because its executives noticed that western graduates were no longer coming east. By 1956, GE had built its nuclear power plant division in San José, Westinghouse

moved into Sunnyvale to supply the Navy with heavy equipment, and Sylvania Electric and Ford Philco moved into Mountain View.

Cities like San José and Sunnyvale became the fastest growing cities in the nation. Many returning vets picked the Bay Area to make their homes, adding to the population of migrant war production workers that were able to settle in the Bay Area after finding postwar employment. Discharged veterans returned to school on the GI Bill and the engineering major was an easy choice for many that had worked on army machinery. The most popular engineering university was Stanford, and UC Berkeley and San José State enjoyed growing reputations.

As more companies moved into the region, the government continued to underwrite the growth through contracts for the Department of Defense and NASA. Between 1952 and 1968 electronics firms employed the majority of workers in Santa Clara County and made more than half of their annual sales to the federal government. The Cold War stimulated some of the continued growth during the fifties and sixties as electronic equipment accounted for nearly 20 percent of aircraft costs and thirty percent of the cost of missiles. Though there were no aircraft companies in the Santa Clara Valley, the region was a crucial producer of aerospace technology.[47]

In 1940, Moffett Naval Air Station leased a large empty hangar to the fledgling National Advisory Committee for Aeronautics (NACA) in order to build the Ames Research Center. NACA, renamed NASA in the early 1950s, used the facility for astrophysical research and as a spacecraft control center. Lockheed Aircraft Corporation, started in Southern California in 1932 by two brothers from Los Gatos, created a subsidiary called Lockheed Missile and Space Company and moved it to

Sunnyvale in 1956 to be close to the NASA-Ames Research Center. The company employed 30,000 area workers, more than any other firm in the valley. Lockheed immediately became the most important industrial force in the South Bay Area. When Lockheed arrived, the valley's agrarian era officially ended. The area was now a technology driven industrial center.[48]

Though large, national firms entered the valley, the region sustained continuous growth in the electronics industry during the 1950s by capitalizing on the success of smaller interests. New large corporations became new local customers for small companies specializing in electrical devices, enhancing rates of growth. The Cold War spawned a need for a new military-industrial complex, one that stressed research and development of electronics and other high technology instruments. The federal government found Terman's military-industrial-university complex in Palo Alto to be useful during Cold War military expansion. The federal government funded university research. The university trained the students. The students built up an industrial network of small firms in Santa Clara County, and large corporations with government contracts bought electronics equipment and machinery from the small firms in order to fabricate military products.

The changes that took place during World War II in the Santa Clara Valley took form in a way businessmen had not anticipated. Area leaders wanted to industrialize the quiet agricultural community. Now many recognized that the community was going to house America's high technology industry. The Santa Clara Valley emerged successfully from reconversion with a young industrial base and a pool of skilled labor. Yet the region still relied on agricultural and raw material exports.

By 1957 the electronics R&D industries still depended heavily on government contracts, and thus on the Cold War. A real economic transformation in the area did not happen until such outside factors were minimized. As the industrial parks opened and attracted businesses and workers to the Santa Clara Valley, one operation was innovating new processes that would change the face of the valley's electronics industry and economic condition. No company represents the manner of change from Santa Clara Valley into Silicon Valley better than the Fairchild Semiconductor Company does.

Palo Alto native Dr. William Shockley was working at Bell Labs in New Jersey, when in 1947 he, John Bardeen, and Walter Brattain co-invented the transistor using the world's first semiconductor. When first hired, Shockley found out that the company was going to replace mechanical switches for telephone exchanges with electronic switches. In the 1930s, "electronic" usually meant the use of glass-enclosed vacuum tubes, like the ones that Philo Farnsworth used in the television and the ones that Varian Brothers used to make the radar. Though an improvement, vacuum tubes took time to warm up, often burned out, and were very fragile. Shockley, with a doctorate from MIT in solid state physics, used his knowledge of semiconductors to develop a solid state—rather than vacuum tube—switch.

A semiconductor acts exactly as it sounds. Conductors such as gold, silver, and copper readily allow the flow of electricity. Insulators like wood and rubber block electrical flow. Semiconductors are an intermediate group. In their pure form, elements such as germanium and silicon tend to resist electrical flow like insulators. Yet when certain elements are added to them, they will conduct electricity. Thus adding a

channel of the elements to the semiconductor, commonly referred to as "doping," creates an insulated electrical pathway.

Shockley's team subsequently discovered the "transistor effect" when they amplified an electronic signal by passing it through a semiconductor.[49] The transistor was revolutionary because it created magnification of electronic messages like its predecessor the vacuum tube. However, it required much less electrical current, did not generate as much heat, and was much smaller and less fragile than the clumsy glass tubes. There were many applications for the new inventions and at least 20 companies began their manufacture. Shockley wanted to benefit from his own invention and moved back to Palo Alto in 1955 to form Shockley Laboratories Inc., financed by his former CIT chemistry professor, Arnold O. Beckman of Beckman Instruments.

One of Shockley's greatest gifts was recruiting young, talented engineers. He found eight men working in East Coast Labs and with his scientific reputation, attracted them to his new company. The "Shockley Eight," as they were known, helped Shockley open for business in Mountain View.[50] They were Julius Blank, Victor Grinich, Eugene Kleiner, Jean Hoerni, Jay Last, Gordon Moore, Robert Noyce, and Sheldon Roberts, all age 29 or younger. The group quickly contrived the use of silicon as a semiconductor for the production of transistors.

However, Shockley turned out to be a difficult person to work for. He was a condescending man who wished to work on new inventions instead of improving the transistor. His marketing and management skills were lacking and, when he failed to come up with a new invention of significance, morale in his young company declined. Seven of the eight realized they did not want to stay with Shockley and began looking

for new work, but no company would hire all seven men. Finally, Hayden Stone, an investment bank in New York, was contacted. Stone's interested management sent Arthur Rock out to California to sponsor the group. After twenty-three companies turned down the group, the president of Fairchild Camera and Instrument Corp. in New Jersey agreed to finance the company if the group could exhibit some management skills. The group convinced Robert Noyce, the lone holdout and the only one experienced in managing a company, to lead the venture. In 1957, the Shockley Eight became the "Traitorous Eight" by defecting to Fairchild. Innovators like Shockley, Hewlett and Packard, and the Varian Brothers began trends of entrepreneurship and business development in the Santa Clara Valley. However, the Shockley Eight were to a large degree responsible for the expansion of the new industry.

The new company first reestablished transistor innovation as the direction of electronics research. In addition, new concepts involving company spin-offs and the modern venture capitalist culture were a direct result of the Fairchild defection.[51] The Traitorous Eight, under the leadership of Noyce, started Fairchild Semiconductor in September 1957 without a product. Fairchild Camera and Instrument decided to fund the silicon transistor project, which Shockley had placed on the backburner, with $1.5 million in return for the right to buy the company in 2 years for $3 million. Attention was drawn to the startup fast, and as soon as the first silicon transistor was feasible for production in January 1958, IBM bought one hundred of them to use as memory drivers for IBM computers. The group hired Stanford graduate students to help production. Fairchild started the Silicon Valley trends of reducing production costs on existing products and adding variations of existing products to the production line. By the end of

the year, Fairchild had $500,000 in sales and one hundred employees. During the year the company added a marketing manager, Tom Bay, and a general management team headed by Ed Baldwin to the company leadership. Unfortunately for the stunned Shockley, he could not make it alone. Shockley Labs was sold in 1960, again in 1965, and was shut down for good in 1968.

