

EXPERIENCING SILICON VALLEY

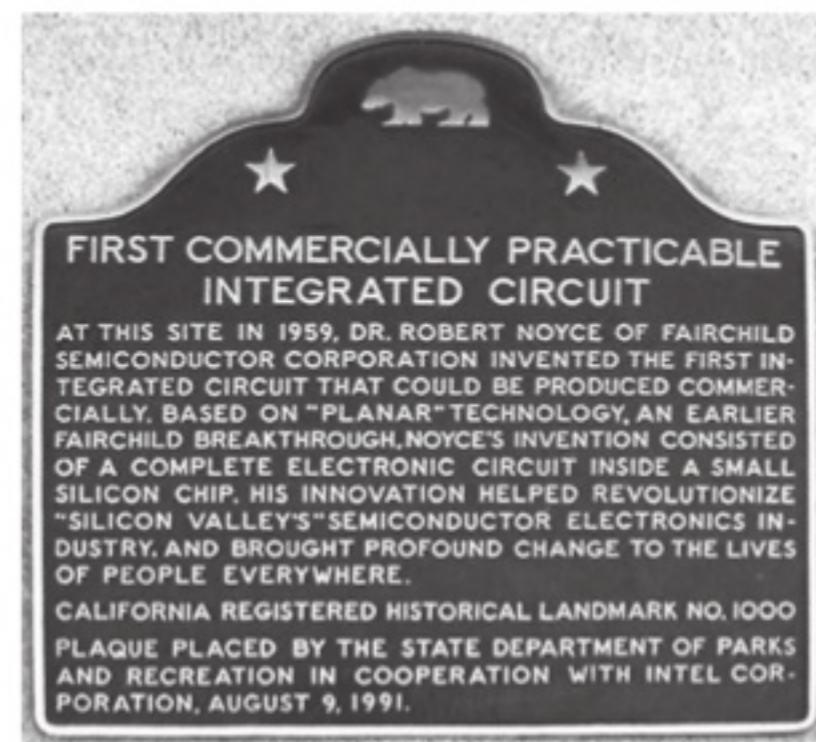
“There are certain periods in history when discoveries and events...create a window when civilization has the opportunity to leap forward. One of these was...the Renaissance...a time of invention, entrepreneurial accomplishments and exploration—very similar to what has occurred in Silicon Valley.”

“The Making of Silicon Valley”

©1995 The Santa Clara County Historical Association

My romance with electronics took root when I was growing up in Jamestown, New York, in the 1950s. A fascination with radio led me to build my first crystal set using my mattress bedspring as an antenna. It seemed like magic to manipulate a “cat’s whisker” atop a small grayish-white clump of germanium and then hear music and radio dramas streaming out of the ether. Many nights I would fall asleep wearing earphones. I never guessed that my early interest in electronics would ultimately lead me to work with America’s most innovative high-tech companies and some of the legendary personalities who established them.

After earning my B.S.E.E. from Syracuse University in 1964, I accepted a position with GTE Sylvania, a military/aerospace contractor. I initially wrote operations manuals for about a year and then moved on to become a field engineer working on Top Secret projects. For about five years, I worked on Minuteman ICBM electronics at both Vandenberg AFB, California, and Grand Forks, North Dakota, and then in 1969, I accepted a brief assignment to oversee the installation of perimeter security systems in Vietnam.



*Location: 844 E Charleston Road,
Palo Alto, California, about 5 miles
from Stanford University*

I was subsequently asked to return to the war zone to direct the deployment of large, dart-shaped seismic detectors along the Ho Chi Minh trail. When I learned that deployment meant dropping electronic darts from a low-flying helicopter, I sensed it was time to alter my career path. In a major career shift, I became the first San Francisco editor for *EDN*, a monthly publication for electronic designers. Thus began my odyssey in a northern California region that was to become famously known as “Silicon Valley.”

“Found on no map, yet famous around the world...”

