The Silicon Valley Story

Scene, Characters, Plot, and Moral of the Tale

by

Rudolf Richter[1]

Why does the place known as "Silicon Valley" exist? Why, in the age of the internet, with its negligible costs of information or communication, is there so narrow a spatial concentration, and that in a quite particular place, namely "Silicon Valley"? Why are the many producers of computer hardware and software not distributed throughout the world? With such products of such low weight as microprocessors, disc drives or complete PCs etc., transport costs cannot be decisive in an age of *just-in-time* production. Nor can decreasing economies of scale be the reason for the concentration. We are not dealing with coal and steel here: in the first 30-40 years at any rate, physical capital had practically no role, all the more for that reason it was human capital; that was decisive[2]. So: what benefits flowed from the spatial concentration of human capital? Why was that concentration effected in a particular area, "Silicon Valley"? Does "Silicon Valley" represent a model that can be replicated, or is it unique? I shall attempt to deal with such questions as the geography of the Valley, technical-economic developments, main characters attempts at explanation, and lessons for policy, it will be purely from the viewpoint of the economist. I am neither an electrical engineer nor an *information scientist*.

1.The place

The name "Silicon Valley" refers to an area of the Santa Clara Valley that begins at San Carlos, about 20 Miles. South of San Francisco, and extends along the St. Andreas Fault south to San Jose – an area as large as Saarland[3],but with a population about double that of Saarland[4].

In 1999, about 1.9 million people were employed in the area, and the average wage was about 60% higher than the US average. There is enormous activity in founding new firms; in a good year like 1997, for example, 3525 new firms were created, involving about 40% of US investments of venture capital.

The name "Silicon Valley" originates from a journalist writing in the 1970s. Fifty years ago, the Santa Clara Valley was a quiet, out-of-the-way, area of fruit orchards, with Stanford

[1] An expanded version of a talk delivered in German on 28 November 2001 in the Landeszentralbank in Rheinland-Pfalz and in Saarland. It draws upon Kaplan (1999), Saxenian (1994), contributions by Kenney (2000), Lee et al (2000) and much other literature as cited. Beierlein and Hagenbruch's Dictionary, and Egon Richter and Uwe Datky provided me with technical information. Of assistance to my work was my visit to the economic sociology class of Mark Granovetter, Stanford University, in the Fall Term 2000. The 2006 revision was stimulated by Harold Shattuck. – English translation by Michael Hudson, University of Leeds, GB.

[2] See further on this below.

[3] About 2,500 square kilometers.

[4] 2.3 million – Saarland has 1.07 million.

University being the only significant institution to be found. That had been founded in 1891 by Leland Stanford, a railway magnate, former governor of California and later a US senator. He donated land in the vicinity of Palo Alto, under the condition that the university could not sell the land but at most lease it out. Hence "Stanford" is even today an island of green among an ever-extending area of houses. The Santa Clara Valley is only a "half" valley, bounded on the west by a partly wooded, partly barren chain of hills, and to the east partly by San Francisco Bay. Car traffic rolls along two north-south highways: the heavily congested, unpleasant Federal Highway 101 along the Bay, and the scenically prettier Junipero Serra Parkway (the Interstate 280) along the foothills.

The visitor to the area who lands at San Francisco airport does best to rent a car and drive along a signposted grid connection straight to the 280 and then further onwards to the south. When they see the street sign "Woodside Road", they turn to the right and go into the town named Woodside – a small town of rambling houses in Western style with power and telephone lines that appear to have been laid in only a stopgap fashion. Here live in elegant villas, tucked away among pockets of the woods, the richest people of the Valley. The wealth of its citizens is not put on show. If you want to get an idea of the life style in Woodside, you go into Roberts Grocery Store, directly to the left in the town center, and look at the show of goods and their prices – not forgetting that of the wines and sherries[5]. Purchase a sandwich, or, if you want, a complete lobster. Then drive back to the 280, to the turning to the south to Sand Hills Road. Turn left in the direction of Menlo Park; when you meet the first traffic light, turn left again, and you will drive directly to the elegant office building of KLEINER, PERKINS, CAUFIELD AND BYERS, at 2750 Sand Hills Road. It is here in this picturesque landscape that the history of the venture capital firms of Silicon Valley begins, and here today throng the venture capital firms of the Valley. The concept of "venture capital" was probably coined by Arthur Rock, who financed the first great successful enterprises of the Valley (FAIRCHILD SEMICONDUCTORS and INTEL).

Continue your journey with a visit to Stanford University. Take time for a look around at the Hoover Tower, walk across the Main Quad with the Memorial Church, and saunter along to the Green Library, the central university library. You will obtain visitor's card to go into this very well-stocked open access library.

> Opening times during term:
> Monday-Thursday: 8 am to 12 midnight; Friday, 8am – 6 pm; Saturday, 9am – 9pm;
> Sunday, 12 noon - 12 midnight[6]

Drive onto El Camino Real and find the corner of Channing Avenue and Emerson Street in Palo Alto. On Emerson Road there is a memorial stone with the inscription:

> ELECTRONIC RESEARCH LABORATORY
>
> Original site of the laboratory of Federal Telegraph Company, founded in 1909 by Cyril F. Elwell. Here with Two assistants, Dr. Lee de Forest, inventor of the three-

[5] Even finer is Draeger's in Menlo Park, at 1010 University Drive, to which a visit is recommended.
[6] Cf.: http://www-sul.stanford.edu/geninfo/libhours.html

element radio vacuum tube, devised in 1911-1913 the first vacuum tube amplifier and oscillator.

You find the next historical site just around the corner at 367 Addison Avenue: in the summer of 1938, in the garage of this mall house, two Stanford graduates, David Packard and Bill Hewlett, began their legendary *start-up* [7]. A memorial stone with the inscription

BIRTHPLACE OF SILICON VALLEY

with an accompanying text is a reminder of that event. In 1939, the two young men founded in this place the firm HEWLETT-PACKARD. In 1940, it shifted from the garage into a rented house on the corner of Page Mill Road and El Camino Real. The administrative buildings of HEWLETT-PACKARD are still located today in Page Mill Road, only further westward, on the corner of Hanover Street, in extensive parklands.

Few of the Silicon Valley enterprises of today are still to be found in Palo Alto. The technical firms are scattered throughout the Valley; computer producers are to be found above all in San Jose and Milpitas, semiconductor firms in Santa Clara, software/internet enterprises in Palo Alto, Mountain View and Sunnyvale. The best known and thickest cluster is made up by the venture capital firms along Sand Hill Road, the leading law firms are in Palo Alto in the vicinity of Page Mill Road, consulting firms in Menlo Park and Palo Alto, and accountancy firms in San Jose (Lee et al. 2000, 271 ff.)

What you can still find in Palo Alto, and indeed in immediate proximity to the Stanford University campus, is the *Stanford Research Park* covering an area of 280 ha. Hidden behind a hill, it lies within the extensive Stanford farmlands. If you travel further westward along Page Mill Road, with luck you will find yourself at a left turning (to “Deer Creek Road”). There is not much to see there, nor are there guided tours for visitors, as previously at the FORD works in Detroit. These interested in finding out more do best to go to the home page of the Research Park[8]. The architecture of the institutes and production premises is mostly of a bland exterior appearance, somewhat similar to bunkers, though occasionally historicizing facades can be seen.

2. People and behavior

From the early times of low voltage technology, electronics played a role in Santa Clara Valley, even if only of modest extent. In 1890, the FEDERAL TELEGRAPH COMPANY was founded in Palo Alto, about which I wrote briefly above. Around about this time, too, there began in San Jose the first continuous radio transmissions. Transmitting and receiving technology were based upon vacuum tubes, which on the far distant West Coast served above all to amplify the long overland telephone conversations to the East Coast[9].

The “father of Silicon Valley” may be said to be Frederick Terman, son of a Stanford professor, who had gained his Ph.D at MIT as an electrical engineer in the interwar period, and was appointed professor of Electronics at Stanford in 1924. Within a few years, he had

[7] See below.

