

The Significance of Military Spending in Silicon Valley: An Historical View

by Lenny Siegel

This paper was prepared for the October, 1986 conference, "Silicon Valley: The Future," at the University of California, Santa Cruz, and updated in June, 1987. Lenny Siegel is the Director of the Pacific Studies Center, a public interest information center in Mountain View, California, and editor the Center's monthly newsletter, **Global Electronics**. The author wishes to thank Crystal Gray (sp?) for his research assistance.

Silicon Valley, the belt of communities at the southern end of the San Francisco Bay, is recognized worldwide as the foremost concentration of commercially oriented, high-technology electronics companies. With more than four billion dollars of Pentagon contracts flowing into the Valley each year, as well as two major military installations, the areas is also a leading recipient of U.S. military outlays.

Indeed, early in Silicon Valley's development, military contracting dominated the Valley's high-tech industry. Military research and procurement funds drew a critical mass of high-tech talent to the Valley, and on a national scale Pentagon programs subsidized the early growth of what were to become the Valley's two leading commercial industries, computers and semiconductors.

During the 1970's, however, market-oriented production eclipsed government contracting as the driving force in Valley growth and technological development. Many high-tech professionals have chosen the commercial sector over government work, so the commercial sector is increasing its lead in numerous key fields.

The Defense Department has created several programs designed to regain its technological leadership, but its needs have diverged from those of civilian

industry. Pentagon efforts, particularly restrictions on exports and technical publication, could undermine the commercial accomplishments of Valley firms.

Terman's Community of Technical Scholars

Silicon Valley exists where it does because the Santa Clara Valley provides high-tech industry's most critical input, brainpower. The Valley offers a climate and lifestyle that attract and retain many of the world's most capable engineers, computer scientists, and entrepreneurs. However, despite all the hype about the dynamism of the area's free market economy, the high-tech complex is rooted in an industrial policy designed by Stanford University and funded, in its early years, by the U.S. military.

Once upon a time, the Santa Clara Valley was known for its prunes and apricots, not its silicon chips. Lee De Forest invented the vacuum tube in Palo Alto in 1912, and David Packard and Bill Hewlett built audio oscillators there for Walt Disney's "Fantasia" in the late 1930's. But not until after World War II, did the South Bay Area emerge from its bucolic traditions.

More than any other person, the late Stanford Engineering Dean and Provost, Frederick Terman, was responsible for the rise of Silicon Valley. An electrical engineering professor, he helped his two most famous students form Hewlett-Packard. Following World War II, he returned to the campus from Harvard's Radio Research Lab with a vision of a university-industry partnership that he called the "community of technical scholars."

Terman built up Stanford's electronics research labs, and he encouraged graduates and faculty members to join or found local high-tech firms. In the early 1950's he convinced the Stanford Board of Trustees to set aside land for long-term industrial leasing, and soon Hewlett-Packard and Varian Associates, another

Terman-sponsored venture from the thirties, set up shop in the Stanford Industrial Park. In a few years other firms, such as Lockheed, moved to the Park to take advantage of Terman's technical community, and the burgeoning high tech businesses repaid Stanford for its foresight by contributing funds to build more labs and classrooms on campus.

The Park became a model for high-tech industrial development in the Santa Clara Valley, and before long Terman's formula for business-academic cooperation inspired imitators around the globe. Most important, it established a critical mass for high-tech industrial growth which has made the Valley both the greatest concentration of high-tech industry anywhere and a uniquely comfortable place to start a new high-tech business. Impressed by the Stanford environment, Lockheed set up its giant, new Missiles and Space division in nearby Sunnyvale in 1957.

When William Shockley, who had led the Bell Labs team that invented the transistor, returned to Palo Alto in 1955, Terman's community of technical scholars was a blossoming reality. Though Shockley's own company floundered, the professional team that he put together went on to found, directly and indirectly, the dozens of the semiconductor firms that gave "Silicon Valley" its name. Without Terman's spadework, the Santa Clara Valley would have developed along the lines of Dallas, Texas. Dallas is the home of Texas Instruments and a few other major high-tech firms, but it is not nearly so dynamic as Silicon Valley.

