

Steven Wozniak: A Pioneer of Silicon Valley and Beyond

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It is hard to imagine that in less than twenty-five years, personal computing has revolutionized our lives. Few recognize the faces beyond these revolutionary changes, rather the brands that have changed the industry. Apple Computer Corporation, founded in 1976 by two young gentlemen named Steven Wozniak and Steven Jobs created a brand that brought computing technology to individuals and corporations. While Steven Jobs developed the management and marketing strategy of Apple Computer Corporation, the real genius behind the Apple technology was Steven Wozniak. Wozniak admits that he wanted technology to be fun, for the people. Wozniak is one of the pioneers in the development of the personal computer, a world-renown philanthropist, and an inspirational visionary to technology in education.

Born in August of 1950, Wozniak's father was an engineer at Lockheed while his mother managed a household of three children. At the age of seven, the family moved to the community of Sunnyvale, California. At the time, Steve was fascinated with electronics. Because of his father's position at Lockheed and in particular his experience with technology in education thus far, he began to dabble into learning about computing. Steve was seven when his family bought him a crystal radio kit that he built. Following the success of the radio kits, Wozniak's parents saw his potential and interest in developing electronics so they bought him an electronics kits that contained items such as switches, lights and buzzers. Steve used the kit quite well and experimented with many techniques. The product which he ultimately produced was an electrolyte tester for the science fair. This tester consisted of two battery carbon rods, connected to AC and a light bulb and then dipped in the test solutions. Steve's imagination and passion only expanded further after he received honors for this work.

The following year, Steve had further explored the electronics and the scientific fields. His next electronic masterpiece was the development of a large atom display with lights for each possible electron in each possible shell and orbit position. This experience gave Wozniak more experience in chemistry. It was in sixth grade, however, that Wozniak received his first true comprehensive exposure to what makes a computer function. Steve's father taught him how transistors worked; this also incorporated the development of logic circuits. One of the most important lessons Wozniak's father explained was how to develop OR gates from resistors or diodes. He also learned about the AND gates from diodes, and inverters from transistors. Getting

access to these kinds of materials was extremely expensive. However, because of Wozniak's father's job at Lockheed, Wozniak's father went to a local semiconductor company named Fairchild. Fairchild was delighted at the idea that a young boy that was Steven's age would be interested in learning about semiconductors. They provided him with semiconductor parts that were supposedly "cosmetic defects." Some of the parts they provided him with were hundreds of diodes and transistors. From this donation, Wozniak's father instructed him on how to create gates that could make decisions. The first product Wozniak ever created with this contribution was a tic-tac-toe game. As Steven Wozniak states:

“My dad taught me how gates could make decisions based on inputs. He said how you could combine all the inputs of a tic-tac-toe game (which squares had "X," which had "O" and which were empty) and gates could decide the best response. “(Rahimzadeh, 3)

It was unfortunate however that Steve was unable to use this knowledge to provide him a tool to enter the seventh grade science fair because of his lack of time to produce a sufficient product. However, Steve's parent did not want him to give up since he has become so knowledgeable in areas that most children would not dare touch. Therefore, it was in eighth grade when Steve's father had access to computer reports that explained how to construct hardware and employ Boolean Algebra in the development of systems. The book contained content which included logic diagrams of a binary adder (one bit with carry in and out) and a binary subtractor. Steve explains that as he got more exposure to the content that his father accessed, the more he became passionate regarding the development of the computer. He says:

“I stared at the two circuits long enough to see that they were quite similar, and I added logic of my own to make one circuit add or subtract based on a logic signal from a switch. The first adder and subtractor bit which I soldered together, using about 20 transistors and various diodes and resistors did not work perfectly. I used a meter and determined from my electronics background that my diode-transistor NOR gate needed a resistor before the base of the common-emitter transistor to avoid drawing down the driving voltages. The fix worked and before long I had a 10-bit adder/subtractor with binary inputs on toggle switches and outputs on lights. I had done such a job that, although I was only in eighth grade, I was awarded the Air Force electronics award covering up to 12th grade! As a result, they gave me my first airplane flight.” (Rahimzadeh, 5)

Steve credits his experiential knowledge directly to his father since he was involved in the development of the first generation of integrated circuits at Lockheed. Steve's exposure to his father's work at trade shows, at home, and in the corporate world fortified this passion. Because

Wozniak's father was an associate of many of the executives in the computer industry of the 1950's and 1960's, he had the accessibility to computing literature that few children had. This only helped Wozniak with the vision of how to build the first computer.