[8] http://www.stanford.edu/SMC/researchpark/park04.html

[9] The vacuum tube was developed in Germany (by TELEFUNKEN) and England (MARCONI). For its early development in Santa Clara Valley, see Sturgeon (2000).

written the leading textbook on radio engineering. His *Graduate Course on Radio Engineering* attracted gifted students, among them David Packard and Bill Hewlett. At Terman's encouragement, in 1938 the two developed in the garage already referred to above a new oscillator, and in 1939 undertook the first high tech *"garage-start-up"* [10].

Silicon was first introduced into the Santa Clara valley only in the 1950s by William Shockley[11], who had been brought into the *Bay Area* by Fred Terman, in the meantime Provost of Stanford University. Previously (in 1947), Shockley had developed the transistor in association with Bardeen and Brittain – not in the Santa Clara Valley, though, but far away on the East Coast in the Bell Laboratory. The three received the Nobel Prize in 1956. The transistor was very much superior to the vacuum tube: it was quicker, more stable, cooler and smaller. Within a year of its invention, its commercial development had already begun. Few inventions had so sweeping effects as that of the transistor. In 1956, Shockley founded his own firm in Palo Alto, the SHOCKLEY SEMICONDUCTOR LABORATORY, to produce transistors and other semiconductor apparatuses. Now Shockley was indeed extremely bright but a totally incompetent manager. A year after the founding of his firm (1957), eight of his leading technical staff left him, to be named by the angry Shockley as the "traitorous eight": Sheldon Roberts, Eugene Kleiner, Jean Hoerni, Gordon Moore, Jay Last, Victor Grenich, Julius Blank, and Robert Noyce. They had had the idea of a "double diffused silicon transistor", which had hitherto not been produced anywhere but which Shockley had refused to let them develop further.[12]

The "Traitorous Eight" set themselves up independently, with the support of a New York investment bank, HAYDN STONE & CO. This took place as follows: two bankers in Haydn Stone, Arthur Rock and Alfred Coyle, made the eight known to Sherman Fairchild, the owner of the FAIRCHILD CAMERA and INSTRUMENTS CORPORATION, a medium-sized military-related firm on Long Island. Sherman Fairchild was himself an engineer, and brought some degree of understanding to the eight's idea. He made available to them a loan of $1.5 million. In 1957, in Mountain View (right alongside Palo Alto), the FAIRCHILD SEMICONDUCTOR CORPORATION was set up, 20% owned by the banker Haydn Stone and 10% owned by each of the eight rebels. FAIRCHILD CAMERA controlled the board of Directors along with Haydn Stone and the eight engineers. Sherman Fairchild had reserved for him the option to purchase the semiconductor firm after 2 years for $3 million or after 8 years for $5 million. This was the first venture capital agreement of the time.

The concept of the "double diffused silicon transistor" developed by the eight was successfully offered to the US Air Force. While the output of the radically new transistors was subject to considerable difficulties in the beginning, the eight quickly overcame them, and the

[10] With only $538, Stanford University engineers William Hewlett and David Packard started the company in 1939 out of a Palo Alto garage. Walt Disney, their first big customer, bought audio oscillators (electronic devices made to test sound equipment) to use in the making of the film *Fantasia* (1940). In 1947 the business was incorporated. Founded as a test-and-measurement company, HP pioneered technologies such as the digital oscilloscope (an instrument used to test electronic equipment) and developed new applications for its computer technology in analytical and medical instrumentation (HP website).

[11] Silicon diodes and transistors were first produced in the USA in Texas and Southern California. Silicon was first brought into the Santa Clara Valley by Shockley and Fairchild.

[12] Cf. Kaplan (1999, 49).

first deliveries were made a year after the founding of the firm, in 1958. For the following year and a half, the firm had a monopoly for its product.

A technical problem existed in the production of the electrical linkage of the tiny silicon dies, a microscopic work demanding much patience. Yet even in the founding year 1958 that problem was solved by the independent invention of the integrated circuit by two people, Jack S. Kilby (TEXAS INSTRUMENTS) and Robert Noyce (FAIRCHILD). In 1958, the first integrated circuit developed by Noyce went into production, with the linking wires having been made superfluous. That was the first "chip" – of the size of a fingernail. It developed very rapidly from a die with a few transistors to a silicon substratum with soon more than 15 million transistors. The second industrial revolution had begun.

Noyce's integrated circuit was decisive for the upswing of FAIRCHILD SEMICONDUCTORS, and in 1959, hence two years after its founding, Sherman Fairchild exercised his option to buy. Each of the Traitorous Eight received $250,000, and thereby became rich people by the standards of the time. [13] Yet the buy-back proved fatal to FAIRCHILD SEMICONDUCTORS, the Traitorous Eight gradually parted company with Fairchild, the last to leave being Noyce and Moore in 1968. FAIRCHILD ceased to exist. In the grounds of its headquarters in Mountain View now stands the office building of NETSCAPE – an example of Schumpeter's (1942) concept of "creative destruction".

In July 1968, Noyce and Moore founded in Mountain View the firm "Integrated Electronics", INTEL for short, in close proximity to FAIRCHILD. They did not simply duplicate the work they had done in FAIRCHILD but set out on a completely new path, that of miniaturization. In 1969 the first memory chip was brought out by INTEL, and in 1971 it came out with its first microprocessor[14] and floated on the stock market. The Santa Clara Valley was christened Silicon Valley USA by the journalist mentioned above, Dan Hoefler of the *Electronic News*. (Cf. Kaplan 1999, 65.)

INTEL first produced mainly for the Minute man rockets, and so, like FAIRCHILD, for the military[15]. Its turnover rose from $500,000 in 1958 to $21 million in 1960, and its number of employees from 180,in 1959 to 1400 in 1960. In comparison to its chief competitor TEXAS INSTRUMENTS, INTEL had radically changed its production methods, and raised standards of reliability in an exemplary fashion. When in 1974 TEXAS INSTRUMENTS put the first successful microcontrolled[16] TMS1600 onto the market, INTEL followed in 1976 with the INTEL 8748.

---

[13] Cf. Kaplan (1999, 57 f.).

[14] A microprocessor is the *Central Process Unit*, CPU, of a computer system, embodied in a chip. The CPU consists of the components: CU (Control Unit Controller), ALU (Arithmetical Logical Unit), several registers and a linkage system for the coupling of memory and peripheral components.

[15] Defense contracts played a considerable role in the development of Silicon Valley, but they had to be won against competition from the "Route 128" region among other developed regions. In any case, the large armaments expenditures of the Cold War significantly contributed to the development of IT (See Lesley 2000).

[16] A microcontroller is a complete microcomputer system on a single chip. The Central Process Unit, storage, peripheral components and Interrupt-system are integrated together on one chip and linked with one another by one or more busses. Initially, the main areas in which they were employed were industrial guidance systems, table and pocket calculators, electronic games and digital watches. The programmability of chips rendered them universally usable, and led to their unexpectedly widespread employment.

> It is interesting to note the large number of firms set up by FAIRCHILD during the 1960s in Silicon Valley: 31 semiconductor firms, named "Fairchildren", were founded at that time. Only 5 of the semiconductor firms instituted in the USA between 1959 and 2976 were not located in Silicon (Rajan and Zingales 2000).
>
> The Association of the Semiconductor Industry (SEMI) in San Jose printed a family tree of the Fairchildren, too big to be represented here.[17]

The introduction of the microcontroller opened the way to the personal computer technically. In 1976, two young electronics dabblers, Steve Wozniak (26 years of age) and Steve Jobs (21 years old), put together, in Jobs's garage at 2066 Crist Drive in Palo Alto[18], a PC built from electronic components available through trade channels, linked it to a keyboard and a monitor, and called it Apple 1. They offered their creation under the firm name APPLE COMPUTERS at a price of $666.66 in computer stores around Silicon Valley and by mail-order[19]. Only about 175 units were sold, and the tool awakened little interest in the industry.[20] The young men were lacking start-up capital, but this was eventually made available to them by Arthur Rock. APPLE COMPUTERS INC. was then formally established and the Apple II that had been developed in the meantime brought onto the market. With its plastic shell it looked like a complete machine and sold well. By 1978, APPLE COMPUTERS had already made a profit of more than $2 million; in 1980, it was floated on the stock market.[21]

In September, IBM marketed the "IBM Personal Computer 5150" that had been developed in Florida. While APPLE had developed its own operating system,[22] IBM did not want to burden itself with the development and maintenance of software. Hence it purchased from Bill Gates the licence for the utilization of MS-DOS ("Microsoft Disc Operating System"), though Gates himself did not as yet possess it but only purchased it subsequently, inclusive of all rights to its use, for $375,000 from an engineer in Seattle with whom he was acquainted, Tim Paterson[23]. Now, IBM had not inserted an exclusive-rights-clause in their contract with Gates, nor reserved to themselves any copyright on their own personal computer. Consequently, anyone who wanted to could build "IBM-compatible" PCs, and purchase from Microsoft the

---

[17] The "family tree" had already been begun in 1972 by the journalist mentioned above, Dan Hoefer, and continued by the Semiconductor Industry Association (SEMI) until 1986. It lists 129 firms, many of which were spin-offs from spin-offs. It also contains the names of the engineers, inventors and entrepreneurs who appeared as founders, a total of 372 persons. Note that it is only technical enterprises (hardware producers) who figure in these lists.