As Robert Noyce's silicon transistor project brought sales to the company, some of the profits were diverted into the product's improvement. Between 1958 and early 1959, Jean Hoerni of Fairchild and Jack Kilby of Texas Instruments each independently developed processes for producing the integrated circuit. The revolutionary idea was to place multiple transistors on a single silicon chip. Instead of one chip with one transistor performing one task, the integrated circuit was one chip with conceivably a million transistors on it performing an infinite number of tasks. Kilby filed for a patent in February 1958. Yet his process was not practical for mass production. Before Noyce applied for a patent, he waited for the production process to be mastered. Hoerni's planar process sandwiched oxides on the surface of the silicon chip until a flat transistor was formed on a two dimensional plane. The process could be systematically repeated on the surface of the same chip until a series of interconnected transistors was formed. Noyce's patent was approved in July and instantly the court battle over who invented the integrated circuit began. In the end, both companies split royalties from the start-up semiconductor companies even though they had to use the planar process, because TI filed first! "Kilby made the National Inventors Hall of Fame and Noyce became a legend."[52] Contracts kept rolling into the small firm, so in 1960, Fairchild Camera and Instrument decided to exercise its option to buy Fairchild Semiconductor for $3 million,

leaving the founding eight members with $250,000 each. Many impressive young engineers flocked to Fairchild. Many names that are today synonymous with the Silicon Valley's highly competitive technology industry began their careers as co-workers in the late 1950s and early 1960s. Fairchild's rise is important because of the number of entrepreneurs working for the firm who became multimillionaire industrialists in and around Silicon Valley.

However, after the exuberance of the initial success began to wear off, the subsidiary had immediate challenges to face that developed into considerable problems over the following six years. The first challenge was retaining employees. The mother company now controlled the assets and began diverting profits to fund other non-microchip oriented projects. Moreover, the company's employment packages soon fell behind those of other firms. Rival semiconductor companies, such as Motorola in Arizona and TI were able to attract talented engineers away from Fairchild with tempting stock options.

Morale began to dip, and entrepreneurs who at first believed in Fairchild's unique innovative style had thoughts of leaving. They remembered when Ed Baldwin and his management team defected in 1959 to form the Valley's first real spin-off with a copy of Fairchild's technology manual. Three of the original "Shockley Eight" left in 1960. Integrated circuit and planar process innovator Jean Hoerni took Eugene Kleiner, and Sheldon Roberts with him to form Amelco. Entrepreneur Hoerni left the start-up just two years later and went on to create more than two dozen more firms during his career. Also in 1960, four other "Fairchildren" branched out to form Signetics. The start-up was financed by Corning Glass and Philips Electronics of the Netherlands. \

These spin-offs are not the big semiconductor names that one might think of when considering today's Silicon Valley technology firms. Yet these new companies found success, making millionaires of their founders, and either still exist or have been acquired by larger industrial companies seeking to invest in technology. The success of the offshoots caused a slow leak of talented individuals that continued during the early sixties. Much of the success of these firms was due to their proximity to the larger firms that moved into the Stanford Industrial Park and other business parks. IBM, Westinghouse, GE, and the Ames Research Lab created a significant demand for semiconductor transistors.

Still, the remaining core of the Fairchild employees remained with the company for a few more years and those who left were successfully replaced—until 1967. Charles Sporck was hired in 1960 to handle Fairchild's biggest weakness, manufacturing, and he made an immediate impact. With strong organization and management skills, Sporck held the company together by keeping production on schedule with the prospering sales department. As Noyce's assistant, Sporck helped the company grow to 12,000 employees and sustain annual sales of $130 million during the mid-1960s. However, in 1965 Noyce was promoted to Fairchild group vice president, which made him responsible for several divisions other than semiconductors. Sporck was named general manager of Fairchild Semiconductor in his place. Noyce, Sporck, and those who were moved to replace them were now in positions that limited their ability to continue the progress the company was making. Corporate offices on the East Coast unwittingly loosened the tightly knit core group of executives. Because Sporck was now out of manufacturing and because strong sales and marketing

continued, a backlog of orders piled up. In addition, the corporate offices continued to divert profits to other wings of the large firm. Smaller semiconductor firms attracted young college graduates with contracts Fairchild refused to match and stock options at other new firms continued to lure away lower level workers. In 1966, during the company infighting, both Motorola and TI surpassed the semiconductor giant in sales and profits. After constant battles with headquarters came to no avail, a frustrated Sporck walked out of Fairchild with four other executives in February 1967.

The impact of the resignation was detrimental to Fairchild, but it was also important to the development of the high-technology industry in the Santa Clara Valley. Sporck and his group went to turn around a backward National Semiconductor, and many of their former employees followed them there. Jerry Sanders followed their lead and left to start Advanced Micro Devices. Marshall Cox and Bernie Marrin both quit and went on to start Western Microtechnology. In fact, "Fairchildren" founded a plethora of new companies, realizing that the moment to take a risk was at hand. Some of these were Four-Phase Systems Inc., Cartesian, Precision Monolithics, Computer Micro Technology, Qualidyne, Advanced Memory Systems, and Integrated Electronics. Close friends were now fervent competitors.

In June 1968, Fairchild experienced its biggest setback when Robert Noyce, who had been upset by Sporck's departure but had tried to press on at Fairchild for over a year, finally resigned. He, "Shockley Eight" member Gordon Moore, and young Andy Grove opened Intel in a vacated Union Carbide Electronics building (incidentally, one of the many enterprises started by Jean Hoerni, who was already on to another venture) in Mountain View. There the group took control of the entire computer memory business

with the introduction of its first two memory chips in 1969. Just three years later, a young designer came up with the idea of placing multiple tasks on a singular integrated circuit while designing chips to be placed in the desktop calculators of a Japanese firm. Until that point, each chip could only perform a singular task. Thus the large calculators needed several chips: one to control the keyboard, one for the printer, one to do arithmetic, etc. In 1972, Intel unveiled the world's first microprocessor and another revolution was underway.[53]

Don C. Hoefler, editor of a weekly semiconductor industry periodical called *Microelectronics News*, officially bequeathed the region with the name "Silicon Valley" in 1971.[54] The transformation from Santa Clara Valley to Silicon Valley was completed when Intel incorporated in 1968 and rapid economic growth continued. The maturation into a stable industrial economy was well underway. The Silicon Valley had virtually become an internally independent economy. The region no longer depended on federal defense spending for growth. Up until 1965, the U.S. Military purchased 70 percent of all integrated circuits sold. The government helped maintain Silicon Valley's rise as industry opened new markets in civilian business. By 1978, military purchases fell to only 7 percent. Though Silicon Valley firms were awarded $2 billion in defense contracts annually, Noyce contends that the instrument of growth in the valley always remained the expectation of large commercial sales.[55]

Over fifty ex-Fairchildren started new firms. A survey conducted by county planners stated that 38 industrial parks, modeled after Terman's, existed in the Valley. Between 1950 and 1960, the number of new residents and new homes doubled as the portion of the population employed in industry grew by 134 percent. The median family

income grew by 50 percent in constant dollars and the median age fell by three years. By 1974, ten years before Apple initiated the personal computer industry, Silicon Valley housed approximately 800 high-technology firms that employed 150,000 people. By 1980, the number had grown to 200,000 as one in five new high-technology jobs in the nation was created in the region. Between 1950 and 1980, the population of Santa Clara Valley quadrupled, from 290,500 to 1,250,000.

The growth of an electronics industry can be illustrated in 5 steps. First, entrepreneurs in the university complex founded companies to produce electrical devices for defense contracts. These include the World War II success stories of HP and Varian that achieved growth because of the war, war production, and Regulation V guaranteed loans. Next, national firms like Lockheed, Sylvania, and Philco located branches in the area to take advantage of the proximity to the university complex, employing area residents, encouraging engineers to remain local, and thereby promoting community growth. The technology culture developing in the valley attracted some of these companies. The culture in turn helped them recruit scientists, engineers, and white-collar professionals from other parts of the nation. A third trend that transpired was the establishment of technology research and development in Santa Clara Valley companies already in existence, but which were not initially in the industry. Two examples are the Fruit Machinery and Chemical Company of San José, which developed its Central Engineering Laboratory, and the Atomic Power Equipment Department of General Electric. The fourth step was the spin-off of existing firms, like Fairchild from Shockley, and the many subsequent spin-offs from Fairchild (Intel, AMD, etc.) with low start-up costs and the ability to specialize in electronic devices. Engineers

who independently discovered solutions to industry-wide challenges left their jobs to focus on bringing those new products to market. Often, much of a spin-offs initial business came from selling new products back to their former employers.