Terman's town-gown community had a third partner, silent only inasmuch as most accounts of his accomplishment ignore or play down its role. To fund the growth in Stanford engineering departments, Terman relied heavily upon research funds from the Pentagon. In the 1960's, most of the major high-tech firms in the

Valley—Lockheed, Philco-Ford, GTE Sylvania, Varian—and many of the minor ones did most of their business with the Department of Defense. Firms with few direct military contracts, such as Hewlett-Packard, sold a large share of their products to the producers of weapons.

Even the youthful semiconductor industry was dominated by the Pentagon. When Fairchild Semiconductor and Texas Instruments first marketed integrated circuits in the early 1960's, the Minuteman missile program and other military and space projects gobbled them up. As late as 1965, 70% of the chips sold in the U.S. were bought by the Defense Department.¹

At the time the computer industry played a minor role in the Valley's economy, but military-supported research, particularly at Stanford and the Stanford Research Institute, spawned technological breakthroughs that would later prove critical to the development of the computer industry, not only in the Valley, but elsewhere. At SRI, for example, Douglas Engelbart developed the conceptual framework for personal computers, invented the "mouse," and designed interactive computer displays. Engelbart's work, as well as most advanced computer science research at Stanford, SRI, and other academic institutions and think tanks in the U.S., was sponsored by the forward-looking Information Processing and Technology Office of the Defense Department's Advanced Research Projects Agency.²

¹Leonard Weisberg, in *Industrial Technology* hearings, Senate Committee on Commerce, Science, and Transportation, October 30, 1978, pp. 74-75. For an excellent description of Defense's early role in the development of the integrated circuit industry, see John E. Tilton, *International Diffusion of Technology: The Case of Semiconductors*, Brookings Institute, 1971, pp. 89-97.

²For more on IPTO's leading role in advancing computer technology in the 1960's, see Howard Rheingold, *Tools for Thought: History and Future of Mind Expanding Technology*, Simon & Schuster, 1985.

Meanwhile, researchers at IBM's San Jose labs designed and perfected the first disk drive computer memory device in 19???. Today, dozens of Valley firms make drives, disks, and related equipment. Though IBM now is considered primarily a market-oriented firm, back in the mid-1960's it did nearly half its business with the U.S. government, primarily the Department of Defense.³

With its vast resources and oft-used authority to classify technical breakthroughs as secrets, the military stood at the state-of-the-art of most new technologies. Military contractors attracted the brightest young scientists and engineers. Civilian firms applied new ideas only after the military sector perfected them.

In Silicon Valley, weapons production dominated the manufacturing economy. In 1962 and 1963, more than thirty percent of all manufacturing employment was in the ordnance industry—that is, missiles at Lockheed and a few other firms, and ground vehicles at FMC. If one adds military electronics employment—not broken out in official statistics—military production probably represented more than half of the Valley's manufacturing employment in that period. (See Table 1.)

The Commercial Sector Pulls Ahead

By the late 1960's, however, the pace of technological innovation surpassed the Pentagon's ability to absorb and manage it. While the Pentagon was bogged down in the rice paddies of Southeast Asia, Silicon Valley's engineers and entrepreneurs were rapidly developing and marketing new products and technologies.

³International Competitiveness in Electronics [Washington: US Congress, OTA-ISC-200, November, 1983], p. 147, citing ????

Exciting new firms like Intel, formed by chip-inventor Robert Noyce, and System Industries, founded by 1986 Republican senatorial candidate Ed Zschau, eschewed military work. Though activists on the Stanford campus were at the time raising angry, political objections to military-sponsored research, the Valley's commercially oriented entrepreneurs were more turned off by the Defense Department's inflexible, bureaucratic ways of doing business. Robert Blumenkamp, one of the Valley's many successful consultants and investors, recalls that he left "the government-funded aerospace companies in Southern California because they were too rigid. The new firms in Silicon Valley were different. They wanted creativity and got it by being very flexible. It was exciting--no wonder top people were lured to the area."⁴