[18] About 20 kilometers south of the Stanford campus. You drive on the 280 until Foothill Boulevard, turn left there, and go on a short distance further.

[19] For further on this, see Kaplan (1999, 92ff.).

[20] It was said of the two young man that the Apple was not practical, was not marketable, and had not even been designed by real engineers (Kaplan 1999, 95).

[21] Cf. Kaplan (1999, 100).

[22] An operating system is a program (or several programs) which "masks" the hardware from the user, i.e. a programmer does not need to think about how they e.g. have to activate the write or read access of the disc drive, or when they must turn on the motor, or so on. The operating system does that. The programmer uses only simple functions like "read (x)" or "write (y)".

[23] Gerry Kildall had already developed a *Central Program* in Silicon Valley for the INTEL microprocessor. It was the first "*Disc Operating System*", DOS for short, for the PC. His software was widely used, but he neglected to come to an agreement with IBM as to its use in IBM's PC. Bill Gates, who heard of this, offered IBM a user system which he bought from Tim Paterson for $75,000 – the program Q-DIS ("Quick and Dirty Operating System"), an imitation of Kildall's system. Gates re-christened it as MS-DOS. Kildall later threatened legal action against IBM, a threat skillfully warded off by IBM. (see Kaplan 1999, 108f.)

licence to the operating system MS-DOS that had to be used. (Microsoft moved away from the DOS system only after 21 years, with the clearly better "Windows XP"). As a result, IBM had established an open software standard, while Apple adhered to its closed standard. The outcome was that IBM-compatible systems and the operating system harmonizing with them became the industry standard, with which the producers of software aligned their output. Nevertheless, it must be noted that MICROSOFT's operating system in turn corresponded to a closed standard. Microsoft kept the "source code" secret, so that it became virtually impossible to determine what a program really did[24]. MICROSOFT and INTEL (which supplied the central units – CPUs – for the IBM PCs) were the winners[25]. APPLE COMPUTERS, on the other hand, then got into considerable difficulties with its closed standard.

The next stage in the development of Silicon Valley began in 1993 with the commercial exploitation of the internet and the creation of the world wide web. While the net existed already[26], it only became generally accessible through the development of the user-friendly program "Mosaic" by the 21 years old Marc Andreesen (University of Illinois).[27] The word "browsing" took on its present meaning.[28] Mosaic was *freeware*, i.e. could be downloaded without cost from the internet. By the end of 1993 there were already a million users. Despite this, the leadership of the laboratory in which Andreesen worked at the University of Illinois lacked interest in Mosaic. At the end of 1993, Andreesen completed his exams at Illinois and went off, having in the meantime turned 22 years old, to Silicon Valley. Here he met Jim Clark, the wealthy founder of Silicon Graphics. Together, on 4 April 1994, they set up the firm MOSAIC COMMUNICATIONS, which they shortly afterwards re-named NETSCAPE. The new firm had its seat in Mountain View, and indeed, as noted in section 1 above, on the premises

[24] A source program is a program that is to be utilized by another program (the translator). The source program is mostly translated into machine language. Which can be directly processed by the CPU. Since the source code of Microsoft is not open, the program's security cannot be tested. Errors in the program always recur, and are used by viruses and "Trojan horses" to infect the user's computer. Microsoft has difficulties in stopping up the holes. For other objections, see http://www.heise.de/newsticker/data/hps-21.02.02-000/

[25] The method chosen by IBM to communicate with the hardware differed from that of APPLE. In addition, IBM computers operated with control units from INTEL, while those used by APPLE came from MOTOROLA. The two also have different numerical formats: with INTEL, the numbers are read from behind, with Motorola from in front

[26] In 1958, the US Defence Ministry set up the research organisation APRA, which developed, i.a., the APRA-NET, which went into operation for the first time on 10 December 1969. With this forerunner of the internet, four computers (at the University of California at Los Angeles and at Santa Clara, Stanford University and the University of Utah) first exchange packets of data. Until then, data could be exchanged between computers only via ticker and tapes. In the same year, the US Defense ministry on this basis started up a project whose aim was to create a network between military coordination points. The demands such a system had to meet were: (1) in case of war, the net should remain functioning, even when parts of it were destroyed; (2) decentralised structure of data and computers with the same rights for all the computers linked to it; (3) data packages to find their path independently, routes were not set down in advance (cf. http://www,emabonn.de/geschi/).

The code that makes to days web pages appear as it does is called hyper text markup language, or HTML. "The original HTML was proposed in 1991 by CERN researcher Tim Bernes-Lee. It was designed to make it easy to link documents at a research facility, but it quickly became obvious that documents on any machine on the Internet could be linked. Bernes-Lee and Cailliau made both HTML and its companion HTTP [hyper text transfer protocol] freely available to anyone to take." Lessig (1999, 103). It became popular because it was easy to copy. "Openness – not property or contract but free code access – created the boom that gave birth to the Internet…" (*ibid*.)

[27] Mosaic processed the HTML commands quickly and invisibly.

[28] Cf. Kaplan (1999, 229).

of the firm FAIRCHILD SEMICONDUCTORS that had gone out of business. In October 19094, Netscape put onto the markets its first browser, "Navigator", which was an even greater success than Mosaic[29]. Contrary to Andreesen's plans, NETSCAPE immediately demanded licence fees for the use of its Navigator. On 8 August 1995, NETSCAPE went to the stock market: the price per share initially sought was between $12 and $14, but the shares closed at $58 ¼![30] This success pushed Silicon Valley once again into the public interest, and Bill Gates did not hang about in reacting to it: only two weeks later, he brought out his new program Windows 95, whose browser "Internet Explorer" was supplied free with the PC . As well, the Explorer was made available to users of older Windows programs without cost. With this move, Gates enjoyed a bombshell of a success – something that did not remain without effect on the development of NETSCAPE's profits. In 1998, NETSCAPE had no other choice than to likewise make its browser freely available. The series of antitrust proceedings in which a judgement will probably be made this month then began (18 May 1998)[31].

NETSCAPE was taken over by AMERICAN ONLINE (AOL) in November 1998, though after its loss of the browser market it remained a leading player in internet technology.

In the meantime, a new mode had developed `in the internet sector, the supply of "portals". The pioneers in this area were two Stanford Ph.D students in electrical engineering, Jerry Chih-Yang and David Filo, who initially put together for their own use a list of hyperlinks, arranged as to subjects.[32] They first named this list "Jerry's Fast Track to Mosaic", and then YAHOO. When the number of entries grew rapidly, they added a search engine to the assemblage. By the end of 1994, YAHOO already had 100,000 visitors a day. What the two had begun as a lark, they now built into a business. To make money, they decided to operate it like private radio, and offer their services combined with advertising. Together with Mike Moritz and the venture capital enterprise SEQUOIA, which made $1 million available to them in exchange for a 25% participation, they arranged for YAHOO to be registered as a public limited company in early 1995. The enterprise established itself in Mountain View, and was floated on the stock market a year later, on 12 April 1996. The shares were initially quoted at $13, but ended at $33, meaning that the market value of YAHOO was $849 million. Decisive for their success was that, as also elsewhere in Silicon Valley, they had had the right idea at the right time. Competition from other, newly-set-up search engines was rapidly forthcoming, but YAHOO's advantage lay in having been the first on the market. To ensure customer loyalty, YAHOO soon offered free e-mail to its users, and took every step to maintain *links* to other websites. In early 1999, four years after its foundation with a capital of $1 million, Yahoo had a market value of nearly $8000 million. Despite the substantial losses suffered in

---

[29] Appropriate for Unix PCs, Mackintosh and Windows-based computers.