When Wozniak's family moved to Sunnyvale, the community was in the midst of its birth. Everything was brand new: the school, the companies, and the homes. The school district interestingly was not even existent so the Wozniak family sent their children to the Cupertino school district. Even the Cupertino district was so new. The district had not invested in a technology program or at least computer club of sorts. Wozniak was a member and president of the club for two years of this computer club at Homestead High School, centered in what has become Silicon Valley. The district had acquired a lot of brand new electronics test equipment, power supplies, and signal generators. The students learned how to develop machinery because of the investment the district made. The director of the program had such a good relationship that many local firms provided supplies to these future inventors. Most of the members of the clubs had been exposed to the ability to calculate, design, understand, build, adjust, and repair lots of equipment up through TVs. The most important component of the Homestead High School Computer club was a relationship in which Wozniak made with a fellow member, Steven Jobs. The two of them became instant friends. Their relationship although lasting one year while at Homestead cannot be forgotten since this team later came together to build a computer empire named Apple Computer Corporation.

Steve Wozniak was a brilliant young man. He graduated from Homestead High School with academic honors. His academic record was superior especially with his perfect performance on the SAT's. Wozniak applied to two collegiate institutes: the California Institute of Technology and the University of Colorado at Boulder. Wozniak chose to go to the University of Colorado because he was not accepted to Caltech because he lacked maturity. When Steve presented himself in the interview process, the interviewer felt that he was not qualified. Wozniak credits his college choice to the following:

“I wanted to be an engineer and design things that work like radios and TV's. I didn't express scientific ideals, only technical ones and I didn't fit the Cal Tech model. My counselor gave me a bad review also because I had done a lot of pranks at the school even though they had only officially caught me for one of them (when the cop tricked me with a lie).” (Min, 2)

Nevertheless, Steve's collegiate years were intriguing. He was undoubtedly a troublemaker. This eventually led him to dismissal from the University of Colorado for poor academic performance

and unacceptable disciplinary behavior. After Steve's year at UC, he went back home and attended a Community College. Community College did not satisfy his love and passion for learning about computers, so he would go beyond the limits.

While getting an education, Wozniak needed to pay for his educational experience. Wozniak's first real-world experience was at a company called Tenet in Cupertino. Steve landed this job by accident. He went to the wrong location for an interview. Instead of going for a job in hardware development, Steve ended up as a programmer. A short time later, they went out of business but before they went out of business, the company provided him with an automobile and capital to continue his education for one year at Berkeley. Steve's next job was at Electroglass, a company building Integrated Circuit wafer probes. Steve admits that he loved this job because he worked the entire day standing. The company knew he was a visionary since he was capable of designing circuits as well as being an intellectual. However, after just six months, a better opportunity confronted Wozniak. He was offered a job at Hewlett Packard. One of the reasons why Wozniak and the Hewlett Packard relationship was important is simple: It was at Hewlett Packard where Wozniak was exposed to being a system designer in a full capacity. Wozniak was one of the essential forces behind the development and design of the first scientific calculator, the HP-35, made by Hewlett Packard. Many of the people that Wozniak accredits his success to in building Apple to the acclaim it has achieved, is because of the relationships he built at HP.

During his tenure at Hewlett Packard, Wozniak began to develop serious machinery. He would take spare parts from the stock room and then go home to build these machines in his garage. It was in 1975, when Wozniak and Jobs came together to form a company whose goal it was to build a machine for the masses to enjoy, use, and learn from. While Wozniak was the engineer and system developer of such a machine, Jobs dealt with management. It was in 1976, when Wozniak co-founded the company Apple Computer Corporation. In order to start-up this company, Wozniak and Jobs had to sell many things. Wozniak sold his HP-35 calculator and his Volkswagon. The reason for this sale was the fact that there was a need for capital. Computer stores and companies loved this machine because no computer before has been developed with the power and the size in comparison to the computers developed by the Apple team. As Wozniak states, the company felt that nothing could go wrong, and that they could do just about anything. Wozniak expresses:

When we started Apple, it seemed as though nothing could go wrong. Our first computers were born not out of greed or ego but in the revolutionary spirit of

helping common people rise above the most powerful institutions. Apple culture began with products that had a huge technological lead over the competition. They were the first low-cost computers ever with built-in color, graphics, sound, and programming languages. In addition, they were usable out of the box. Our vision was that people would find computers useful at home, for "people things" like balancing checkbooks, keeping address lists and typing letters. (Wozniak in Newsweek, 1)

With this fundamental concept in mind, Wozniak built a machine that was affordable and expandable. The machine that was developed became the Apple I. It was not long after the Apple I was built, that the Apple II was already in the development stages.