If the development of any single product marked the eclipse of the Pentagon by the commercial high-tech sector, it was the microprocessor, or computer-on-a-chip. In 1969, a time that the Pentagon was demanding that chip manufacturers build specialized circuits to rigid specifications, a Japanese electronics manufacturer asked Intel to build circuitry for a small calculator. Intel proposed the first single-chip processing unit, and it began delivery in 1971. More flexible than previous generations of integrated circuits, microprocessors quickly found a place in the commercial electronics industry. The Pentagon, however, took years to take advantage of the breakthrough. Regis McKenna, the Valley's best known PR man, remembers the spread of Intel's popular "8080" microprocessor, developed in 1974, "It was second-sourced by Japan in 1975, and by 1977 we had seen a Soviet

⁴Richard Carlson and Theodore Lyman, "U.S. Government Programs and their Influence on Silicon Valley," SRI International Public Policy Center, May, 1984, p. 15.

reverse-engineered copy of it. But the joint Army-Navy task force didn't approve it until 1979."⁵

The military had not overlooked the microprocessor. Rather, it was trapped in a cumbersome set of qualifications and testing procedures known as military specifications, or mil-specs. Mil-specs are designed to standardize components and to make sure that they'll perform reliably in extreme conditions, such as very hot and very cold temperatures. The Navy set the first specifications for military semiconductors back in 1959.

Most semiconductor companies accepted the inconvenience of mil-spec work in exchange for the higher profit margins associated with military contracts. But the mil-spec system could not match the dynamism of semiconductor technology. The mil-spec bureaucracy is not the only reason the civilian chipmaking sector moved ahead of the military sector, but it well illustrates the handicaps facing those who supply components to the military.

Simply qualifying a commercial chip required as long as two years of re-engineering, testing, and paperwork. By the time chips met military specifications, they were obsolete. The commercial sector had moved on to a new generation of more capable, and even more reliable circuits.

In addition, specified testing procedures did not keep up with the increasing complexity of the circuits. For example, as late as 1976 one military standard required the visual inspection of interconnects, the fine lines of metal, imbedded into chips, that connect the various circuit elements. This worked fine on small scale integrated circuits, where the interconnects were about 2 mils wide. However, on large-scale integrated (LSI) circuits, where the interconnects were

⁵John Markoff, "Embracing the Military at Arms Length," *San Francisco Examiner*, August 12, 1986, p. A-4.

about 0.2 mils wide, inspections that had formerly taken several minutes then took several hundred minutes. One contractor said, "This problem is like sending one person to find a contact lens somewhere in a football field with knee-high grass," and he warned that the most advanced semiconductors were going into industrial and commercial, not military, uses.⁶

In the early 1980s, Pentagon investigators found that the mil-spec branches of most Valley chipmakers were not fully testing their chips. National Semiconductor actually admitted(???) criminal culpability for supplying fraudulent documents. But the Pentagon never claimed that the improperly tested chips were defective. The industry responded by arguing, somewhat persuasively, that the testing procedures had become pointless.

By then the semiconductor industry had adopted stringent quality control measures during production. One exec contended, "It should not go unnoticed that a vendor's process-quality guarantee of 150 parts per million is substantially better than any known military screening method now in use, including 100% retesting of IC's when they arrive at the prime contractor's [weapons-maker] factory." In fact, the testing process actually damaged perfectly good chips.⁷

Today there is a move afoot to get the Pentagon to accept commercial quality controls. The Defense Science Board Task Force on Defense Semiconductor Dependency (the Augustine Commission) recommended in March, 1987, that the military start buying more commercial chips, and William P. Perry, Deputy Defense Secretary under Carter and a Silicon Valley leader, said ???.⁸

⁶S.(??) Zipper, "Calls for End of Mils Specs Barring LSI Technology," *Electronics News*, November 15, 1976, citing D. (??) Sorchych of Harris Semiconductor.

⁷Signetics' Ed(??) Macaruso, "DDD Vexes IC Makers," *Electronics Week*, February 4, 1985, p. 67.

⁸Perry quote.

Though the military's insistence upon the mil-spec approach is widening the gulf between the commercial and military sectors, the Pentagon may have no other choice. It cannot match the rewards of the commercial sector to hire or retain engineers and managers qualified to make flexible judgements about the quality of chips. It needs standards that any technically trained bureaucrat can implement.