[30] Kaplan (1999, 251).

[31] The anti trust suit against MICROSOFT seems now to assume definitive results. "MIKROSOFT will put out a slightly changed version of its operating system in August 2002 – 'Windows XP' – which is supposed to allow PC manufacturers and users to replace in a simple manner Microsoft programs like Internet-Explorer or Windows-Media Player … by software of competitors like Netscape or Real Network." (FAZ No. 119, May 2002, p. 16).

[32] Cf. Kaplan (1999, Ch. X).

the year 2001, the stock market value of YAHOO in January 2002 amounted to just on $10,200 million (FAZ, 18 January 2002, p.20)

At this point (1999), we shall break off from the history of the people and their actions of the Silicon Valley story. It is not complete for this year either. Missing from it are important developments in Silicon Valley, above all the history of the *data base software* Oracle, the second largest software firm in the world after MICROSOFT: it began in 1977 with $2000 and by the beginning of 1999 had a market value of $50,000 million. Its leading figure is Larry Ellison, who founded the business in Santa Clara in 1977 (Kaplan 1999, 119ff.). Likewise left out of consideration is the development of the *work stations* . SUN MICRO SYSTEMS, 3D GRAPHICS, SILICON GRAPHICS (all developments within the sphere of Stanford University) or of the NETWORK COMPUTING 3 COM, CISCO SYSTEMS[33].

A Look Backward at People and Behavior

In the last 50 years, the development of the IT industry experienced three revolutionary thrusts:

1958ff: Integrated circuits

1976ff: Personal computers

1993ff.: Commercialization of the internet[34].

Silicon Valley was dominantly involved in all three. The decisive firms were:

Hewlett & Packard 1939

Shockley Semiconductor Laboratory 1956

Fairchild Semiconductor Corporation 1957

Intel 1968

Apple Computers 1976

[IBM Personal; Computer and MS-DOS (1980)]

Netscape 1994

Yahoo 1995

The rate of development was enormous. There took place in the technical sphere what Gordon Moore advanced in 1965 as “Moore’s Law”:

> The number of transistors which can be placed on a chip doubles every year = the cost of production of a transistor falls by half in every year. [35]

---

[33] On the most recent state of the competitive struggle between ORACLE and SUN, on the one hand, and MICROSOFT, on the other, with its point NET plan, cf. *The Economist*, Feb.16, 2000, 69.

[34] Henton (2000, 46ff.)

[35] Cf. Kaplan (1999, 70f.). Since the doubling of the transistor thickness involved no additional costs, the cost of producing a transistor fell by half each year; the users got greater computing power for the same price. In the 70s the tempo of doubling slowed down to once every 18 months, and has remained at that rate until 1997 (1997). Integrated circuits today contain 6 million transistors, and will soon contain 10 million. The problem is that the fixed costs of chip production are rising into the multi-thousand million dollar range. It therefore cannot be excluded that a further multiplication of the number of transistors per chip will not be pursued (Hutcheson & Hutcheson 1997).

In the 70s, nevertheless, the rate of doubling fell by half, yet remained at that lower rate until 1997.

There were corresponding increases in the profits of the firms which carried through path breaking inventions or new economic ideas. Ever fewer years elapsed before a newly established firm reached a market value of $1,000million:

HEWLETT-PACKARD	47 years
(MICROSOFT)	15 years
YAHOO	2 years
NETZERO	6 months[36]

No wonder that a new gold rush had begun. 1999 and 2000 were the years of the internet boom. The "dotcoms", that were technically simple and relatively cheap to set up, shot up like mushrooms. In 2001, however, the speculative bubble burst. What we are currently (2001/02) observing is the classical case of an adjustment crisis after a period of excessive expansion (Saloner, in *New York Times*, 8 October 2001, p. C3). But the semiconductor industry also suffered a decline. In July 2001, the turnover of the chip industry on a world-wide basis had fallen by 37% as compared to the previous year, in the USA in particular even by more than 50%[37]. The "new economy" had to learn that it too is subject to the laws of the market.

> In Silicon Valley, the level of unemployment in 2001 rose to 6.1%, as compared to 1.3% in 2000. *The Economist* of 9 February 2002, p.58, writes: "With the bursting of the (Dotcom) bubble, the quality of life in Silicon Valley also markedly declined. The main reason is the high cost of living, which in 2000 lay 35% above the US average. Added to that is the housing situation: The Valley still has 82,000 dwellings less than needed and corresponding commuting problems".

Yet it must be kept in mind that the Valley had already experienced an economic set-back in the 80s, as a consequence of the transition of the large firms FAIRCHILD, INTEL, NATIONAL SEMICONDUCTORS etc. to the traditional inflexible American organisational forms of mass production (Saxenian 1954, 57). They were then without any more ado caught up with by their Japanese competitors with their new, more flexible organisation of mass production. The firms of Silicon Valley, however, quickly became aware of the recipe for success employed by the Japanese and restructured themselves accordingly. Their semiconductor business revived, the number of specialised firms grew and soon dominated the future of the Valley.

3. Infrastructure

To the network of the division of labor and knowledge of a region belong the providers of service to the producing firms located within it. In Silicon Valley, those are the venture capital firms, law firms, accountancy firms, research institutes, industry associations, etc. They

[36] Jurvetson 2000, 127: NET ZERO is an *Internet Service Provider* (ISP). The firm was taken over by UNITED ONLINE in September 2001, together with JUNO ONLINE Service(www.unitedonline.net).

[37] Source: Semiconductor Industry Association. According to *The Economist* of 12 January 2002. 63, there are nevertheless signs of recovery.

contribute to a considerable extent to the economic development of the region. Here I shall only briefly discuss two elements of the infrastructure: the universities (more precisely, Stanford University) and the venture capital firms.

A. Stanford University

Silicon Valley itself has available to it a great research institute (Stanford University), in addition to a second, closely located, one, the University of California at Berkeley. There should also be noted San Jose State University, which since 1970 has produced as many engineers as Stanford or Berkeley, as well as the six Community Colleges of the region, which also offer technical programs, among them Foothill College in Los Altos Hills, Mission Community College in Santa Clara, and De Anza College in Cupertino. (cf. Gibbons, 2000, 212).

Some brief comments about Stanford University: As noted above, the person who was its Provost for some years, Frederick Terman, can be seen as the father of Silicon Valley. In 1953, he set up a *University Honors Cooperative Program* which created the possibility for the technicians who worked in firms nearby to earn an additional academic degree by enrolling in evening courses. That program strengthened the links between the university and local firms. It enabled engineers active in their profession to keep up to date with the latest developments in technology and university staff to maintain contact with practitioners. In addition to that, Fred Terman at the same time founded the first university industrial park, the *Stanford Research Park* (which, too, has been referred to above), in whi9ch in the year 2000 some i50 firms with 23,000 employees, including 50 research centers, were active[38]. The research institutes served as a link between Stanford University and the industry of Silicon Valley. The appointment and further training of qualified younger staff is controlled through the social network existing between firms and the university professors. The directors of the research centers have experience as both university teachers and business people (Castilla et al. 2000, 230ff.)[39].

In view of the current efforts of German politicians to imitate American universities such as Stanford, the fact may be interesting that Stanford University was founded on the German model, and so not as a college with incorporated research institutes but as an institution in which research (basic research!) and research-orientated teaching in the style of Wilhelm Humboldt were linked with one another. Its seal has a motto in German; it reads: "*Die Luft Der Freiheit Weht*" (The wind of freedom blows).[40]

---

[38] Cf. home page *Stanford Research Park*: http://www.Stanford.edu/dept/SMC/researchpark/park04 html

[39] The setting-up of research parks has today become a much fancied instrument of regional policy everywhere in the world, with the aim of "encouraging the emergence of a new Silicon Valley". The rate of success, however, is low, as Luger and Goldstein (1991) report. (Cf. also Saxenian 2000, 165n10).