Part of the Apple history focuses upon the garage where Jobs and Wozniak developed their first family of Apple Computers. For about a year, the team of Wozniak and Jobs built these machines in a garage. Before opening the first office, the entire assembly of the Apple Computer was a family affair of sorts. Jobs dealt with all the management decisions while Wozniak built, integrated, and repaired all the machines. Job's sister and friends had been the powers behind the assembly and acquisition of computer components for the machine. As Wozniak states:

“Apple I PC boards were manufactured at a company in Santa Clara. We had supplied them our design, the layout done by a friend of Steve's from Atari. After about 50 boards were made, our components came out of a closet there, starting the 30 day clock ticking on payment. Assemblers put all the components in the boards and the boards were wave soldered there, all for \$13 in 1976. We drove down and picked up about 20 boards at a time and drove them back to the garage which had a single workbench. We paid Steve's sister or other friends \$1 per board to insert the ICs. Then we tested them. I had to fix virtually all the ones that failed. Then we drove them to the local computer store, the only local store, the Byte Shop of Palo Alto, and were paid in cash. The store got our PC board in a box. They also supplied 2 transformers and a keyboard with each board. The purchaser had to wire the video output into a TV.” (Rahimzadeh, 8)

Interestingly, Steve Wozniak suggests that his invention of the Apple I was not a complete microcomputer design. All he did was take existing video terminal parts and integrated them into the board that consisted of RAM chips. Each component was then synchronized. Wozniak admits that most of the Apple II was built on the fundamental designs in the Apple I. It was the Apple II, however, where his visionary machine became a reality. Wozniak envisioned a computer with a graphic interface and something that was much faster than a Teletype. Wozniak took the construction of the Apple I and improved on all the flaws. The essential difference that made Wozniak a pioneer to the computing age was the development of a machine that performed “plug-n-play” capabilities. What this means is that a person could plug in a printer card and the

printer worked. All the driver programs were in the system memory card. This technique has since become a standard of computing technology.

Another contribution that Wozniak made was the development of a similar programming language to that of William Gates of Microsoft Corporation. Gates had created a compiler for the language called BASIC and Wozniak later followed up with his own translator. Wozniak also used this language to build many of Apple's most recognized software applications including ColorMath, Checkbook, Star Wars, and the followup to the Atari Breakout. Breakout was an important development because it was the application that removed the dependency on hardware. Wozniak believed and affirmed that never again would most machines depend on hardware support to run software application.

In 1981, Wozniak's role in Apple Computers had changed. Since management changed direction and the vision which Wozniak had not been realized (as well as his passion for technology.) Wozniak left Apple to follow other dreams. For a few years, Wozniak started up a few software companies, did philanthropy work, and most importantly finished his degree at University of California at Berkeley. In between, Steve organized a concert that was considered a disaster called the U.S. Festival. A tremendous amount of capital was invested in this concert to make it feel like a reproduction of Woodstock that combined rock music and nature as one.

Steve later returned to Apple as an engineer in 1983 to reinvent and optimize the Apple IIx systems as well as become a visionary power for the Apple III system. His goal was to be an engineer who creates a system that was free of third party add-ons. The powers at Apple believed only Steve had the answer on how to make this successful. However, it was not the goal to make the Apple II a powerhouse, rather than the Apple III. Steve worked shortly at Apple to make his vision a reality but again management wanted him to take on a greater role beyond engineering. They wanted him involved in the central management decisions, which is something he was simply no longer interested in. Steve says he would rather be known as the inventor of the Apple II since he designed a great computer and wrote all the software for it, then known as the co-founder of Apple because he is simply a modest man who loves technology.

Another facet of Steve Wozniak's life that has not been mentioned is his love for education, his philanthropy, and the connection of both in his life. Wozniak states that he does continue to have a role in Apple. He says: "I have never left the company. I keep a tiny residual salary to this day because that's where my loyalty should be forever. I want to be an "employee"

on the company database. I won't engineer, I'd rather be basically retired, due to my family.”(Wozniak in People, 2) It is his family though that brings out his love for education. It was the inspiration of his son Jesse and his passion for computers that developed when he was in fourth grade that made Wozniak become a philanthropist for computer education.