By the end of the 1970s, the military's demand for semiconductors had slipped to less than ten percent of the total U.S. market. Mil-spec chips typically lagged two years behind comparable commercial designs. And the brightest young engineers—even those who supported U.S. military policy—were choosing the commercial sector over military employment or contracting.

Silicon Valley's computer industry was outdistancing the Pentagon as well. Before the microprocessor, computers resided only in the inner sanctums of government, corporate, and university computer centers, but the cheap, adaptable flake of silicon enabled the creation and spread of a new type of machine, the microcomputer. Many of the hobbyists who pioneered the personal computer industry were anarchists and activists who enjoyed working in high technology but detested large institutions like the Pentagon and IBM.

Fred Moore, the man who published the flier launching Silicon Valley's fabled Homebrew Computer Club in 1975, was a veteran draft resistance organizer. Lee Felsenstein, who designed the Sol and later the Osborne personal computers—and chaired Homebrew's well attended meetings in the auditorium of the Stanford Linear Accelerator Center—had assembled home-brew bullhorns for Stop the Draft Week, the 1967 assault on the Oakland induction center. Even Steve Jobs and Steve

Wozniak, the founders of Apple Computer, were products of the 1960's counterculture.⁹

The Rolm Corporation was by no means a product of the Bay Area's anti-war youth culture, but its shift into civilian work was also made possible by breakthroughs in semiconductor technology. In 1969, four young electrical engineers from Texas--their initials spelled "ROLM"--started building rugged, "military-specification" computer in an old Silicon Valley prune-drying shed. Though the mil-spec business was profitable, the company lost nearly a third of its business in 1973 when the Navy decided to standardize on a competing product. Concerned about the capricious nature of the military market, Rolm established an entirely new product line, computerized phone exchanges.¹⁰ By the time IBM bought Rolm in 1984, mil-spec computers made up only 15% of its business.

Only in the area of advanced computer science research did the Pentagon maintain leadership, in the form of ARPA-funded research at Stanford and a handful of private firms. However, the armed services could no better make use of advanced computer technology that they could utilize state-of-the-art chips.

For example, in 1973, ARPA installed the Illiac IV, at the time the world's most powerful computer and a landmark in parallel processing, at NASA's Ames Research Center in Silicon Valley. Just down the street, however, the Pentagon's sole Satellite Control Facility was using obsolete Control Data 3800's. When the Air Force first brought in newer machines, it handicapped them by design. To avoid developing and testing new software, it actually programmed Varian 77's to

⁹See Paul Freiberger and Michael Swaine, *Fire in the Valley* (Berkeley: Osborne-McGraw Hill, 1984) for a detailed, authoritative history of the genesis of the microcomputer industry.

¹⁰For more on ROLM and other Silicon Valley success stories, see Michael Malone, *The Big Score*, ?? ???, 1985.

emulate the 3800's. In the late 1980's, the Air Force is finally replacing the old computers with newer, but already one-generation old-machines, from the IBM 803X(???) series. The lengthy, cumbersome process of designing and installing major military computer systems means that hardware is always obsolete when put into operation.

The rise of commercial technology in the Valley went hand in hand with the growth of the commercial market. By one measure, military business fell from nearly thirty percent of the Valley manufacturing economy in the late 1960's to only half that a decade later. (See Table 2.)

The Pentagon Strikes Back

There has been a great deal of criticism, most of it justified, of the military's choices of technology, its methods of implementing it, and of course the goals of U.S. military policy, but there is no doubt, in both conventional and nuclear arenas, that the U.S. military relies heavily upon advanced electronics technology. The contributions of Silicon Valley firms and research institutions, commercially oriented as well as associated directly with the Pentagon, are seen daily on the battlefields and arsenals of the world.

However, by the late 1970's, commercial products such as war-simulating video games were employing more sophisticated hardware and software than the real thing. Military leaders became worried that the Russians might absorb the new technologies first. It should not be surprising, therefore, that the Pentagon launched a series of initiatives designed to regain its hegemony in high-tech—to get first crack at innovations that at least in part have sprung from military-sponsored research

In semiconductor technology, these include the Very High Speed Integrated Circuit (VHSIC) program, Gallium Arsenide development, and the proposed Semiconductor Manufacturing Technology Institute. In computer technology they include the Strategic Computing Program (SCP), the Innovative Projects Office of the Strategic Defense Initiative (Star Wars), and the Software Engineering Institute.