The fifth common pattern of technology firm growth included mergers and acquisitions. As an industry grows, a consolidation usually takes place. Companies integrate vertically to achieve economies of scale. This final step exists outside the scope of this study, occurring primarily in the 1980s and late 1990s.

Sources of Human and Physical Capital

Industrial Parks, businesses, and workers did not "magically" appear in the valley during the rapid growth period of 1946 to 1971. In order to enter into business, a firm usually required internal and external capital investments. Demand for skilled workers—namely engineering and management executives—influenced an industry-wide shift in employee management and compensation. Many companies adopted Hewlett Packard's new egalitarian, rewards-based style of administration. A reversal of Frederick Taylor's "scientific management" techniques adopted by industrialists early in century, new electronics companies invested in the intellectual growth of skilled workers. Investment in employees often stimulated loyalty. Conversely, educating business-savvy workers in successful practices increased their productive capacity and often their willingness to leave their jobs in order to incorporate independently. Capital investment needs rose steadily during the period keeping pace with an increased number of needy fledgling companies. Consequently, venture capitalists entered the area, making the Silicon Valley the nation's most highly growth-invested region by the end of our period.

In 1957 Hewlett-Packard officially reiterated a resolution to reward loyal and productive employees. That year, when their company reached over 1200 employees, Bill Hewlett and David Packard felt it was necessary to begin an annual off-sight manager meeting to review company progress and plan for the future. They wished to know more employees personally, and attempted to maintain a small company atmosphere of openness and communication. The partners brought to the meeting a list of company objectives, which included a commitment to sharing company success with employees, offering job security, fostering individual motivation and initiative, and contributing to the growth of the community.[56] The system became known as the *HP Way*.

Management by objectives was a breakthrough in industrial organization. Rather than placing fear in employees by way of punishment and negative reinforcement, Hewlett and Packard contrived a system of rewards for their workers. Rather than enforcing strict hierarchical and conformist guidelines, the company rewarded autonomy and initiative. The company executives formulated objectives and presented them to teams. The teams were responsible for devising a plan of action and tactics for implementing the plan. Furthermore, employees who developed ideas could sell them to the company; initiative effected a bonus. After implementing *The HP Way*, Packard and Hewlett believed productivity increased dramatically.

The *HP Way* combined human benefits with business benefits by making employee satisfaction a corporate priority, according to Javier Castelblanco, a senior sales executive at HP. Castelblanco was hired in 1971 as a printer circuit board tester on a "frequency counter" production line. Castelblanco came to San José in 1969 from

Colómbia, via New York City. Trained as an electronics technician at the Ford Philco Technical Institute, he became the first Latino in his division. Before Affirmative Action of 1972, Hewlett and Packard recognized that in order to serve a wider range of customers, the company should maintain a workforce representative of their markets.

Castelblanco remembers that the founders thought investing in employees and diversity was not only humanistic, but increased profits as well. HP paid for Castelblanco to attend San José State where he received a bachelor's degree in Electrical Engineering. The company paid many expenses, including parking and food, for those who worked long hours while attending school. Employees even received a ten-dollar per week voucher to go to the movies!

This new administrative strategy changed business management in the Silicon Valley. HP attracted the best minds in the region, and instilled a loyalty in them that made them feel like the company was theirs. Castelblanco states that he guarded against waste and treated the company like he treated his home. Hewlett Packard quickly built a reputation for employee satisfaction and could choose from the best college graduates. As a result, other companies imitated HP and established casual and egalitarian working environments. The Silicon Valley moved away from the shirt and tie hierarchy of East Coast IBM or RCA. The valley became known for longhaired engineers and surfing CEOs. To open communication lines Hewlett and Packard removed offices, and installed cubicles for all employees (including themselves). Likewise, some corporate executives have complained that they have trouble finding parking spots in the morning as the prime locations are reserved for *Employees of the Month*. "The *HP Way* was a seed planted in fertile ground, the people were ready for

it...It allows the nobility of the human to flourish."[57] Finally, many well-educated and motivated employees become entrepreneurs in this story. A management style that promoted education led innovative engineers with some business administration sense to risk their jobs for a chance at autonomy.

Early on in the period, starting a business based on electronics manufacture could be achieved with little outside assistance. For instance, Hewlett and Packard used Stanford University's engineering lab to produce as many oscillators as possible for sale. In 1938 the partnership's first significant sale went to Walt Disney, which purchased eight oscillators for the production of *Fantasia.* HP reinvested their earnings in order to increase their productive capacity, eventually renting space outside the university, establishing a line of credit with a local bank, and purchasing manufacturing equipment. The firm could then build and sell one hundred oscillators to IBM.[58] Varian Associates followed a similar path, selling klystrons as fast as they could produce them. However, both firms also benefited from war production investment. Sperry Gyroscope invested in Varian for mass klystron production, as the devises were to be fastened in allied airplanes. The Smaller War Plants Corporation enabled HP to expand their small outfit to produce microwave equipment for the war effort.

Success stories of companies built from the ground up continue throughout the period and on into the 1970s. Steve Wozniak and Steve Jobs are now infamous for inaugurating the personal computer age by making "Apples" in their garage. Wozniak started working at HP in 1971, and figured that the process of selling whatever could be produced might be repeated for microcomputers. Jobs and Wozniak pilfered some electronics parts from Atari (Jobs's employer) and HP and bought some generic

microprocessors for $20 each at a local electronics show. Eventually, the Apple I could be built in less than six hours. Jobs sold his Volkswagen and Wozniak his calculator for a total of $1300 to pay for the production of 100 computers. Previously, microcomputers came in kits, and were built buy consumers. However a local computer retailer, The Byte Shop, wanted fifty fully assembled computers from Apple in June 1976 for which it agreed to pay $50 each. The units were the first, fully assembled personal computers on the market and the Byte Shop became the first full-time computer store. The popularity of the computer expanded rapidly, and the tandem continued to float their investments until Apple Computer was founded in the fall.[59] As late as the 1970s, reinvestment remained a useful form of capital investment. However, as local integrated circuit competition grew in the late 1950s, outside capital investment flocked to the valley.

Venture capitalists found their way to the valley as early as 1957, when Arthur Rock of Hayden Stone, an investment bank in New York, located funding for the defecting "Shockley Eight." The successful investment immediately drew investment capital into the region. "Basically venture capitalists will find the entrepreneurs. And if they're in California or if they're somewhere else they're going to find them."[60] Thus, venture capitalists look for areas that they believe will foster entrepreneurship. Arthur Rock believed that the Bay Area was the best place to invest in, so in 1961 he left Hayden Stone and moved to San Francisco. There he co-founded the region's first limited venture capital partnership.[61] A limited partnership usually includes a general partner, who accepts the risk of liability for lost assets in an endeavor in return for control of the capital investments. The general partner(s) finds limited partners to

augment the capital investment. Like common stockholders, limited partners can only lose their own investment. Rock raised $5 million for Intel in 1969, played a role in the expansion of Apple Computer, and has been recognized by writers in Silicon Valley history as the kingpin of venture capital.