[40] Supposedly the German translation of a Latin motto by the German pioneer of humanism and intellectual freedom Ulrich von Hutten (1488 – 1523).
The old university seal is scarcely used. I could not find it either on the home page of Stanford nor in the souvenir section of the Stanford Bookstore. Finally the Marketing Director of the Bookstore could, after some searching, help me with a black and white copy.

That motto simultaneously characterises, intentionally or not, the cultural background of the whole Bay Area.

Stanford University has seven faculties ("Schools"):

1. Graduate School of Business
2. School of Earth Sciences
3. School of Education
4. School of Engineering
5. School of Law
6. School of Medicine
7. School of Humanities and Sciences (= Philosophical Faculty)

The Philosophical Faculty itself has 85 departments, among them such "useless" studies as archaeology, art and art history, classics, comparative literature, drama, economics (with over 40 professors), history, music, philosophy, political science, and sociology. The intellectual climate at this university can only be imagined.

B. Venture Capital Firms

The venture capital firms originated in the 50s, above all in Silicon Valley, and in the latter in Menlo Park. American venture capital firms are not banks but a mixture of financiers, managers and engineers, who are experts in particular problems of current business. The venture capitalist is simultaneously a shareholder in the firm they have founded, indeed with a participation of at least 20%. They sit on the board of directors and occasionally also chair it. As shareholder, they are involved in all the critical decisions of the *Venture*. At least in the initial period, the venture capitalists of Silicon Valley were themselves experienced founders of firms (cf. Kenny and Florida 2000)[41]. Well-known venture capital firms in Silicon Valley are KLEINER, PERKINS, CAUFIELD & BYERS, HAMBRECHT & QUIST VENTURE CAPITAL, INSTITUTIONAL VENTURE PARTNERS and MAYFIELD FUNDS. Venture capital firms lay great weight upon spatial proximity top borrowers (one venture capitalist says that he participates only in ventures which are not more that one and a half hours drive from his office).

From the American viewpoint, the German translation "risk capital" is interesting. It emphasises the risky side, while the Americans understand by "venture" first of all an activity, an "undertaking"[42].

The number of venture capital firms rose dramatically between 1968 and 1975. They enjoyed their greatest success in the 80s. Since July 1980, the *Venture Capital Journal* has appeared monthly.

---

[41] Venture capital was previously made available only by friends, family members or rich people (today named "angels"), but not by banks or specialised financial institutions (Kenney and Forida 2000, 103).

[42] At the Stanford Business School, Thomas Hellman (2001, 113) is currently working on venture capital firms.

C. The Moral of the Story: Attempts at Replication

What explanations for "Silicon Valley" does traditional theory provide for us?

(1) One naturally thinks first of Joseph Schumpeter's *Theory of Economic Development* (1912/1933). It bases itself upon the "implementation of new combinations" of the factors of production (1933, 100) by the "Schumpeterian entrepreneur". That entrepreneur is a visionary personality, who finds out but does not create the new combinations: they are always at hand. His function is thus to implement them (1933, 128). But that does not apply to Silicon Valley, at least not in its initial phase, for this phase of its development was marked by the inventive spirit of entrepreneurial engineers *and* capitalists such as the "Traitorous Eight" and their venture capitalist Sherman Fairchild. Only later, in the dotcom phase, did management begin to play the leading role. Nor did Schumpeter mention the significance of the social network, which was demonstrated in Silicon Valley by the development of the "Fairchildren".[43] Schumpeter's entrepreneurial figure is the great loner, who at best has only a remote relationship to the leading actors in the social networks of Silicon Valley. That part of Schumpeterian theory which is fully relevant in Silicon Valley, however, is his assertion that the new combinations do not come in and replace the old, but at first exist alongside them. "It was not the postmasters who founded the railway" (1933, 101). In fact, the greatest part of the economic prosperity of Silicon Valley was based upon new foundations and not on technological developments in large, already established firms such as HP (Jurvetson 2000, 127). In this connection, Gordon Moore, one of the "Traitorous Eight", says:

> "It is an immense advantage to be in the position of being able to leave behind you all that you have previously done and start over completely a new. It is extremely difficult to do that in an established business" (According to Kaplan 1999, 52).

But that is true not only of this region. The question remains: Why did this pathbreaking development happen precisely in Silicon Valley?

(2) Another approach which might provide an answer to that question is offered by conventional economic location theory. To explain the "why" of the coming into being of an agglomeration of complementary enterprises, it emphasises the

[43] In Silicon Valley, a central role is played by the encouragement of entrepreneurs in consequence of their embeddedness in the mental attitudes of the population and in the existence of a helpful infrastructure (Lee 2000, 95).

– economising on transport costs

– utilization of increasing economies of scale ("internal savings" arising from mass production) and the

– "agglomeration effect", i.e. the positive externalities ("external savings" resulting from the spatial agglomeration of qualified labor, know-how. etc. (von Boeventer 1981, 410; Krugman 1995)[44].

In modern location theory, networks also play a role, and so there is something in the *Annals of Regional Science* studies on the theme of "Network-Scientists"(Andersson and Pearson 1993; Martin Beckmann 1993, 1994). These studies emphasise the significance of collaboration for scientific creativity – the creation of new knowledge – but modeled in a static way. The production function is extended by a spatial and an intellectual property component with respect to transaction and information costs.

Certainly, agglomeration effects and network externalities play a role, but again, that is everywhere true. Why is "Silicon Valley" located precisely in the Santa Clara Valley? That is a question which none of the traditional theories of location succeeds in answering.

(3) Marshall (1969, book IV, Ch. 10, § 2) comes closer to an answer. He emphasises the importance of a crystallization point for the settling of an industry in a particular place, when he thought of the attractiveness of the seats of the nobility in this respect. In the case of Silicon Valley, the Stanford University founded by Leland Stanford became a crystallization point, a process driven above all by Frederick Terman, the "father of Silicon Valley". Andersson and Pearson (1993, 14ff.) illustrate the connection between universities and "creative regions" in Europe[45].

(4) The game theoretic variant of the new institutional economics suggests an explanation of regional agglomeration. The accumulation of actors with the same interests can be interpreted as the equilibrium of a repeated coordination game (Cooper 1999). Each player chooses a particular activity (the production of a class of goods, in the case of "IT products") from out of a number of different activities; the gains of the players increase as the number of participants rises – i.e. with the increasing extent of the network. The incentive to make greater contributions is greater, the more the other players contribute (positive network externality, Tirole 1988, 404-409). The consequence is an amplifying effect.

From the viewpoint of regional policy, it is interesting that coordination games (in theory) have many possible equilibria, "good" and "bad" (efficient and inefficient). As a result, the invisible hand does not automatically yield an efficient solution. Since the equilibria are self-enforcing, they continue to exist even when the individual players recognise that better solutions are available. In technical terms, that means that the coordination equilibria are of the Nash-equilibrium type. In equilibrium, no player has an incentive to deviate from their action plan, so long as the other players do not do so. It may

[44] Once the agglomeration process has begun, it creates a momentum of its own.

[45] "…old university towns such as Cambridge, Uppsala and Heidelberg have been enclosed into corridors of creativity".

therefore come about that the actors end up in a clinch, a bad equilibrium. We then have coordination failures. Since the regional politician is them self a part of the coordination game, they cannot separate the actors entangled with one another simply by whistling them to order. In this lies the problem faced by regional (and also national) development policy.

In the language of game theory, Marshall's crystallization point can be understood as a Nash equilibrium that stands out – as a "focal point" (Schelling 1960). But this does not enable us to say why it was precisely Stanford University which constituted the focal point for a region like Silicon Valley and not perhaps MIT (the research university of the older electronic region, "Route 128"). The development of the two regions shows clear differences (Saxenian 1994).