...Silicon Valley is that great nursery of new companies and technologies that are revolutionizing our lives,” wrote the late Gene Bylinsky, the former science and technology editor for *Fortune* magazine. “Silicon Valley is the 20th Century’s counterpart to the Fertile Crescent, the cradle of modern civilization in the Near East where wheat and farm animals were domesticated and (the) first writing evolved. In Silicon Valley, this densest concentration of innovative companies in the world, the new kind of writing is done on silicon, in intricate microminiaturized patterns that plot man’s path to the future.”

“Silicon Valley: High Tech Window to the Future”
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My High-Tech Odyssey

As *EDN* magazine editor, I had rare opportunities to interview entrepreneurs before they became Silicon Valley legends. I recall interviewing a professorial Bob Noyce a few weeks after he left Fairchild Semiconductor to start Intel. I also interviewed a flamboyant Jerry Sanders shortly after he left Fairchild to start Advanced Micro Devices. And then there was cigar-smoking Charlie Sporck and cerebral Don Valentine, the top execs at National Semiconductor. Don later founded Sequoia Capital, which became the gold standard for venture capital companies. Sequoia was an early investor in many successful high-tech companies, including Apple Computer and Cisco Systems.

I also met the taciturn John Bardeen, who won the Nobel Prize in Physics twice, first in 1956 for co-inventing the transistor at Bell Labs, and then in 1972 for his work on superconductivity. I caught up with Dr. Bardeen in 1970 after he presented his latest esoteric findings on superconductivity at Stanford University.

I was completing my second year with *EDN* when a market research firm hired me to edit its monthly analysis of technology developments for the financial community. I worked one year there, once scooping *Business Week* by publishing the first comprehensive article about digital watches. (Considered high-tech marvels at the time, they originally sold for about \$200. The magic of ICs and the forces of global competition quickly drove down prices to less than \$25.)

Inspired by the entrepreneurial spirit of Silicon Valley, I set out to “do my own thing” in 1972: first as an independent technology writer and then as a principal in a high-tech marketing and communications agency. Over more than 25 years (and through three different partnerships), I held virtually every management position in the agency as we served cutting-edge companies.

It was exhilarating to be on the front lines as we helped promising startups launch their very first products. We worked closely with Dr. David K. Lam, the founder of Lam Research, who launched his innovative plasma etch system in 1981. Born in China, he became the first Asian American to take a company public on the NASDAQ exchange in 1984. (I am currently a business advisor to Dr. Lam who now oversees Multibeam Corporation, an early stage developer of Complementary E-beam Lithography systems.)

In 1994, I was recruited by Cirrus Logic, one of my agency’s clients, to become its VP of corporate communications, and this gave me the opportunity to work closely with the late Mike Hackworth, co-founder and CEO, over a seven-year period as the semiconductor company’s revenue rocketed from about \$400 million to more than \$1 billion annually. Mike’s vision was to build all the critical chips around a microprocessor—i.e., chips to handle graphics, communications, hard disk control, power management, etc. Through an aggressive program of acquisitions, his company came closer to realizing this dream than any other semiconductor company. However, Cirrus Logic eventually spun off its acquisitions, which triggered a new wave of startups. When the company relocated its headquarters to Austin, Texas, I chose to stay in Silicon Valley.

Who Named Silicon Valley?



Don C. Hoefler (1923–1986) coined the term in a 1971 series of articles that was published in *Electronic News*, the only major weekly covering the emerging semiconductor industry. Don was the West Coast reporter for *EN* at the same time I was West Coast editor for the monthly *EDN* magazine. I regularly bumped into him at press conferences. In his brief San Francisco obituary, they credited him with naming “Silicon Valley,” noting that he later quipped when asked about it, “How was I to know that the term would be adopted industry wide and become generic worldwide?”