Shortly after Rock arrived, other venture capital firms opened. In 1959, Continental Capital Corporation began raising funds for Santa Clara Valley start-ups from the Bank of America building in San Francisco. The Asset Management Company in Palo Alto was probably the next capital investment firm, opening in 1962. Bank of America's investment department led to the creation of two venture capital firms. In 1968 George Quist left his job as president of the venture capital agency at BofA to co-found the investment bank Hambrecht and Quist in San Francisco. Hambrecht and Quist eventually underwrote the initial public offering of Apple, Genentech, and LSI Logic. Steve Merrill replaced Quist at BofA, and his team backed Advanced Micro Devices, Four-Phase Systems, Federal Express, and Tymeshare until they also formed their own venture capital firm. In fact, by 1971 nearly sixty venture capital firms located to the Silicon Valley. Fifteen of these firms resided in one building in Menlo Park only minutes from Stanford University. In 1969, investment by these firms peaked at $171 million annually.[62]

However, in 1969, the U.S. Congress passed a bill that gradually raised the long-term capital gains tax rate from 29% to 49%. New private capital committed to venture capital firms steadily declined until equaling only $10 million in 1975. In 1969 investment banks underwrote the public offerings of over seven hundred small companies. In 1975 that number was reduced to four companies for whom only $16

million was raised. Federal policy is largely responsible for stunting entrepreneurial activity in the Silicon Valley during the mid-1970s. Capital investment did not grow significantly in the valley until the capital gains tax rate was reduced to 28% in 1978, spurring $570 million in investment. In 1981, the rate was further reduced to 20% and venture capital commitments exceeded $1 billion for the first time.[63]

In like manner to capital investment, expansion in Silicon Valley business reached a high point between 1969 and 1971. In 1969, IBM confirmed the semiconductor industry by replacing vacuum tubes and transistors with integrated circuits in all of its products. That same year, Douglas Engelbert unveiled the first functional personal computer (PC) at the trade show SRI International. The computer possessed a pointing devise, a video display window, and real time editing. In 1970 Xerox founded the Palo Alto Research Park where employees developed laser printing, the computer mouse, and graphical user interface (GUI), which led to Apple's Macintosh and Microsoft's Windows operating systems. The next year, Nolan Bushnell of Atari brought the first video game to market: Pong! In IBM's San José branch, Alan Shugart, who later founded Seagate, invented the floppy disk. Furthermore, HP devised the first handheld scientific calculator and, of course, Intel's 4004 microprocessor went on sale. 1971 was a fitting year to rename the region "Silicon Valley" after all. Significant changes to the product lines would not come until the popularization of personal computers and the Internet in the late eighties and early nineties.

On Population and Industrialization: The Local Government Story

Technology became the driving force of the Silicon Valley's economic expansion because it took advantage of fortunate trends in the region. The technology industry provided attractive employment for the pool of skilled laborers already present in the valley. Cities seeking growth utilized the industry to create employment for the continuous flow of newcomers into the state of California. With goals of establishing higher standards of living by stabilizing erratic agricultural economies, local governments became instrumental in channeling growth into Santa Clara Valley communities. The Santa Clara Valley was an effective Sunbelt location for the new industry; it was close enough to San Francisco to take advantage of a rapidly developing post-war Pacific Rim, while simultaneously handling the demands of continental industry and military needs.

After the war, researchers and community planners recognized that population was still growing rapidly in California. Originally, they believed that workers migrated to the state because of the substantial wartime job opportunities. However, migration continued following the war, and many came without securing employment first. Americans viewed the San Francisco Bay Area as a temperate haven of opportunity. Returning veterans, who first experienced the Bay Area as the lift off point to the pacific theatre, and other ambitious individuals brought their families west. In addition, wartime migrant workers settled in the region instead of returning to their home states. Even though war production contracting for aircraft and ship manufacture diminished between 1945 and 1950, the short-term increase in work set a migration trend in motion that continued well after the war.

Bay Area businessmen believed that population growth was now the key factor in the changing location of industry—the growing population of the west was going to force industries to relocate. Studies by research agencies, such as the Stanford Research Institute, indicated that postwar industries would move where people wanted to live. New industrial areas were going to form because of new locational factors, such as regional culture, educational opportunities, climate, and a suburban atmosphere. By 1957, the population of California was growing at a rate twice that of the nation and the rate of industrial growth in the state was six times that of the nation. Between 1950 and 1956, the civilian workforce grew by over one million workers. In 1957, the state of California projected another two and one-half million workers to enter the state by 1970. As a result, the West launched the most vigorous efforts of all the nation's regions to attract industries to employ its growing population.[64]

As the impact of federal spending on electronics instruments became minimized, Santa Clara Valley planners searched for effective ways of attracting potential residents to the region. What made the development of the technology industry a success in the Santa Clara Valley, and different from how other communities subsequently attempted to adopt the Silicon Valley formula, was the way in which the growth of the strategic technology industry was in this case planned and implemented. Creating a culture of the valley was of key importance to attracting and maintaining a skilled labor pool that averaged two more years of formal education than did Americans in the rest of the nation. Business organizations, like San José's Progress Committee, contended that development had to be friendly to industry and at the same time attractive to employees. The County Planning Commission therefore maintained the post-war policy

of steadily increasing the standard of living in the region. This was accomplished by establishing more research parks in suburban settings and by building communities on nearby annexed land that catered to middle class family needs. This entailed extending the freeway infrastructure and building schools. The region could then meet rising skill demands better than other areas could, making it attractive to businesses.[65] This long-term process began with the shift in the mode of thought more receptive to a new industrial based economy during World War II.

Five years after the war, when area officials generally recognized that industrial development was would continue in the direction of technology, orchards were allowed to be sold to developers. 490 separate subdivision developments were approved in the valley between 1944 and 1950. Preparation for a change in land use also took place as canneries began transporting a majority of apricots, pears, and peaches into the valley for canning. The valley then spent the 1950s building the communities around the industrial parks to house the new industry. The new industry took advantage of military demands at first, but it also had the potential to develop into a strong peacetime industry, a necessity for the valley.

Growth Attraction

After World War II, most standing outside the emerging business community would have assumed that agriculture would remain the dominant economic enterprise of the Santa Clara Valley. In 1948, Industrial Survey Associates, a consulting firm out of San Francisco, reported to the San José Chamber of Commerce that "agriculture will continue to be a major factor in the local economy."[66] During the immediate postwar

period, however, city and county governments in California scurried to retain wartime population and economic growth rates by encouraging continued industrial expansion and pre-planning new housing construction.

Since California's Board of Equalization historically gave the counties tremendous leeway in land development and tax assessment, the counties wielded tremendous influence over controlling (or not controlling) prospective growth. Thus from the 1950s through the 1970s, local government elections saw businessmen advocating increased growth contending with grassroots residential organizers supporting restraint and redevelopment. Two cycles of booming land annexation and subdivision resulted, the first followed by agricultural rezoning in the late 1950s and the second followed by a new managed growth policy in the late 1960s.

Business leaders in the valley viewed industrial expansion as an opportunity to stabilize a fluctuating economy based on agricultural commerce. They achieved this goal by lobbying for an increased marketing role for the Chamber of Commerce and by creating political organizations to infiltrate local governmental positions. A committee established in 1943 by the Santa Clara County Chamber of Commerce to oversee industry recruitment convinced the county board of supervisors to budget $35,000 per year for advertisements to attract businesses. In 1944, the Chamber launched a $60,000 a year national advertising campaign. The project was deemed a success, as the Chamber announced in 1950 that 44 national firms established local branches, followed by an additional 124 in 1954. The Chamber credited the campaign with compelling IBM, General Electric, Pittsburgh Steel, Owens-Corning, and Kaiser to build plants in and around San José. Another example of the crusade's success is that in

1953 it attracted a Ford plant across the San Francisco Bay in Richmond to relocate in Milpitas adjacent to San José's northeastern border. The 150-acre facility employed over four thousand workers. San José Steel followed the move, purchasing 30 acres 1 mile from the new plant. The Chamber utilized the move in later campaigns to attract businesses, sending pamphlets to more than two thousand firms exclaiming, "if it's good enough for Ford, it's good enough for us." General Motors followed suit, opening a 250-acre plant in Sunnyvale in 1956.[67]

The expansion of San José exemplifies a valley-wide attitude of encouraged industrial expansion. In San José, 100 attorneys, merchants, industrialists, and large property owners formed the Progress Committee in 1944 to publicly advocate growth and seek political office. These Chamber of Commerce and Merchant Association members were interested in "building a new metropolis, in the place of sleepy San Jose."[68] With the support of the *San Jose Mercury* and the *San Jose News*, the Progress Committee candidates easily won control of the city council that same year. The new expansion oriented city council set out to harness the fast growing population and make the city capable of accommodating a metropolis-sized populace.