(5) In seeking further explanations, we enter ever more deeply into regions of economic sociology. They key words here are, among others, "social risk", "culture", "social networks", and "trust". Thus sociologists emphasise as a significant reason for the local agglomeration of entrepreneurs willing to experiment, and thereby also very creative, the low social risk of economic failure in Silicon Valley. What distinguishes Silicon Valley from other regions in the US (among them above all the "Route 128" region mentioned earlier) is the absence of social disapproval of "bankrupts". On the contrary, in social terms, an audacious failure can rank right behind a boldly achieved economic success[46]. That is a cultural phenomenon. The debtor-friendly US bankruptcy law also plays a role, by permitting to the individual a fresh start more than does German law[47]. Nevertheless, US bankruptcy law applies across the whole country, not only in California, and so this proposition cannot explain the particular features of Silicon Valley. We must link It together with the local phenomenon of the low social risk of economic failure, with the "culture" of the region[48].

> That is the positive side of the flower power movement of the 60s in the region. "Alice's Restaurant", the meeting place of the motorcycle punks of the 60s, is less than half an hour's drive from Woodside. Still today, the grey-haired, long-haired people of that time meet on Sundays on their Harley Davidsons.

One consequence of the low risk of economic failure is the figure of the *repeat entrepreneur* – the entrepreneur "with a past", who already has one or more failures behind them. The facility with which the actors in Silicon Valley can found a new enterprise means that there more new technical possibilities were and are tried out than elsewhere (Saxenian 1994, 112).

Other sociologists see the main reason for the success of Silicon Valley as the dense social network of formal and informal relationships[49] between the "Fairchildren". However, not only

---

[46] Baron and Hannan (2001, 37): "More generally we suspect that the traditional sources of status in a community affect the perceived reputational risks associated with entrepreneurship.."

[47] Chapter 7 of the American bankruptcy law gives the honest but unfortunate individual the right to a *fresh start*. According to that law (sec.541,), his future income is not regarded as part of his estate, and the provision in sec.727 secures the future income of the individual debtor from the grip of their creditors. The right to a new start, a sort of insurance, naturally raises lending rates. The right cannot be waived so as e.g. to obtain cheaper loans. Ch. 1 pf the law serves for the restructuring of public limited companies (cf. Baird 1992, 13ff.)

[48] A characteristic sociological assumption is that institutional structures are in the first instance determined by their pre-history and political and cultural forces. Hence they are not unconditionally efficient (Rauch and Hamilton 2001, 20)

[49] Castilla et al. (2000, 218): "The most crucial aspect of Silicon Valley is its networks".

the many spin-offs but also the enormous flexibility of the labor market has contributed to the development of so dense a network[50].

> Thus it is said that, at least in the initial phase, engineers changed their employer so frequently that at home they no longer spoke about it. Their wives became aware of the change only when they noted that their husbands drove out of the garage in the morning in a direction opposite to that which they had previously taken [51].

This "networking" did not involve links relating to relatives or of a contractual kind, but simply more or less acquaintance- in the jargon of sociologists, "“weak ties”[52]. Burt (1992) explains that it is precisely the weak ties that contribute to the diffusion of new ideas . In cases of stronger ties ("in the family"), everyone knows what all the others also know[53]. Noteworthy in this connection is that, at any case in the initial phase, the engineers of competitive firms met after work in "hang-outs" that became famous, and spoke with each other about their technical problems and experiences. Firm secrets were not so tightly regarded. In this connection, sociologists point to the trust-building effect of social networks, as well as to their promotion of cooperation (Powell 1990, 324ff.) On the latter, an example: it was not unusual for a production engineer to ask their friends in nearby competitive firms for help when a quartz valve broke down or chemicals ran out (Saxenian 1994, 44; further examples are also given there). Yet intentionally-conducted cooperation of firms also played a role, as with cross-licensing or second-sourcing. Both accelerated the diffusion of technical innovations. Imitation and "reverse engineering" (in plain words: illegal copying) also played a role (Saxenian 1994, 46). The cooperation was driven "upstream" by the fact that competition "downstream" continuously demanded innovation, a paradoxical situation (Saxenian 1994, 46).

Trust promotes the social exchange of new knowledge, the division of knowledge (Hayek 1937, 49; Helmstädter 2001). For the production of new knowledge is enormously expensive, but its transmission is incredibly cheap. While the exchange of well-known, "old", knowledge can to a certain extent be protected by copyright, legal protection of absolutely new knowledge (knowledge in becoming") is difficult. On the other hand, the exchange of new insights – the free exchange of scientific ideas – is indispensable for the development of new knowledge. It lies at the heart of the Age of Enlightenment. The productivity (creativity) of the individual is raised not only by the division of labor but also by the division of knowledge. The exchange of knowledge "on the knowledge frontier", however, no longer takes place via the market but, as pointed out, through forms of social exchange (Homans1960, 1974), which functions the better, the more "qualified" the social network of the "knowledge worker". Reciprocity is of central significance in Silicon Valley.

---

[50] Though it is not significantly higher in Silicon Valley than elsewhere in the USA (Kenney and Florida 2000, 133)

[51] Castilla et al. (2000, 218) write: "An outstanding feature of Silicon Valley is the mobility of labor, which creates rapidly shifting and permeable firm and institutional boundaries and dense personal networks across the technical and professional population. The high degree of mobility strengthens the dense networks and the canals along which technical and market information, as well as other imponderables, such as organisation culture and trust, are distributed among firms and used by them in common.

[52] Granovetter (1974/1995, 52ff.)

[53] Burt (1992, 72). The idea is that in clusters with strong ties each person tends to know what the other people know. Therefore, and this is the insight of the argument, the spread of information on new ideas and opportunities must come through the weak ties that connect people in separate clusters.

> I cannot here go into detail about the theory of social networks, a theme much In vogue in sociology. Just a few remarks: by "social networks" is understood a system of bilateral relationships between actors. The formal presentation of the concept is made with the help of graph theory (Wasserman and Faust 1994, ch.4). Examples of non-economic network relationships are personal relationships between actors but also physical linkages (streets, telephone numbers), legal or family relations, intellectual relations (shared views, convictions, culture) and so on. The centrality, prestige, social position, the social role of the actors, as well as the frequency or intensity of the existing bilateral relations and their density, are measured. Competition can in this context be understood as the struggle for social positi0oning in a net (Burt 1992). A new arrival must position themselves in a social network; they must form relations (in the most general sense of the word) with the actors already present in the net, which demands the employment of resources, in the case of "social transaction costs". An example: the costs of establishing an enduring relationship (a relationship with customer) ("fixed transaction costs") and of maintaining it ("variable transaction costs). The frequency and intensity of the relations between the actors is significant and characterises the "social structure" of the system of relations, e.g. of a market or, as in the present case, of an economic region.

Finally, one should not forget the influence of defense spending on the evolution of the IT industry! As the *Economist* (June 1st 2002, 63) put it:

> „It was tax dollars that first primed the technology pump. Without money from the Pentagon, Silicon Valley might still be covered with fruit orchards. The Internet was for years a government- funded research project, and some big technology companies would not exist without government contracts."

But remember: Tax dollars were not spent by way of the watering-can principle. Inventors had to compete with each other by selling their already developed products, not for the advancement of R&D tax money.

To summarise: By the region "Silicon Valley", we understand a social network with weak ties between actors who have common interests and values. It forms the basis of an enthusiastic intellectual climate. The spatial proximity of people with similar interests but different areas of work effects a rapid diffusion of new knowledge, in the sense of the exchange of knowledge. It is not Schumpeter's entrepreneur, the lonely visionary personality, that is decisive, but the cooperation of individual outstanding personalities in a social network. Labor market flexibility and a positive attitude towards economic reversals promote the willingness to experiment and the building-up of experience. Spatial proximity lowers the "social transaction costs" in the widest sense of the word. The choice of place or region may be an accident. As concerns Silicon Valley, Stanford University served as crystallization point or "focal point". The pre-history of the region always plays a role; in jargon, the development of a region is path-dependent. The Santa Clara Valley had the advantage that in it, other than in e.g. Saarland, no deep historical linkages existed. A network of the quality of Silicon cannot be stamped out of the soil to order. Rather, it is the outcome of a free social process, which at best can be encouraged by intelligent legislation, though the "invisible hand" need not lead to the first best solution.