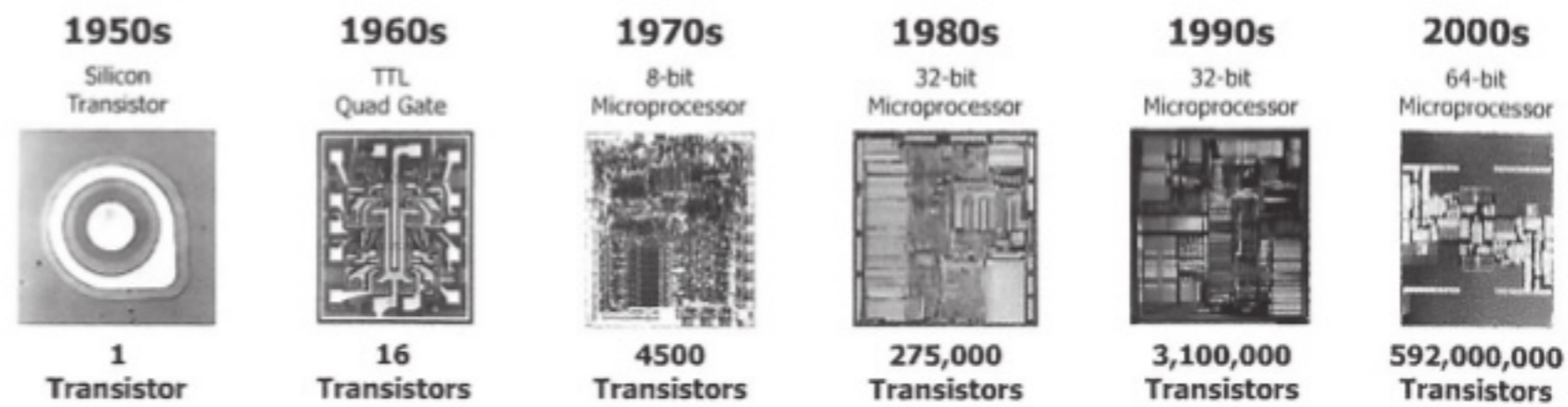
The Silicon Valley Phenomenon

Like the Renaissance and the Fertile Crescent, Silicon Valley emerged from a confluence of favorable factors. The Renaissance, during the fourteenth to seventeenth centuries was fueled by pent-up desire to emerge from the Dark Ages and the generosity of wealthy patrons of the arts, most notably the Medici family. The Fertile Crescent flourished some 9,000 years BCE, thanks to the natural irrigation from the Tigris and Euphrates rivers. Key factors creating Silicon Valley included a temperate northern California climate and enviable geography, plus great universities and a community of high-tech venture capitalists.

Comparing the emergence of Silicon Valley to other historical periods gives us clues about its future impact. The Renaissance, for example, started in Italy around 1350 and subsequently spread throughout the rest of Europe until about 1620. The Silicon Valley phenomenon has also spread, albeit more rapidly, from its roots in northern California to other metropolitan centers hoping to emulate its economic success. From “Silicon Prairie” in Dallas-Fort Worth to “Silicon Alley” in Manhattan to “Silicon Glen” in Scotland, the marvel of Silicon Valley continues to migrate around the globe, inspiring many. Perhaps the most remarkable emulators of Silicon Valley culture are now taking shape in China and India.

Moore's Law

Transistor density on integrated circuits doubles about every two years*



Silicon “chips” have grown in capability from a single transistor in the 1950s to billions of transistors today. These extraordinary engines powered the computing and communications revolution of the information age.

**Source: “Moore’s Law: Raising the Bar” (Intel Corporation 2005)*

Photos courtesy of Fairchild Semiconductor and Intel Corporation (images are not to scale)

Microprocessor Magic

Silicon Valley culture seemed to reach a critical mass for explosive growth in 1970, about a year before Intel introduced its 4004 microcomputer, or “microprocessor” as it was later called. The emergence of the microprocessor chip was followed by a tidal wave of innovations throughout the adolescent semiconductor industry.

The advent of the microprocessor propelled us into the Information Age. To appreciate how fast and how far we have progressed, we need only look back about a half century when computers were huge machines operated by vacuum tubes. They filled entire rooms and were costly, making them accessible only to labs operated by the government, universities, and major corporations.

Complex semiconductor devices, which emerged in the 1970s, set the stage for computers as well as a host of other electronic products to be made much smaller and more affordable. The most complex integrated circuit back then was an 8-bit microprocessor that integrated nearly 5,000 transistors on a single chip. Today, IC transistor density is now in the billions. Moreover, semiconductor manufacturing has gone 3D both at the transistor and packaging levels to seek higher densities. Moore’s Law, which asserts that transistor density of ICs will double about every two years, is still on track.