In the late 1940s, the council set about expanding the city's infrastructure with limited success. The Progress Committee advocated the creation of new streets, an improved sewer system, a deep-water port in the San Francisco Bay, and an airport. Federal Funds paid for most of the airport's construction. A new city hall and county office superstructure was also approved. However, San José residents refused to support the offering of General Obligation bonds to pay for further improvements.

In 1950 Anthony P. Hamann became city manager (there was no mayor in San José at the time and the city manager was a councilman appointed to fulfill similar duties). The former Santa Clara University business manager was a public relations specialist who successfully sold growth to the city residents with the help of Joseph B. Ridder, who in 1952 bought the *Mercury* and *News* from the locally famous Hayes family. Ridder immediately promised "to make the *Mercury News*...a vital and constructive force in the development of San Jose and its territory."[69] With a strong city manager, the Progress Committee was now in a position to use governmental vehicles to grow the city. The tool of growth became annexation.

Annexation, A County Growth Policy

Santa Clara County's northern border is adjacent to the southernmost point of the San Francisco Bay. Alameda County occupies the region immediately northeast of Santa Clara County, and includes Oakland and Berkeley that are directly across the bay from San Francisco. To the northwest is "the peninsula" that contains San Mateo County and then San Francisco. In the County of Santa Clara, Palo Alto rests in the northwestern corner, adjacent to San Mateo County. Moving south, Mountain View, Cupertino, and Sunnyvale border each other from west to east and Milpitas sits east of these three towns. The City of Santa Clara divides San José, which is south of the county seat, from the rest of the county. The county is nestled between the Díablo Ranges and the Santa Cruz Mountains, both are part of the Coast Ranges.

The cities of Santa Clara County lacked the incorporated space take full advantage of the residential growth that they estimated was possible. Furthermore, city

governments commonly favored engulfing potentially profitable land. Annexation became a competitive contest for the acquisition of lots among the cities on behalf of developers. Cities were extended along highways, rivers into fertile valleys and out to the San Francisco Bay. "The expansion mania occurs not only because the city government is dominated by the developers, but because of the economic mythology that getting good land within the city limits enables the city to plan without interference from conflicting land uses in other nearby cities."[70] The quotation expresses obvious anti-development sentiment, but nevertheless points out that cities were interested in finding ways to control attractive plots of land. The cities utilized an obscure 1939 state law that allowed cities to annex uninhabited areas that had less than 12 registered voters and in which two-thirds of the landowners approved of the annexation. In 1951, KAR Construction wanted to build 500 new homes on a 123-acre ranch adjacent to Sunnyvale. Wishing to avoid unwanted costs involved in providing the development with municipal services, the company approached Sunnyvale, asking it to annex the territory. The city invoked the Uninhabited Territories Annexation Act to take over the undeveloped area.

The decision sparked a war between the local cities to absorb as many prospectively profitable areas of undeveloped land as possible. In order to avoid too many registered voters, the areas were often cut into peculiar shapes. San José sometimes found it successful to divide lots in half, as in the case of Monterey Park 1 and Monterey Park 2, so that only 8 registered voters resided in one and 6 registered voters resided in the other. San José and Santa Clara (the city) annexed 53 lots of 500-acres or more between 1946-52.[71] Thus a map outlining the boundaries of San José in

1963 looked more like the skeleton of a dinosaur than a city. The consequence of such actions had in interesting effect on the pattern of urban development in the county. Nowhere else was the label *urban sprawl* more fitting. One study indicated that if all the urban development in the county were bunched together into one parcel of land in the late 1950s, the total area would be less than thirty square miles. Instead, every square mile in the two hundred square mile valley had at least a single subdivision.[72]

One reason annexation was so easy was that tax assessors had a tendency to over value farmland on the immediate outskirts of the city limits. They often based an appraisal on the potential value of the land, and on whether it could be developed for residential or commercial uses. The higher the land appraisal, the higher the property taxes for the farmer. High taxes and high property values made selling land to speculators and land developers tempting to farmers. Small farmers were more than willing to sell their land at $1500 per acre when they could buy land with similar soil quality in the Central Valley for one-third the price. If the farmer refused to sell, the developer simply bypassed the plot and sought lots further outside the border of the city. The city followed suit, annexing a strip of highway that led to the lot and then annexed the lot as well. The obstinate farmer's property was left unincorporated, though the land might be almost completely surrounded by city limits.

A county aggressively pursuing expansion, combined with an ever-growing population in an area of temperate climate and plenty of available land was an inviting location for new branches of national firms, but it also prompted capital investment in new businesses. Most new businesses that offered the potential for the highest return of investment were in the ever evolving and expanding high technology industry.

Expansion in the 1950s

At the Conference on Industry and Your Community in San Mateo in 1957 it was noted that industrial growth in the region was not proceeding in the traditional fashion, that is, from resource-based industries to secondary fabricating industries and then finally to technologically based industries. Instead, "we have hopped right over and are going to develop concurrently technologically based industries to a point where they are already substantially more important in the total California picture than they are in the national picture."[73]

A change from agriculture to electronics took place in the 1950s. In the 1950s, the valley successfully integrated the new populace into manufacturing employment. Canning and food processing had reached their peak importance, having supported the valley's growth up until 1940. At first, a large portion of the manufacturing base was food related (83% in 1950). Still, manufacturing became the primary employer in Santa Clara County by 1951. By 1955, agriculture was still the number one export sector employer (16,000) and canning remained second (9,900). Electrical machinery and ordnance (missile manufacture), only employed a combined 6,700 workers.[74] However, as early as 1957, after the early success of the Stanford Industrial Park, The Santa Clara County Planning Commission began implementing electronics technology as the strategic industry of the future.

In the new Industrial Revolution, the economy of the under-industrialized region shifted from a reliance on raw materials exports to electronics equipment manufacturing. Federal spending was mandatory for such a change to occur, and the

Cold War influenced Santa Clara County's ability to found an industrial base. The Santa Clara Valley shifted its dependence on agricultural (resource based) industries to a dependence on electronics based industries. Between 1954 and 1963 the Santa Clara Valley's growth rate in industrial employment outpaced the national rate by a margin of 31.5%: 118.5% for the valley to 87% for the nation. The canning and preserving industrial complex remained static in employment, registering only a small loss as a local industry. Agriculture and food processing employment also stagnated in the decade, fluctuating between 24,000 and 27,000 workers employed between 1950 and 1960. Local market-oriented industries registered minimal gains and incurred only insignificant changes in employment. Self-sufficiency measurements, as compared with other SMSAs[75] with similar populations, suggest that local industries failed to meet local requirements of goods and services in 1960, and in fact became more dependent on outside sources, between 1950-1960. For example, San José doubled in population in the decade of 1950 to 1960, but internal-serving industries did not grow. The analysis indicates that overall county growth centered on the defense-space sector and that there was not an accompanying parallel growth in the third sector, residual economic activity. Between 1950 and 1960 the economy of the Santa Clara Valley relied on federal defense spending the way it previously relied on exports of agricultural products.[76]