Though the focus of each of these initiatives varies, most of them differ from commercial R & D projects in two fundamental ways. First, they attempt to speed the utilization of new technologies by linking research directly to weapons development. VHSIC, for example teams chipmakers such as National Semiconductor and ?? directly with military systems manufacturers.

Along the same lines, the Strategic Computing program, has computer scientists working on projects such as the development of a robotic ground vehicle for the army. Since actual weapons work is discouraged at many major research universities, SCP has helped fund the operations of new off-campus think tanks. In Silicon Valley today there are several profit-making computer science labs, Most are direct spin-offs from Stanford, and most take the bulk of their income from the military or from military contractors.

Second, all proceed under actual or potential restrictions on the circulation of ideas. Under Reagan Pentagon has attempted to impose a wide range of limitations on publication, technology export, and participation by foreign researchers. Soon after the VHSIC program was announced, officials made clear that its technologies would be subject to controls. The VHSIC director proposed restrictions on the publication of unclassified university research results arising

from Defense sponsorship, prompting an open letter of opposition from the presidents of five of America's top research universities, including Stanford.

Academia and the Pentagon are still fighting over publication rights, but VHSIC's industrial contractors—who receive the bulk of the program's funds—never questioned the program's approach to security. Any chip developed under the VHSIC program may be sold only to military contractors eligible to receive arms under the International Traffic in Arms Regulations. Many VHSIC technologies are actually classified secret by the Defense Department.

Still Behind

There is no doubt that the military's initiatives will speed the flow of advanced electronics machinery and software into American weapons systems, but it is unlikely that the Pentagon will regain its high-tech leadership, for five principal reasons:

First, America's military industry is more consumed with making money than winning wars—in contrast to Israel, which more effectively exploits electronics technology.

Second, the military requires small production runs, such as a few satellites, a few hundred sea-launched missiles, or a few thousand tanks. By the time companies learn how to build something efficiently, they're done.

Third, as described above, the military and its allied agencies deliberately control the flow of information. It's hard to make use of someone else's work if you don't know about it.

Fourth, the military electronics budget, though huge, cannot grow exponentially. It is limited by the size of its single source, Federal tax revenues. Though the Reagan administration has done its best to pump funds into high-tech

weaponry, the military electronics market is expected to grow only ?? % in fiscal 1988 and ??% the following year.¹¹

The fifth reason is least recognized but most important. Many of the brightest minds in Silicon Valley don't like military work. The creation of the Strategic Computer program, for example, stimulated the formation of Computer Scientists for Social Responsibility. Many leading computer scientists who for years had taken money from the military balked at the linking of their work to specific weapons.

Many left critics of the military suggest that the Pentagon employs the cream of America's scientific and engineering talent. Since the late 1970's, however, this has not been case—at least in Silicon Valley, and the military electronics industry knows it. One corporate recruiter complains, "In the late sixties, young engineering students, like others on campus, were told that it was not *right* to work for military contractors. While many were mature enough to discount the disillusionment of Viet Nam, by the mid-seventies the lure of Silicon Valley and the well-publicized opportunities in the semiconductor and computer industries turned even the most patriotic people away from opportunities in [electronic warfare]."¹²

Bob Kirby epitomizes the Valley professionals who have left military electronics. He worked at ESL, a homegrown electronic warfare contractor, from 1974 to 1977. He had no complaints about pay or benefits, but Kirby says, "I wasn't going anywhere." Though ESL had a reputation for working on exciting technologies, he found little satisfaction writing software to determine how nuclear explosions might affect satellite communications. "The reports were

¹¹¹²Robert Brudno, ??, *Journal of Electronic Defense*, November, 1984.

filed, read by some general, and that's about it..." Each year, he and his team merely refined the previous year's finding. He adds, "I needed more feedback...to make something that people used."