When further silicon integration finally reaches its atomic limit, we will no doubt see new materials and processes emerge to store and manipulate binary 1s and 0s so that even more data can be packed into ever smaller form factors.

Throughout the 1970s and 1980s, semiconductor startups blossomed in the Valley, a good number of them tracing their roots to Fairchild Semiconductor. Its progenitor was the Shockley Transistor Corporation founded by William Shockley, one of the co-inventors of the transistor.

Shockley was brilliant but not easy to work with. It's now the stuff of colorful Silicon Valley folklore how Bob Noyce, Gordon Moore, and six other young technologists bolted from Shockley's company and banded together to form Fairchild Semiconductor under the auspices of Fairchild Camera & Instrument. Helping to put the deal together was a young M.B.A., Arthur Rock, also a Syracuse University graduate, who later became a lead investor in Intel and a premiere venture capitalist.

"The Traitorous Eight," as Shockley called them, went on to make Fairchild Semiconductor a leading manufacturer, as well as the incubator for numerous entrepreneurial talents who eventually spun out to start their own semiconductor companies. Most notable among these were Intel and Advanced Micro Devices, which became fierce competitors in the microprocessor market.

Following the proliferation of semiconductor device manufacturers in Silicon Valley, a new class of early stage ventures emerged to build the sophisticated equipment to manufacture and test the chips—the "pipes and plumbing" of the industry, as some have called it. Such equipment included lithography systems, plasma etchers, diffusion furnaces, automated testers, and packaging systems. The strong demand for such equipment led to the formation of the Semiconductor Equipment & Materials (SEMI) trade association, which has since grown in stature and today stages SEMICON tradeshows around the globe.

Megabyte Milestones

A good candidate for the 20th century equivalent to the Gutenberg press in terms of the impact it has had on communications is the IC, which gave rise to microprocessors, RAMs, ROMs, flash memory, and a host of application-

specific systems on a chip. A close second would be the hard disk drive (HDD) that has enabled access to an extraordinarily large and increasing amount of affordable mass storage.

Interestingly, both ICs and HDDs—not unlike the Gutenberg press—rely on a printing process to bring information from the one to the many. While both optical and E-Beam Lithography systems facilitate the printing of patterns on silicon wafers to create ICs, HDDs deploy heads that float above spinning disks to imprint magnetic data on the disks.

Without the IC and HDD technology advances that took place in the last quarter of the 20th century, there would be no affordable computers, no highly functional mobile handsets...and no Internet. ICs are needed to control HDDs, which in turn are needed to store the vast amounts of information to make computers and all their derivatives, as well as the Internet, work.

While Moore's Law was conceived for ICs to forecast the doubling of transistor density every two years, it has also been applied to disk storage density. If you begin tracking storage density in terms of Megabytes, starting with IBM's Winchester HDDs that came to market in the 1970s, you would find that HDD storage density has easily doubled (and perhaps more than doubled) every two years.

To appreciate even more the steep ramp of innovation in HDD technology, flash back half a century when IBM introduced the world's very first HDD system, dubbed RAMAC for its designated function, "random access method of accounting and control." Weighing one ton and designed with vacuum tubes, RAMAC controlled fifty 24-inch diameter hard disks to provide access to 5 Megabytes.

The RAMAC was leased for \$3,200/month; its cost per Megabyte was about \$10,000. Now fast forward to the present when you can purchase for about \$100 an internal HDD (that can be installed in a desktop computer), which provides access to 2 Terabytes, which equals 2,000 Gigabytes or 2,000,000 Megabytes, bringing its cost per Megabyte to a mere \$0.00005!

Although magnetic recording has been around for half a century, non-volatile semiconductor memory, or "Flash" memory as we now commonly call it, came on the scene about 30 years ago. There has been some speculation that the Flash memory, now so ubiquitous in mobile handsets and numerous other electronic products, will eventually replace HDDs.