By 1953, the Korean War spurred a 30% increase in manufacturing employment by 1953. Nearly 30,000 workers were by then employed in the county's manufacturing sector. But the increase in manufacturing employment did not end with the war. By 1960, 70,300 of Santa Clara County's 228,000 employees were in the manufacturing

sector. By that time, only 18% of these remained specifically involved with food industries. Manufacturing employment continued to grow after the Korean War because of the Cold War demands for military research and development. Of the four sectors of the military's aerospace complex, only aircraft and parts manufacture was not found in Santa Clara County. The electrical machinery and ordnance industry was, by contrast, in abundant evidence in the valley, thanks to the NASA-Ames program and Lockheed. Aerospace employment rose from 2,800 employees in 1949 to 35,400 in 1960. About 98% of the jobs were in ordnance and electrical machinery, while instruments employed 700 workers. Santa Clara's aerospace workforce accounted for about 8% of California's total aerospace workforce in 1960, which was an increase of 320% over the 2.5% of state aerospace employment in the county in 1949. Over 330 new industries located in the valley between the end of the war and 1960. In the decade, manufacturing rose from second to first place in total employment in the valley. Services rose from third to second, trade dropped from first to third, and agriculture dropped from fourth to sixth, below government and contract construction jobs. Because of the growing communities based on technology industries and military contracts, the population of Santa Clara County more than doubled during the ten-year period from 290,000 to 642,300. Growth of this magnitude led the Santa Clara Planning Department to label 1950-60 "the valley's most spectacular period of growth" in 1967.[77]

Agricultural land in Santa Clara County was thoroughly partitioned in favor of industrial expansion between 1947 and 1957. Consequently, some of the region's most fertile land was built over. Before the turn of the decade, the county board of supervisors revised a seemingly aimless method of choosing the location of industrial,

commercial, and residential subdivisions. Acknowledged as one of the strongest hopes in California for planning in the public's interest, the county government contained a highly touted planning staff that openly publicized its designs to further grow the region, but under a managed policy—the first county to propose such a plan. The Santa Clara Planning Department made constant press releases promising to follow through on the goal, bringing national attention to the forward-looking regional planning body. However, the group secured more open space and fought commercial rezoning more effectively than any other California county, according to the Ralph Nader Task Force on Land Use in the State of California.

The County Planning Commission worked with farmers to set-up zoning ordinances with the object of maintaining "greenbelts," or areas that were set aside for the sole use of agriculture so that they could not be appraised under the assumption that the land might be used for industry. The California State Legislature made the creation of ordinances easier, by passing the "Green Belt Exclusion Law" in 1955 and the "Agricultural Assessment Law" of 1957 that officially disallowed subdivisions, industry, and commerce on any greenbelt ordinance area. By 1958, the county separated forty thousand acres for agriculture. The area increased to seventy thousand acres by 1960. Farmers were also left with avenues to "unzone" the land in the event that they wished to sell it for development.[78] By 1960, local government completed the first cycle of relentless growth and then revision in favor of planning. County and city planners were instrumental in attracting firms to the region, and in encouraging continued growth of existing companies with land development policies. They then harnessed the growth to maintain a balance with the agriculture industry.

Acceleration in the 1960s

The economic expansion of the 1950s, though seemingly extensive, really only laid the groundwork for what was to come in the 1960s. First, the valley remained dependent on federal spending in the decade. The era of transformation was only underway, and after new county zoning measures of the late 1950s were set in place, rapid growth resumed. An indication of the misconception that Santa Clara County had peeked economically in the 1950s is contained in the projection made late in the 1950s for growth in the 1960s. In 1957, the San Francisco Bay Area Council released its view that Santa Clara County would continue to grow only at its present rate, rather than continue to accelerate in growth rate. The project made a high projection based on this static growth rate and made a low projection in the event that economic changes created less favorable conditions for growth. In fact, the high projections significantly fell short of the reality. The analysis slighted the growth in population for 1957-1960 by over 140,000 people. It then projected that a high of 736,000 people would be living in Santa Clara County in 1970, or 15.16% of the Bay Area's population. Incidentally, the study estimated that Santa Clara County's population would be about 1 million people in 1990, a number that San José alone was fast approaching by that time.

Furthermore, the study also underestimated county manufacturing employment projections for 1960 by nearly 50%, estimating that only 36,500 would be employed. It then projected employment of 53,000 workers in manufacturing by 1970, which would amount to 15% of the county's population.[79] These estimates indicate that some members of the community believed that growth would continue, but not at an increased

rate. They had not yet come to recognize the technology industry for the economic force that it was only just becoming. Companies like Fairchild Semiconductor were indeed in place, but still young. In the late fifties, the integrated circuit was only quietly becoming a major export.

The industry made successful transitions from manufacturing vacuum tubes in the 1930s to transistors in the 1940s and most of the 1950s. Yet the integrated circuit became the most significant product of the 1960s. By 1967, 11 north-county firms specialized in new integrated circuit technology, producing half of the nation's yearly output of 150 million ICs. These firms were Fairchild Semiconductor, Raytheon Semiconductor, Amelco, National Semiconductor, Stewart-Warner Corporation, Philco-Ford Microelectronics Division, Signetics Corporation, Siliconix, Union Carbide, American Microcircuits Inc., and ITT Semiconductor.

In 1965, electronics and defense-related industries in the northern section of Santa Clara County employed 60% of the full-time manufacturing positions in the valley (54,000 of 90,000 jobs). Lockheed, in Mountain View, employed by far the most area residents, over 30,000, followed by Varian, HP, Sylvania, and Fairchild, each of which employed over 1000 workers, and had branches in Palo Alto, Santa Clara, Cupertino, and Mountain View. Land grab, outside of agricultural zones, continued unabated for much of the decade as the valley manifested the fruits of transformation from an agri-business economy to an economy built around the exports of high technology.

Because most of the industry located in the north county, most of the residential areas were formed to the south in San José. The city approved 900 annexations in the 1960s, most of which went to residential development. Construction restrictions were

limited compared to other cities in the area, making home building attractive. More important to developers was an extensive infrastructure. Financing of sewer and road expansion had eluded the city council during the 1950s. However, as city manager Hamann became popular, general obligation bonds were finally approved. With a continued endorsement from the *Mercury News* and significant campaign contributions from such Progress Committee members as San Jose Waterworks, Pacific Telephone and PG&E, voters approved capital improvement bonds in 1957, 1961, 1966, and 1969.

The $134 million doubled the city's indebtedness. City streets and sewer lines were made longer and larger than necessary to prepare for the planned population growth to take place on newly annexed lots. The funds were also used to create the largest sewage disposal facility in the South Bay.[80] A developer of a new residential area needed to be annexed to have city services provided to the new homes. Thus San José, which allotted the most generous allocation of funds for improvements, grew larger than any other city in the county.