Kirby's dissatisfaction led him to question the "whole idea of nuclear armaments and defense buildup." He is active today in the Technology and Society Committee, a luncheon forum for Valley professionals with concerns about the military, social, and environmental impact of high-tech. In 1977 he left ESL to make medical instruments at Syntex, primarily because he felt stifled by military work. He reports, "I get plenty of feedback now. At Syntex, users called all the time. What you did, you could see working." Syntex sold the division, and later Kirby moved to another instrument manufacturer, but he recalls proudly, "Someone used one of our X-ray spectrometers to win a Nobel Prize in chemistry."

Impact on the Valley

Western scholars use the concept of the "dual economy" to explain how the Soviet Union reached parity with the U.S. in the development of strategic weapons, while remaining an also ran in the international high-tech economy. The USSR concentrates its scientific resources on the military side of its economy, and that sector has little overlap with the civilian economy.

In the United States, a similar yet more complex dual economy has emerged. Two sectors, military and commercial, function side by side, often within the same corporate organizations. They compete to exploit the latest technologies. In a few areas, the military sector stands in the lead. But in technologies with proven commercial value, the commercial sector has dramatically outdistanced the military.

In Silicon Valley, the two sides of the economy grew from the same root, Stanford University, but the needs and the styles of the two sides of the economy have gradually diverged. Today there are two fundamental differences between military-sponsored and market-driven production. First, companies serving the mass market don't have the military industry's short production runs. They can take advantage of economies of scale and learning curves, for they must produce tens or even hundreds of thousands of computers or chips each year.

Second, not only do the military and its allied agencies deliberately control the flow of information, but under the Reagan administration the Federal government has attempted to conceal even the existence of billions of dollars of so-called "black" weapons programs. Though commercially oriented companies also restrict the flow of information—especially before products are released—they always depend for success upon public knowledge of their products' capabilities. Often they deliberately make available design information as well.

By diverting resources and controlling the flow of information, the American national security establishment threatens the health of commercial high tech. In fact, the battle between military and civilian priorities in chip and computer technology is more significant than competition with Japan in determining the long-term vitality of high-tech industry in the U.S.

The VHSIC program, the oldest of the military technology catch-up initiatives, illustrates how little military programs do for the commercial sector. Some in industry, the press, and even the Defense Department have portrayed VHSIC as a response to government-industry collaboration in Japan. The business press has contained many articles promising commercial spin-offs, but in its actions VHSIC never emphasized the development of new commercial technologies.

However, VHSIC appears to have been designed well to serve Pentagon goals. Gordon Bell, Assistant Director of the National Science Foundation, says, "The VHSIC program simply sucked the technology out of the commercial industry and brought the military into the mid-80s."

Three characteristics of the VHSIC program kept it from strengthening the commercial sector. First, as described above, the Pentagon clamped controls on the flow of goods and the dissemination of technology. This probably slowed the pace of innovation; it definitely kept products out of the commercial marketplace, particularly the international market.

Second, the chips sought by the Pentagon were not well suited for mass production. Even within the field of custom chip design, VHSIC contractors have chosen design tools that do not maximize the utilization of the chip's surface. This makes sense in the military's world of short production runs. Commercial firms, however seek high-density designs which will pay off at higher volumes.¹³

Third, it chose to work with large semiconductor and aerospace companies, missing a chance to work with many companies operating at the leading edge of semiconductor technology. Ever since AT&T began to circulate transistor knowhow, a major share of significant innovations in semiconductor technology has come from small, new companies. Of course, given the emphasis of VHSIC on non-commercial technical problems, the program's hands-off approach might have actually made it easier for small companies to come up with commercially viable technologies.

¹³Leslie Brueckner, "," Berkeley

Looking Ahead

VHSIC and other technology initiatives sponsored by the US military are not a sign that the Pentagon dominates the leading edge of computer science and electronics technology. Rather, they are evidence that the military recognizes that it has fallen behind, particularly in Silicon Valley.

This is not to say that the military, by restricting information flow, prohibiting exports, and doubling its budget, could not regain its dominance at the expense of the civilian sector. Pentagon policy initiatives, such as the proposed Semiconductor Manufacturing Technology Institute, should be firmly rejected. History, however, is on the commercial side of the chip.