Given the much lower cost per Megabyte of HDD and its history of easily keeping pace with Moore's Law, it appears that HDD and Flash will co-exist and complement each other for the foreseeable future. Flash will be best to store data in small form factors and in high performance applications, while HDDs will continue to reign supreme where there are vast amounts of non-volatile storage required at the lowest price point, such as in supporting cloud computing.

Cloud computing continues to grow in popularity as leading Internet companies, particularly Google, provide Internet users with access to more and more Petabytes of storage and applications "in the cloud"—or more specifically from the vast number of servers it has installed around the globe.

Mobile Platform Impact

The widespread use of cell phones that began in the 1990s set in motion a series of rapid technology advances that have transformed the basic cell phone into a powerful touch-screen handset that can now perform virtually any task that used to require a powerful desktop computer. Today's smartphones can operate as an Internet browser, an e-mail port, camera, photo album, music library, GPS, FM radio, and much more.

As a mobile platform for electronics, the automobile has been no stranger to using advanced ICs. By some estimates, a typical automobile today deploys some 50 microprocessors in various modules, each dedicated to controlling a specific function, such as power distribution, airbag deployment, cruise control, climate control, transmission control, and so on. Many smartphone applications are migrating to automobile dashboards, and this increased use of ICs has improved safety, reliability, comfort, and convenience.

New Faces of Silicon Valley

Internet companies such as Google, Facebook, and Twitter represent the new faces of Silicon Valley. Nobody has yet come up with an equivalent to Moore's Law to forecast the growth of time spent online or the rate at which the number of unique web pages is growing, but it looks like these statistics will continue to rise for the foreseeable future.

Facebook now has nearly 1 billion monthly active users, 14 percent of the world's population. Twitter has about 500 million registered users. The rate at which Google continues to grow its infrastructure is truly mindboggling: it quickly, easily handles some 100 billion search queries per month. The number of unique web pages identified by Google has reached 30 trillion, up from 1 trillion in 2008.

Among the numerous content categories available on the Internet, Google's YouTube videos are one of the most popular, with more than 4 billion hours being watched each month. In an earlier report, YouTube reported traffic of over 800 million unique users/month and over 70 hours of video uploaded each minute. Whether for productive or entertainment reasons, more and more people are spending a lot of time online.

YouTube today is localized in over 40 countries and across some 60 languages. Although YouTube has attracted many users because of its viral videos, it will likely attract even more when it adds more original and professionally produced channels. With most new flat-panel TVs coming to market equipped with an interface to the Internet, YouTube is likely to popularize a new class of Internet TV channels.

The demographics of advanced technology adopters have changed dramatically over the years. Thanks to the emergence of the easily accessible Internet and the profusion of affordable computers and mobile handsets, a growing number of "power users" can be found in virtually every population segment, from young children to senior citizens. All have become enraptured by the high-tech products that open up new doors to communications, education, and entertainment.

Coming Full Circle

Technology in any of its forms is simply a tool, not unlike the wheel or fire. However, the easily accessible technology tools of the 21st century can bestow unprecedented power on a single person or small group to involve vast populations in record time. Moreover, the exponential use of social networks is making the world's inhabitants better informed, regardless of borders, race, gender, sexual preference, age, or religion. This increased knowledge sets the stage for positive societal and political change.

We've come so far, so fast, and yet I know that we have only begun to scratch the surface of advanced technology. As I write these final paragraphs on my computer, I am pleasantly distracted by a news headline that has popped up on my screen that reads, "NASA Shows First Color Photo of Mars." Space, the final frontier, will no doubt beckon new generations of engineers and scientists to quicken the stride of technological developments.

I would like to believe that many youngsters around the globe are fascinated with some aspect of technology, as I was so many years ago. My hope is that their individual voyages of self-discovery will take them to exciting new places like Silicon Valley, which I was so lucky to experience. ☞

"There is of course no single answer, no simple formula by which Silicon Valley can be emulated. Rather, this story shows what is possible if the right conjunction of events takes place to release and align human freedom and aspirations. It is a biography of an area, which, as a good biography should, inspire others and other regions to believe in themselves and be the best they can be."

Robert N. Noyce (1927-1990)

Co-inventor of the Integrated Circuit

"Silicon Valley: High Tech Window to the Future"

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