Between 1960 and 1969, the population of Santa Clara County increased another 390,000 people, a ten-year increase of 40.1%. This growth represented 40% of the new population of the entire 9-county Bay Area during the decade. The population of the county converged with that of Alameda to comprise the largest in the Bay Area after having ranked third in 1960, behind San Francisco County.[81] Santa Clara's decade population growth for the 1960s exceeded the population growth of each of the following: the United States (13.3% increase), the 13 Western States (24.1%), California (27%), and the San Francisco Bay Area (27.2%). However, Santa Clara County's Population increase was slightly less than the increase of the Southern California 10-

county area (42%) as Orange County experienced a similar population explosion in the decade. San José played the most significant role in the decade's population growth, more than doubling from 204,196 residents in 1960 to 445,779 in 1970 and remained the only city in the county with more than 100,000 residents. Still, seven incorporated cities in Santa Clara County more than doubled in population during the decade. Cupertino registered the single largest population expansion, growing fivefold from 3,664 residents in 1960 to 18,216 residents in 1970.[82]

As the labor force became settled in the valley, it played a larger role in city planning. Residents in San José, many of whom were brought in by the growth-oriented council, questioned the worth of spending property taxes, which went to pay the large interest payments of the general obligation bonds, on more growth. Capital improvement spending overshadowed spending on services and facilities for current residents as the focus remained on attracting future residents. Local residential organizations grew in the decade. By the end of the 1960s, grassroots strength grew to the point that residential welfare oriented councilmen were winning elections. They promised to increase fire and police protection and decrease air and water pollution. Finally, in 1969, three urban redevelopment candidates and an environmentalist won seats on the council. Anthony P. Hamann was forced to resign as city manager. In 1969, San José began receiving Model City federal funds as a recently established community action agency took part in the federal war on poverty by renewing Hispanic barrios and other low-income neighborhoods. The aggressive annexation policy was abandoned in favor of improving the large vacant space already within the city's borders.[83]

San José's change in policy influenced a countywide shift in policy. A 1971 Rand Corporation Survey of the county concluded that though growth would be difficult to halt, the consequences of a continued take-it-as-it-comes attitude by local cities would mean the loss of the region's best agricultural land and urban decay in a matter years. The survey called for a vision for growth. A land development plan could assist administrators seeking state support for roads and waterways. With such a plan, research for monetary needs could be done in advance of growth, making spending more efficient and saving tax dollars. In addition, the survey suggested that a plan would help cities avoid "geographic balkanization," or the creation of artificial city boundaries arising from unexamined annexations that make little practical sense and limit the ability of city officials to make sound policy.[84]

A new county agency, the Local Agency Formation Commission (LAFCO), for the first time set strict annexation guidelines in response to the survey. Leapfrogging, highway strip annexation, and land grabbing for potentially high property values were disallowed. Moreover LAFCO encouraged cities to follow San José's lead and develop vacant or decaying urban areas already within city boundaries before further annexations were approved. Furthermore, the County Planning Department began countywide analyses in 1967, and used the Planning Policy Initiative to make suggestions to city planning departments, many of whom had too little funds to do serious investigative research over their own jurisdictions. Santa Clara Valley was fast becoming the Silicon Valley, but residents usurped control of local public offices to make sure that Silicon Valley did not become Los Angeles.

Community intervention into rapid industrial growth protected the high standard of living in the formative stages of the Silicon Valley. The labor force in the valley continued to significantly outpace the nation in education. For example, 34% of the men and 21% of the women living in Palo Alto completed four or more years of college or university schooling, compared to a national average of 7% and 5%, respectively. Thus the ratio of scientists and engineers to production line personnel remained around a 3 to 1 ratio throughout the decade.[85] Santa Clara County residents enjoyed significant growth of personal income through the decade of the sixties. The county began the decade with the third largest total personal income in the Bay Area at $1.54 billion, behind both San Francisco ($2.89 billion) and Alameda ($2.57 billion) Counties. However, Santa Clara's total personal income grew by over 25%. By 1968, Santa Clara was still third. Yet it narrowed the margin as individuals earned $4 billion, versus $4.35 billion for San Francisco and $4.59 billion for Alameda.[86]

Furthermore, without sacrificing living conditions, the valley added tremendous value to California's post-World War II productivity. The impact of the industrial growth is illustrated by comparing the value added by manufacture[87] and new capital expenditures by manufacturers[88]of the different statistical regions in California between 1958 and 1972. In 1958, Santa Clara County SMSA ranked third in value added by manufacture, or just over 5% of the state of California. Los Angeles-Long Beach SMSA ranked first with 56% and San Francisco-Oakland SMSA ranked second with 17%. However, by 1972, Santa Clara County's productivity in manufacturing almost doubled as a percentage of the state's value added to over 9%. Though still third, Santa Clara County closed the gap in value added by manufacture to San Francisco-Oakland and

Los Angeles-Long Beach, as each decreased its share of California's manufacturing. Los Angeles more than doubled its output by 1972, but its share of output decreased to 48.8%. San Francisco-Oakland share of manufacturing output was reduced to 12.2%. The only region of California to outpace Santa Clara County in growth of manufacturing output was Orange County, which grew from 2.6% of the state's value added in manufacture in 1958, which grew to 8.7% in 1972. Orange County surpassed San Diego to move into fourth place in the state, as its absolute manufacturing output of 1972 equaled more than eight times that of 1958.[89]

New capital expenditures for manufacturing provide a similar conclusion. Santa Clara County's share of building construction and new equipment was augmented considerably during the during the 1960s, indicating a spreading demand for integrated circuits, electronics, and electrical equipment which by then dominated production in the valley. Santa Clara County ranked fourth in 1958 in new capital expenditures. Once again, in the 1950s Los Angeles-Long Beach and San Francisco-Oakland regions were dominant in manufacture growth, accounting for a combined 61% of new capital expenditures, and Riverside County ranked third with 13%. Orange County and Santa Clara County exhibited the largest rates of new capital expenditure growth in the 1960s. By 1972, Orange County, now the fourth largest purchaser, went from 3.3% to 8.8% of the state's total expenditure on new plant construction and equipment. Likewise, Santa Clara County became the third largest purchaser of plants and equipment, accounting for 10% of the state's total, spending $164.7 million. San Francisco-Oakland declined significantly as a percentage of the state's new capital expenditures 13%. Over the

fourteen-year period, Los Angeles-Long Beach expenditures remained static as a percentage of the total state, growing slightly to approximately 42%.

These comparisons illustrate the dynamics of economic growth in the Santa Clara Valley over the period of focus. From 1946 to 1971, the region's industrial base, commercial enterprise, and residence experienced accelerating expansion. As federal spending became minimized in the region, local politicians used powers delegated by the state to make conditions favorable for continued industrial expansion. Many policymakers believed that expansion in industry would correlate with increases in the region's standard of living, as it had during World War II. Though they did not make the population grow (this happened on its own), Santa Clara Valley political leaders made an effort to facilitate newcomers. As residential communities settled, they effectively combated urban sprawl by ousting growth-oriented businessmen from local political offices.

Further Implications

As was the case with America's first and second Industrial Revolutions, the third Industrial Revolution has occurred in a sustained and incremental fashion. A continuous rate of growth can be traced as far back as the 1820s. Cottage manufacturing expanded in the early 19th century as innovations in transportation, including better roads and the introduction of a canal system, opened regional markets to large urban centers such as New York City and Philadelphia. Many Northeastern artisan proprietors were forced to close shop and join companies as skilled wage earners. Likewise, the invention of the steam engine and extension of a railroad infrastructure following the Civil War brought the continent within reach of industrialists. The assembly line, interchangeable parts, and motorized machines expanded productive capacity. Rival manufacturers merged form monopolies and trusts in order to corner product markets and increase profits. Entrepreneurs then joined sectors of commerce vertically under singular corporate enterprises to achieve economies of scale. The growth of American industry took place one step after another.

As Gerald Nash has suggested, an ideology of transformation evolved during World War II, giving shape to the expansion of the young electronics industry in Silicon Valley. The changes that occurred did not follow a "take-off" model. Rather, in the period of 1946-1971, the foundations of new industrial organization emerged steadily. The innovations of vacuum tube to transistor to integrated circuit and then finally to microprocessor illustrate the contention of the contributors to the *Pacific Historical Review*. Each device logically succeeded its predecessor in a continuous manner as postwar innovations resulted from prewar developments in electronics research.

Similarly, the growth of businesses, reorganization of management structures, and transfer of land use from agriculture to industry accelerated in a slowly but persistently. What may be mistaken for a dramatic "take-off" is rather a steady acceleration of growth over the entire period of 1946 to 1971. The birth of electronics did not take place in 1946, nor was industrial expansion complete in the Silicon Valley in 1971. Yet the timeframe is significant because it marks the first period of the new rapid growth now possible throughout the United States.