TABLE 1. Military employment in Silicon Valley

<u>Year</u>	<u>Missiles & Tanks Employment</u> (thousands)	<u>All Manufacturing Jobs</u> (thousands)	<u>M & T / All</u>
1950	0	22.1	0%
1951	.2	26.7	0.7%
1952	.7	27.6	2.5%
1953	.8	28.9	2.8%
1954	1.1	29.4	3.7%
1955	1.3	34.0	3.8%
1956	1.6	39.3	4.1%
1957	4.2	46.8	9.1%
1958	9.6	52.1	18.4%
1959	14.8	62.2	28.4%
1960	18.0	70.3	25.6%
1961	22.0	76.3	28.8%
1962	26.0	85.4	30.4%
1963	26.8	88.3	30.4%
1964	24.3	87.9	27.6%
1965	22.0	89.8	24.5%
1966	24.3	105.8	23.0%
1967	28.7	119.7	24.0%
1968	28.7	127.0	22.6%
1969	24.2	128.6	18.8%
1970	20.7	123.5	16.8%
1971	19.0	117.4	16.2%
1972	19.4	130.9	14.9%
1973	19.5	151.3	12.9%
1974	20.2	167.2	12.1%
1975	21.9	157.7	13.9%
1976	21.1	170.1	13.4%
1977	19.6	180.4	10.9%
1978	20.5	203.4	10.1%

1979	22.1	232.1	9.5%
1980	24.2	250.0	9.7%
1981	25.2	254.7	9.9%
1982	27.0	268.0	10.1%
1983	27.6	270.9	10.2%
1984	29.3	293.3	10.0%
1985	32.2	291.0	11.1%
1986	??	??	

Notes: All data are from the State of California Employment Development Department, and cover Santa Clara County only. The 1950-1971 figures for missiles (and space vehicles) and tanks were categorized "ordnance."

These figures do not include military electronics employment, which is unmeasured. Historically, military electronics, computer manufacturing, and instruments employment, including firms selling components and equipment to weapons contractors, has probably remained roughly equal to missiles and tanks production in Silicon Valley.

TABLE 2: Military business in Silicon Valley

<u>Year</u>	<u>Military Contracts (US\$ millions)</u>	<u>Shipments (US\$ millions)</u>	<u>Ship./Contr.</u>
1966	807.0	3,304.9	24.4%
1967	930.8	3,654.7	25.5%
1968	1,088.4	4,009.6	27.1%
1969	1,219.8	4,201.8	29.0%
1970	1,003.0	4,026.6	24.9%
1971	847.0	4,036.9	21.0%
1972	964.0	5,084.9	19.0%
1973	1,107.0	6,261.8	17.7%
1974	1,344.6	7,669.0	17.5%
1975	1,440.4	7,577.5	19.0%
1976	1,577.3	8,943.0	17.6%
1977	1,734.2	11,339.0	15.3%
1978	2,105.2	13,238.4	15.9%
1979	2,036.5	14,385.	14.%
1980	2,392.8	15,531.	15.%
1981	2,946.2	16,677.	18.%
1982	3,888.2	17,823.0	21.8%
1983	3,893.2	22,014.0	17.7%
1984	4,630.6	25,544.0	18.1%
1985	4,552.1	29,505.7	15.4%

Notes: It is difficult, with available data, to get an exact measure of the Pentagon's share of business in Silicon Valley. The trends, however, are unmistakable. I compare Pentagon figures on Santa Clara County prime contracts with annual manufacturing shipments totals from *Sales and Marketing Management* magazine.

I make the comparison only in general terms. The Pentagon figures are for contract awards, not shipments, and they are by Federal fiscal year (which changed in the late 1960's). They include work that may have been subcontracted out of the area, but not work subcontracted in. They do not include very small contracts (below \$10,000 or \$25,000 depending upon the year) or Energy Department (nuclear weapons) contracts. They do, however, include non-

manufacturing activity such as software, computer services, and university research.

The shipments figures are from *Sales and Marketing Management's* own surveys of establishments with 20 or more employees, published annually in the magazine's table, "Top 50 Counties in Manufacturing Activity." In recent years, Santa Clara County has ranked fifth in the U.S., after Los Angeles, Cook (Chicago), Wayne (Detroit), and Harris (Houston) counties. We could not locate the *S & M* figures for 1979, 1980, and 1981, so those numbers here are interpolations.