A unified theory to explain the Silicon Valley story does not exist, at best a potpourri of explanatory approaches. The key concepts are i.a.:

The Schumpeterian entrepreneur (to a limited extent), agglomeration effects, crystallization point, coordination game, coordination equilibrium, social networks, self-strengthening effects, division of knowledge, flexibility of the labor market, flexible bankruptcy law, culture, path dependence.

5. The Moral of the Story: II: Lessons

“Silicon Valley” has become a model for regional policy. Public efforts to create something similar have occurred everywhere in the world,, but everywhere in the world they have been of questionable success (Saxenian 1994, 166). That is not surprising. “Silicon Valley” cannot be forced into existence by law or administrative acts, nor through encouraging advertising slogans such as “Saarland, the region on the upswing” or “On the catch-up track”. The most that law can do is to create the conditions which are helpful to the economic development of a region. Advertising can possibly contribute to changing the attitudes of the citizens.

The ideas advanced above to explain the phenomenon of “Silicon Valley” suggest i. a. The following recommendations:

- creation of a local crystallization point (“focal point”). In our “science society” that is a research university, i.e. a college in which basic research linked with teaching is at the centre, not perhaps courses of training. A university in which scientists of high standard work, which attracts gifted students, which can maintain its position in international competition, and is well-known far beyond the borders of the state. It serves as a breeding ground for new ideas that are put into practice by alert entrepreneurs
- Creation of a culture and agglomeration of venture capitalists and angle investors. “It is not their money that is important, it is their judgement and courage to back their judgement with their money gained on the financial battlefield that adds value.”[54] In effect, venture capitalists are both gate keepers and midwifes of technical progress.
- Creation of a social regulatory system in which “the wind of freedom blows”, also and precisely with respect to labor and bankruptcy law.
- Promotion of the development of social networks, especially those with “weak ties”, therefore the looser “networking” of a region[55]. Of assistance will also be to make easier the establishment of new firms, change of jobs, “repeat entrepreneurship”.
- Dissolution of actors being at loggerheads with each other (“inefficient Nash equilibria”) through superior political authorities (e.g. “Brussels”).
- Encouragement of entrepreneurial actors, softening the risk of entrepreneurial failures.

[54] Personal remark by Harold Shattuck, Partner, Palo Alto Consulting Group, Palo Alto, CA.

[55] “Networkification” (*Vernetzung*) has become a fashionable word in German development policy. See e.g. the article “*Vernetzung schafft Vorsprünge. Cluster und Netzwerke beschleunigen den Innovationprozess*”, by Franz Joseph Rademacher, “Innovationsstandort Baden-Wuerttemberg”, Verlagsbeilage zur FAZ, 5 November 2001. In doubt, it is the administratively convenient strong ties that are being thought of rather than the loose ties between actors that promote creativity.

The setting-up of a research university may be of help, but think of the time that elapsed until Stanford University was built up and had accumulated the necessary attractive human and social capital (more than 70 years!). What an enormous role was played in all this by the reputation based on its history of achievement – and not at all in the technical sphere, which only came about later! Individual entrepreneurial personalities play an important role, but in association with others. Thus Frederick Terman brought the Nobel Prize winner William Shockley to Stanford; Shockley in turn brought with him, among others, the later "Traitorous Eight", who founded by help of a courageous investor – Sherman Fairchild - a new firm (FAIRCHILD SEMICONDUCTORS), that had as consequence a series of foundations by the departure of individual gifted technicians who found the help of knowledgeable and courageous financiers, and so on – all of whom composed no anonymous mass, all remarkable soloists, but who all only worked in concert.

The Silicon Valley story cannot be copied. Frederick Terman had the rare good luck to cause Stanford University to participate at just the right time in the beginnings of the "new economy", the second (or third) industrial revolution, which was spurred on by the large defense expenditures of the Cold War[56]. Something like this cannot be repeated every year. However, the IT sector still today offers an abundant scope for the economic development of other regions, for IT development is not yet at an end. New possibilities are offered by the further specialization of the chip industry, the covering of the catch-up demand in the IT services sector, the building-up of e-commerce, among other areas (see Postscript to this essay). In addition, there is the participation in the development of other industries of the "knowledge age", e.g. biotechnology – which for the rest likewise is playing a role in the San Francisco Bay Area.

Postscript: The Near Future of the IT Industry (written March 2002)

What are the forthcoming hits on the IT market? First, the further development of services for purchasers of hardware. Thus thinks Hal Varian, University of California at Berkeley, one of the most influential personalities in the electronic business[57]. For every dollar spent on IT hardware, another ten are spent for services such as training of users, system administration,, and reorganisation of business operations.[58]

According to Varian, in the sphere of technical innovations it is above all the imminent development of micro-electrical-mechanical systems (MEMS) that must be noted. MEMS are automatic sensors and communicators of an order of magnitude of a cubic millimetre, also named "Smart Dust"[59].

Economically problematical is the enormous risk of the investment costs for the production of the ever-faster chips. In this respect, the situation as compared with the beginnings of Silicon Valley had radically changed. INTEL, for example, is today investing $11,300 million for the

---

56 Leslie (2000).

57 www.businessweek.com/magazine/content/01 20 /eb25.htm

58 See *New York Times*, 10 September 2001, C4.

59 http://robotics.eecs.berkeley.edu-pister/SmartDust/

construction alone of a new plant (in Hillsboro, Oregon). ADVANCED MICRO DEVICES (AMD) and SAMSUNG are building new plants which cost $1500 million each; MOTOROLA and LG SEMICON in Korea are planning a new plant which is to cost $2000 million. These high investment costs suggest that the technical limits to a further miniaturization of integrated circuits could soon be reached (Hutcheson & Hutcheson 1997). But the railways, air travel or the automobile industry were experiencing similar problems. The construction of ever stronger and faster locomotives, or ever larger and faster passenger planes etc., does no longer pay after a certain point has been reached. Specialisation of plant [32] is avoided. So far as concerns the applications, there are today no great "killer applications" like spreadsheet or desktop publication . Their place is being taken by hundreds of smaller applications, which taken together could lead to considerable savings on costs of production.

To the immediately forthcoming areas of application belongs the <u>ubiquitous computing</u> that has been in development since 1995, the employment of moving internet portals. “Millions of cellular phones, embedded processors, apparatus of the size of a hand, sensors and actuators will soon link and shape appropriate social spheres such as biomedicine, transport, environmental supervision, surveillance, and communication in the economy” (Dietmar Dath, FAZ. 2 January 2002, Nr.1, s39.).It is valuable to look at the works by Gregory Abower, College of Computing, Georgia Institute of Technology, Atlanta, Georgia, and his home page on the internet Annual conferences are already taking place on this subject, thus in 2001 the Unicomp 2001 in Atlanta, under the leadership of Abower.

In the more distant future lie the manufacture and distribution of <u>nanocomputers</u>. The journal *Nanotechnews* reports on this,, and it is said that in 2001 some path breaking discoveries have occurred in this area (FAZ, 16 Feb. 2002, s.46). Nanocomputers are put together from miniature chips of a few millionth millimetres size, with the chips themselves containing one hundred thousand more transistors than the “conventional” chips of today. For further information, see http://www.nanotechnews.com.

References

Alchian, A. A. (1950), “Uncertainty, Evolution, and Economic Theory,” *Journal of Political Economy*, 58, 211 – 221.

Andersson, A. E. and Persson, O. (1993), “Network Scientists”, *Annals of Regional Science*, 27, 11 – 21.

Baird, D.G. (1992), *The Elements of Bankruptcy*, Westbury, N.Y.: The Foundation Press

Baron, J.N. und Hannan, M.T. (2001), „The Economic Sociology of Organizational Entrepreneurship: Lessons from the Stanford Project on Emerging Companies”, Stanford, CA: Graduate School of Business, vervielfältigtes Manuskript vom 26. September 2001.

Beckmann, M. J. (1993), „Knowledge Networks. The Case of Scientific Interaction at a Distance”, *Annals of Regional Science*, 27, 5 – 9.

Beckmann, M. J. (1994), „On Knowledge Networks in Science: Collaboration Among Equals“, *Annals of Regional Science*, 28, 233 – 242.

Beierlein, Th. und Hagenbruch, O. (Hrsg.) (1999), *Taschenbuch Mikroprozessortechnik*, Leipzig: Carl Hanser.