Departing from diversification trends within late 19th and early 20th century business growth, companies of the third Industrial Revolution specialized in the manipulation of electricity to perform automated tasks. A departure from the need for large capital expenditures on large motorized machines meant a new focus on smaller, specialized concerns. Here the federal government initially played a vital role. It changed the location of industry to the Sunbelt during World War II through war production awards, which entailed the use of smaller firms since large corporations were sparse in these areas. Simultaneously, federal policy encouraged small business growth by guaranteeing loans for subcontracts and manufacturing conversion. As a hierarchy of different sized new corporations emerged, small companies sold specific products to larger firms that incorporated those products into larger equipment manufacture—a trend proceeding from wartime aircraft and ship manufacture. The third Industrial Revolution significantly integrated smaller companies into the nation's industrial sector.

Small firms are largely responsible for innovations in technology that reduce the costs of technology. Gordon Moore, founding partner of Intel, theorized that every 18

months the semiconductor speed is doubled as semiconductor market price is cut in half. This fact drives increases in high-speed communications. Hence, the third Industrial Revolution provoked growth rates previously unseen in America's history. For example, the S&P 500 index would have to gain over 60% in value during 1999 in order for the 1990s to match the rate of return of the large stock index during the 1950s. During the immediate postwar period, innovators built businesses on basis of inexpensive production of electricity manipulating devices. Company executives reinvested all or most profits into capital improvements, which translated into large returns for investors. Profit reinvestment sparked a cycle of technological advances and increased investment. Rapid growth attracted investors. Increased investment paid for product research and development. Research created new technologies, and the cycle repeated until a firm, such as Hewlett-Packard that started in a rented garage, signed a long-term lease in an industrial park specially designed for the electronics industry.

After the federal government influence faded, local governments in the Santa Clara Valley installed a land development policy conducive to industrial expansion. Cities in the valley annexed unincorporated land to be developed into residential homes and industrial parks, pushing agriculture to the fringes of the foothills or off into the Central Valley. Though growth may have appeared uncontrolled, active planning departments zoned agricultural land and harnessed urban sprawl purposefully, thereby preventing the creation of a Bay Area Los Angeles. Yet county and city officials encouraged and continue to encourage rapid growth. The region's governments have retained significant influence in the direction of expansion. A belief persists among residents that if the community remains employed and also protected from pollution and

crime, and receives, in addition, the necessary services from public facilities, then leftover taxpayer dollars may be allocated to growth-oriented investments.

The growth of new businesses of the 1950s to 1960s leveled off during the 1970s. New capital gains legislation, taxing gains at 49%, stifled investment during the decade. The bear market of 1973 to 1974 further stalled speculation in small capitalized firms, as investors rushed to treasury bond issues, many of which paid interest rates exceeding 10%. The general increase in raw material prices as exhibited by the oil crisis, and the political turmoil surrounding the presidency and Vietnam War undoubtedly played to Americans' investment concerns.

However, the electronics industry, often hidden because of building height requirements and architecture designed to blend with the landscape, emerged more visibly during the 1970s as companies expanded out to the freeways. In the 1970s for the first time, technology companies replaced the majority of orchards lining the portion of U.S. Highway 101 extending from San Francisco down the peninsula toward San José. Hence the label "Silicon Valley" was coined in 1971 even though this was a feasible title for the region as early as the late 1950s, given the early rise in electronics manufacture employment.

It was not until the 1980s and the inception of the personal computer age that a significant number of companies merged and restructured. Such vertical integration of computer technology created national computer hardware and software giants like Microsoft, Dell, and Sun Microsystems. Yet today smaller concerns still play a big role in bringing computers, computer peripherals, and computer applications to market. Likewise, firms continue to specialize. Device-oriented manufacture of the 1950s and

1960s has evolved into software development, specialized microchip manufacture, and Internet commerce. Thus it is not uncommon to see technology companies, started by an idea, successfully market a concept, gain venture capital, and eventually come to an initial public offering in a matter of months. In fact, many Internet businesses require no capital investment whatsoever. A population accustomed to "smallcap" success stories and new legislation that lowered capital gains rates to 28% in 1978 and then to 20% in 1981 caused the rapid growth story to continue through the 1980s. Fewer than a dozen of the 2,500 Silicon Valley companies were among the nation's 1000 most highly capitalized firms in 1984, and more than 80% of high technology companies employed fewer than 200 individuals.[90] The valley remained and continues to remain a valley of small businesses.

A 1984 hearing before the Joint Economic Committee in the United States Congress surveyed high technology executives on how to replicate the successful industrial growth of the Silicon Valley and Route 128. Interviewees among Silicon Valley businessmen ranged from Robert Noyce, vice chairmen of Intel Corporation and Jerry Sanders, CEO of Advanced Micro Devices, to venture capitalists and founders of small businesses. The overwhelming responses from both the valley and the Massachusetts concerns suggested that university players such as Professor Frederick Terman of Stanford placed an entrepreneurial spirit upon the regions. Nearly all executives pointed to the importance of small businesses that developed ideas and management infrastructures, and all agreed that small business survival depended upon an atmosphere of investment spurred by public policy and participated in by the general population (i.e., a low capital gains tax rate).[91]

The data gathered from observations made by the executives has been influential in the creation of new technology centers in the United States and abroad. Such cities as Austin, Seattle, and Raleigh, have adapted the Stanford Industrial Park model, establishing suburban settings for industry throughout the Sunbelt. Europe and Japan have also kept a reasonable pace with the United States. America's trading partners have benefited from a close relationship with the United States, and vice versa. Many innovations in electrical engineering came out of Germany and Great Britain. Japan has made use of American innovations to become the worldwide leader in electronics manufacture in the 1980s. Concurrently, the United States is exporting the aspects of 1st and 2nd Industrial Revolutions to less developed nations. Investments in higher education levels in the U.S. have created a labor force attracted to white-collar deskwork rather than unskilled manual labor. The Third World, in contrast, furnishes assembly line factories for microelectronics, which both provides much needed employment for these nations' inhabitants, and gives them access to technology otherwise unavailable. For example, while Indonesia lacks the communications infrastructure of the United States most people in that country use cell phones because of their access to satellite communication. The third Industrial Revolution is a worldwide phenomenon that continues to bring nations closer together. The decade of 1990s has shown that the more electronics technology spreads the more the United States benefits. The exportation of high technology has promoted full employment, social mobility, and on unprecedented return on investment in the United States.

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[1] The first quote is an excerpt from Berge, Wendell, *Economic Freedom for the West* (Lincoln: University of Nebraska Press, 1946). The second quote comes from a prepared statement by Regis McKenna, president of Regis McKenna Public Relations in Palo Alto, CA prepared for the *Hearings before the Joint Economic Committee of the Congress of the United States*, 1984.

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[3] Nash, Gerald, *The American West Transformed* (Bloomington: University of Indiana Press), 1985, vii-viii.
[4] Nash, Gerald, *World War II and the West* (University of Nebraska Press), 1990, 41, 67.
[5] Nash, *West & WWII*, 10.
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[8] *PHR*, 364-368.
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[18] *PHR*, 317.
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[20] Letter to SWPC Subcontracting Division from Earl C, Elliott, District Engineer exhibits that HP received four of the first six facilities expansion application approvals in the San Francisco region by 1943 for its Page Mill Road facilities.
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[22] James, 460-461.
[23] Hackley, Howard, "The Regulation V Program" 1945, 5.
[24] Hackley, 18.
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[43] *Climate for Entrepreneurship*, 225-240, 274.
[44] Packard, 65-67.
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[47] Findlay, 134, 144-145.
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[49] Mahon, 66-67.
[50] Everett, 38-39.
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[52] Malone, 88-92.
[53] Malone, 101-112, 138-144.
[54] Everett, 25-26.
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[56] Hewlett, 79-81.
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[58] Packard, 44-53.
[59] Rogers, 8-11.
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[87] This means the value of products shipped less cost of materials.
[88] These are usually for plant improvements and equipment.
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