It was in 1991 when Wozniak realized his potential as an inspirational educator. This was a direct response when his son Jesse, then nine, discovered computers. Wozniak exclaims, "Bit by bit, I showed Jesse how to plug in a hard disk and explained cables," (Newsweek: 1). It was this inspiration from his child that Wozniak began to fund schools in the San Jose area with Macintosh Computers and develop an after school program. The program in 1991 began with Jesse and four of his fifth grade classmates in the summer of 1992. Wozniak personally invested \$4000 in each child on an Apple Macintosh PowerBook 170, the revolutionary first laptop by Apple Computers. The class was taught in Wozniak's office three times a week. What began as a class for learning computer fundamentals became a class on computer hardware, system software, and integrating systems into information networks. Because of the success of this summer institute, Steve expanded this program into an after school program for students who are hand picked by he and the school district. The program encompasses everything from learning fundamental knowledge on the computer system to advanced spreadsheet design. Steve's classes have inspired students to go far beyond the normal gamut of computer knowledge that a pre-teen has. He is an innovator, inspires, and yet is a down-to-earth guy. Most of his students have gone far beyond a teacher-student relationship. Although in his first year of teaching, many looked at him as a computer legacy, he is now simply known as "Steve" or "Woz" to his students, a typical guy with a remarkable background and a heart of gold.

Beyond Steve's contribution to education and the computer industry, his philanthropic efforts are incredible. Sponsoring concerts for protecting the environment, supporting educational causes, and youth foundations are among Wozniak's most noted contributions to the world which has amounted to as much as \$45 million dollars over his lifetime. Steve's greatest philanthropic effort was the creation of The Children's Discovery Museum of San Jose located at 180 Woz Way. The museum is a hands-on museum where children and adults can interact with science and technology in ways only Wozniak could imagine when he was younger.

When Steve Wozniak is not teaching his students or doing philanthropy work in the Silicon Valley region and beyond, he spends his time like any self-respecting eccentric and family man. He watches movies, listens to modern rock, attends Golden State Warriors NBA

games, travels to places like Disney World, plays video games, goes through manuals on new computer programs, and buys sheets of \$2 bills from the U.S. Treasury Department. Wozniak's future includes him getting a teaching certificate to become a full-time elementary school instructor. Steve firmly believes: "I think if kids are going to have a hero in the computer world," he says, "they might as well have a good one." (Wozniak on General Questions, 12) To Wozniak, his passion for his children, his hobbies, and the events that have shaped his success in the computer world have surely attributed him to being a hero of the computer world.

Steven "Woz" Wozniak is undoubtedly one of the fathers of Silicon Valley, the Personal Computing Industry, and computing in education. His integral role of being a co-founder of Apple Computer Corporation has left him a legacy because it is he who developed and integrated new techniques into engineering, computing. Beyond his contributions in the computing world, Wozniak is an inspirational teacher who goes beyond the limit of teaching students. He inspires them with a program that makes them think and expand the realm of possibility. That in conjunction with his generosity as a recognized worldwide philanthropist, makes him a dominant force of the information age.

Bibliography

1. Garr, Doug. Woz: The Prodigal Son of Silicon Valley. New York. Hearst Corporation. 1984.
2. Hruschak, Peter James. Apple fans savor a 'Woz' moment. Cincanatti Enquirer. Gannet Corporation. October 22, 2000.
http://enquirer.com/editions/2000/10/22/loc_apple_fans_savor_woz.html
3. Min, Janice. Wizard of Waz People Magazine. Hearst Publications. February 14. 1994
<http://www.woz.org/pages/wozscape/Articles/WizardofWoz/WizardofWoz.html>
4. Rahimzadeh, Auri. The Woz Interview !Fishers, Indiana. 1995.
<http://www.woz.org/pages/wozscape/pgsinterview.html>
5. Wozniak, Steven. *How We Failed Apple*. Newsweek. Newsweek Publication Corporation. February 19, 1996
http://www.woz.org/pages/wozscape/Articles/Newsweek_FailingApple/FailingApple.HTML
6. Wozniak, Steven and Others. *Letters-Questions regarding the "Pirates of Silicon Valley"* Woz.org. 2000. <http://www.woz.com/letters/pirates/index.html>
7. Wozniak, Steven and Others. *Letters-General Questions to Woz Answered* Woz.org. 2000
<http://www.woz.com/letters/general/index.html>