Bienenstock, E. and Bonacich, P. (1997), „Network Exchange as a Cooperative Game“, *Rationality and Society*, 9, 37 – 65.

Böventer, E. v. (1981), Art. „Raumwirtschaft, I: Theorie, *Handwörterbuch der Wirtschaftswissenschaft* (HdWW), Hrsg. W. Albers et al. Sechster Band, Stuttgart, Tübingen, Göttingen: Fischer, Mohr-Siebeck, Vandenhoeck&Ruprecht.

Brown, J.S. and Duguid, P. (2000), “Mysteries of the Region. Knowledge Dynamics in Silicon Valley,” in: Lee et al. (2000), 16 – 45.

Burt, R.S. (1992), „The Social Structure of Competition“, in: N. Nohria und R.G. Eccles (Hrsg.), *Networks and Organizations. Structures, Form and Action,* Boston, MA: Harvard Business School Press.

Castells, M. (1996), *The Rise of the Network Society,* Oxford: Blackwell.

Castilla, E.J., Hwang, H., Granovetter, E. und Granovetter, M. (2000), “Social Networks in Silicon Valley”, in: Lee et al. (2000), 218 – 247.

Chandler, A.D. Jr. (1977), *The Visible Hand: The Managerial Revolution in American Business*, Cambridge, MA.

Coase, R.H. (1937), “The Nature of the Firm”, *Economica*, 4, 386–405.

Drucker, P. (2001), “The Next Society. A Survey of the Near Future”, *The Economist*, November 3rd 2001, London.

Dutta, B. and Jackson, M.O. (2001), “On the Formation of Networks and Groups”, Forthcoming in B. Dutta and M. O. Jackson (eds.), *Models of the Strategic Foundation of Networks and Groups*, Heidelberg: Springer.

Gibbons, J. F. (2000), „The Role of Stanford University: A Dean’s Reflection,“ in: Lee et al (2000), 200 – 217.

Granovetter, M. (1974/1995), *“Getting A Job. A Study of Contacts and Careers”*, Chicago: Universität of Chicago Press; 2. Aufl.

Hayek, F.A. von (1937), „Economics and Knowledge”, *Economica*, N.S. IV, 33 – 54.

Hellman, T. (2001), “Developing a Venture Capital Industry”, in: G. Kochendörfer-Lucius and B. Pleskowic (Hrsg.), *The Institutional Foundations of a Market Economy,* Villa Borsig Workshop Series 2000, German Foundation for International Development (DSE), Berlin.

Helmstädter, E. (2000), “Wissensteilung,”, Thünen-Vorlesung bei der Jahrestagung 2000 des Vereins für Socialpolitik, Berlin, 20. Sept. 2000, abgedruckt in: Graue Reihe des Instituts für Arbeit und Technik, Gelsenkirchen.

Homans, G. (1960), *Theorie der sozialen Gruppe*, Opladen: Westdeutscher Verlag.

Homans, G. (1974), Elementarformen sozialen Handelns, 2. Aufl., Opladen: Westdeutscher Verlag.

Hutchison, D. and Hutchison, J.D. (1997), “Technology and Economics in the Semiconductor Industry”, *Scientific American,* October 1967.

Jurvetson, St. (2000), “Changing Everything. The Internet Revolution and Silicon Valley”, in: Lee et al. (2000), 124 – 149.

Kaplan, D. A. (1999), *The Silicon Boys and Their Valley of Dreams,* New York, N.Y.: Harper&Collins.

Katz, M. and Shapiro, C. (1994), “Systems Competition and Networks Effects”, *Journal of Economic Perspectives*, 8, 93 – 115.

Kenney, M. (Hrsg.) (2000), *Understanding Silicon Valley. The Anatomy of an Entrepreneurial Region,* Stanford, CA: Stanford University Press.

Kenney, M. and Florida, R. (2000), “Venture Capital in Silicon Valley: Fueling New Firm Formation”, in Kenney (2000), 98 – 123.

Krugman, P. (1995), *Development, Geography, and Economic Theory*, Cambridge, MA: MIT Press.

Lee, Ch. M., Miller, W.F., Hancock, M. G., and Rowen, H.S. (eds.) (2000), *The Silicon Valley Edge. A Habitat for Innovation and Entrepreneurship*, Stanford, CA: Stanford University Press.

North, D.C. (1990/92), *Institutions, Institutional Change and Economic Performance*, Cambridge; deutsch: *Institutionen, institutioneller Wandel und Wirtschaftsleistung*, Tübingen: Mohr-Siebeck 1992.

Lee, C.-M., Miller, W.F., Hancock, M.G., Rowen, H.S. (Hrsg.) (2000), *The Silicon Valley Edge. A Habitat for Innovation and Entrepreneurship,* Stanford, CA: Stanford University Press.

Lee, C.-M. (2000), „Four Styles of Valley Entrepreneurship“, in: Lee, C.-M., Miller, W.F., Hancock, M.G., Rowen, H.S (2000), 94 – 123.

Lessig, L. (1999), *Code and Other Laws of Cyberspace*, New York: Basic Books.

Leslie, St. W. (2000), “The Biggest ‘Angel’ of Them All: The Military and the Making of Silicon Valley,” in: Kenney (2000), 48 – 67.

Luger, M. I. and Goldstein, H.A. (1991), *Technology in the Garden: Research Parks and Regional Economic Development,* Chapel Hill: University of North Carolina Press.

Marshall, A. (1969), *Principles of Economics. An Introductory Volume,* 8th ed., London: Macmillan Student Edition.

Mayerson, R. (1977), "Graphs and Cooperative Games,", *Math. Operations Research,* 2, 225 – 229.

OECD. *The New Economy: Beyond the Hype*, The OECD Growth Project, Paris, 2001.

Piore, M. and Sabel, Ch. (1984), *The Second Industrial Divide*, New York: Basic Books.

Powell, W.W. (1990), "Neither Market nor Hierarchy: Network Forms of Organization", in: B.M. Staw and L.L. Cummings (eds.) *Research in Organizational Behavior,* 12, 295 – 336, Greenwich, CT: JAI Press.

Powell, W.W. and Brantley, P. (1992), "Competitive Cooperation in Biotechnology: Learning Through Networks?" in: N.Nohria and R.G. Eccles (eds.), *Networks and Organizations: Structure, Form, and Action,* Boston, MA: Harvard Business School Press.

Rajan, R.G. and Zingales, L. (2000), "The Firm as a Dedicated Hierarchy: A Theory of Origin and Growth of Firms", Manuskript, University of Chicago and NBER, May 5, 2000, abgespreichert unter http://gsblgz.uchicago.edu.

Rauch, J.E. and Hamilton, G.G. (2001), „Networks and Markets: Concepts for Bridging Disciplines," in: J.E. Rauch und A. Casella (eds.), *Networks and Markets*, New York: Rusell Sage 2001, 1 – 29.

Richter, R. und Furubotn, E.G. (1999), *Neue Institutionenökonomik. Eine Einführung und kritische Würdigung,* übersetzt von M. Streissler, 2. Aufl., Tübingen: Mohr-Siebeck.

Saxenian, A. (1954), *Regional Advantage. Culture and Competition in Silicon Valley and Route 128,* Cambridge, MA: Harvard University Press.

Schelling, T.C. (1960), *The Strategy of Conflict*, Cambridge, MA.

Schumpeter, J. (1912), *Theorie der wirtschaftlichen Entwicklung*, zitiert nach 4. Aufl. (1933), Leipzig: Duncker&Humblot.

Schumpeter, J. (1942/1950), *Capitalism, Socialism and Democracy,* New York: Harper; dtsch. Übersetzung *Kapitalismus, Sozialismus und Demokratie*, Bern: A. Francke.

Sturgeon, T.J. (2000), „How Silicon Valley Came to Be", in: Kenney (2000), 15 – 47.

Wasserman, St. und Faust, K. (1994), *Social Network Analysis. Methods and Applications,* Cambridge: Cambridge University Press.

Williamson, O.E. (1985), *The Economic Institutions of Capitalism*, New York; deutsch: *Die ökonomischen Institutionen des Kapitalismus*, Tübingen: Mohr-Siebeck 1990).