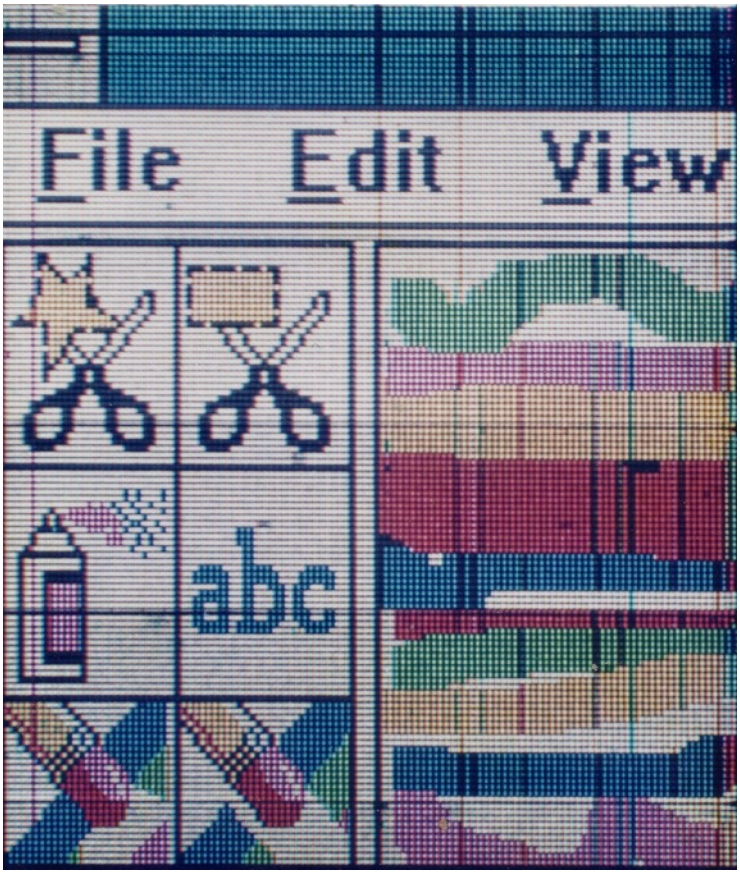
Chapter 15

SVC & Candescent



This is a picture of a very early display using SVC field emission technology.

It began in a most leisurely fashion. After I sold XMR to Amoco, was fired, and was looking around for something to do. Paul Lavoie contacted me and asked me if I would be interested in helping start a new company. I had worked with Paul in one form or another since I came out to the west coast. His technical expertise was in glass ceramic seals and dye lasers. I got to know him quite well when we both worked at ILC technology in 1978.

We had many and far ranging technical discussions during that time. Paul, Darryl Wilburn and Lowell Noble, who was an independent inventor was running his own research lab and surviving on government contracts, came to see me and presented their idea for a novel form of flat-screen cathode ray

tube display. I had worked on cathode ray tube displays at RCA for many years and was familiar with RCA's effort to make a thin cathode ray tube. I was intrigued.

Their concept involved having a thin vacuum tube which contained a cloud of electrons that could be directed to an adjacent phosphor screen and generate a display. In retrospect I should have realized that their basic concept of constraining a cloud of electrons was technically improbable and probably inefficient, but I was really looking for something to do. We incorporated a new company under the name Silicon Video and started seriously looking at the technology.

I joined the company as CEO, Ted Fahlen joined us as technical manager. Paul had found some early investors for a few tens of thousands of dollars and Lowell was busily bidding on several government contracts. Initially I thought the biggest problem would be finding a ceramic material for the spacer that would be required to support the thin structure against atmospheric pressure, but we also needed efficient low voltage phosphors for the display to enable the potential advantage of such a thin display.

We constructed a few displays using this original hot cathode concept. We demonstrated them inside a larger vacuum chamber so we did not have to seal them. While these worked, it appeared that it would be extremely difficult to make a large display using this technology.

Our thinking evolved from using a hot cathode to using field emitters. We brought Chris Spindt on board to join Ted Fahlen, our technical manager. Chris's father, Capp Spindt was one of the early inventors of field emitter cathodes.

Before Ted and Chris came on board, I was the only employee. We had submitted a proposal to DARPA for investigation of flat-panel displays that would be useful to the military. Silicon Video needed to raise significant investment to continue research beyond the work we were doing for the government contract.

I failed their equal opportunities test as I was the only employee. A representative from the local small business administration was assigned to visit us every three months and confirm that we were progressing towards equal employment. He turned out to be a very nice guy and totally supportive, so there was no problem.

A field emitter is a tiny metal point which emits electrons when a high potential gradient is applied to it. If the point is sharp enough, the emission voltage does not have to be more than a few volts to make an efficient field and easy emission of electrons. These electrons then strike the phosphor immediately in front of them and produce the colors for the display. I mentioned this detail because it relates to our ongoing technology. Three of these emitter phosphor sets are required to produce the full red green blue color spectrum and the combination is called a pixel.

Our goal, as presented to investors, was a 40 inch wide display with 1000 pixels across the display. This meant we had to have 25 pixels per inch. In this horizontal plane eight pixels consisted of three individual color pixels requiring us to have 75 color pixels per inch. This requires each pixel to be some 14 mills or some 14 thousandths of an inch.

The Wall Problem

This type of lightweight structure requires internal walls to keep the front and back faces from collapsing on themselves. We eventually allowed five mills for the walls at each pixel. We assumed that somehow this could be done but we had to hire a ceramic expert.

Field Emitter Noise Problem

Field emission is inherently, a noisy process. To obtain a uniform brightness we estimated we would need as many as 100 emitters per sub-pixel. This requires our individual field emitter to be in the order of 1 1/2 to 2 mils dimensions. As time went on, we discovered we might need as many as 5000 sub pixels per pixel.

We did not dwell on the fact that no one had made field emitters this small or ceramic walls this thin or phosphors that were efficient at low voltages, but we went bravely forward. I only mention these aspects of the technology to indicate what we were selling our investors.

The First Investors in SVC

A small group of private investors called Capform invested $400,000 based on the interests from DARPA. This enabled

us to move from a second floor space above an insurance office to a small building on Bubb Road in Cupertino. About 1 mile from my house. This property was owned by a local real estate investor named Carl Berg. Carl is a fascinating, somewhat overweight man. He runs his operations out of a small office in Cupertino and happily drives around in a Mustang convertible. We must have hit it off because he continued to invest in companies that I was involved in over multiple years and many million of dollars.

The majority of the investors in the area around Cupertino, were up near Palo Alto at the intersection of Sand Hill Road and Highway 280. Through some of our Laserscope contacts, we made a few presentations to the investment group called Sequoia Capital. They agreed to put in $1 million, but they were cautious about our technology. We made a sales pitch to Hewlett-Packard and they liked our technical ideas enough to agree to put in $1 million if we could find an investment group to set our valuation.

The Sierra Investment Group needed few details. The Hewlett-Packard investment, however, required writing down and discussing every possible way that our display might possibly interact with any division of Hewlett-Packard and who would have what rights. My friend Craig Johnson, who was our corporate lawyer at Laserscope worked for many long ours to negotiate the Hewlett-Packard complexities.

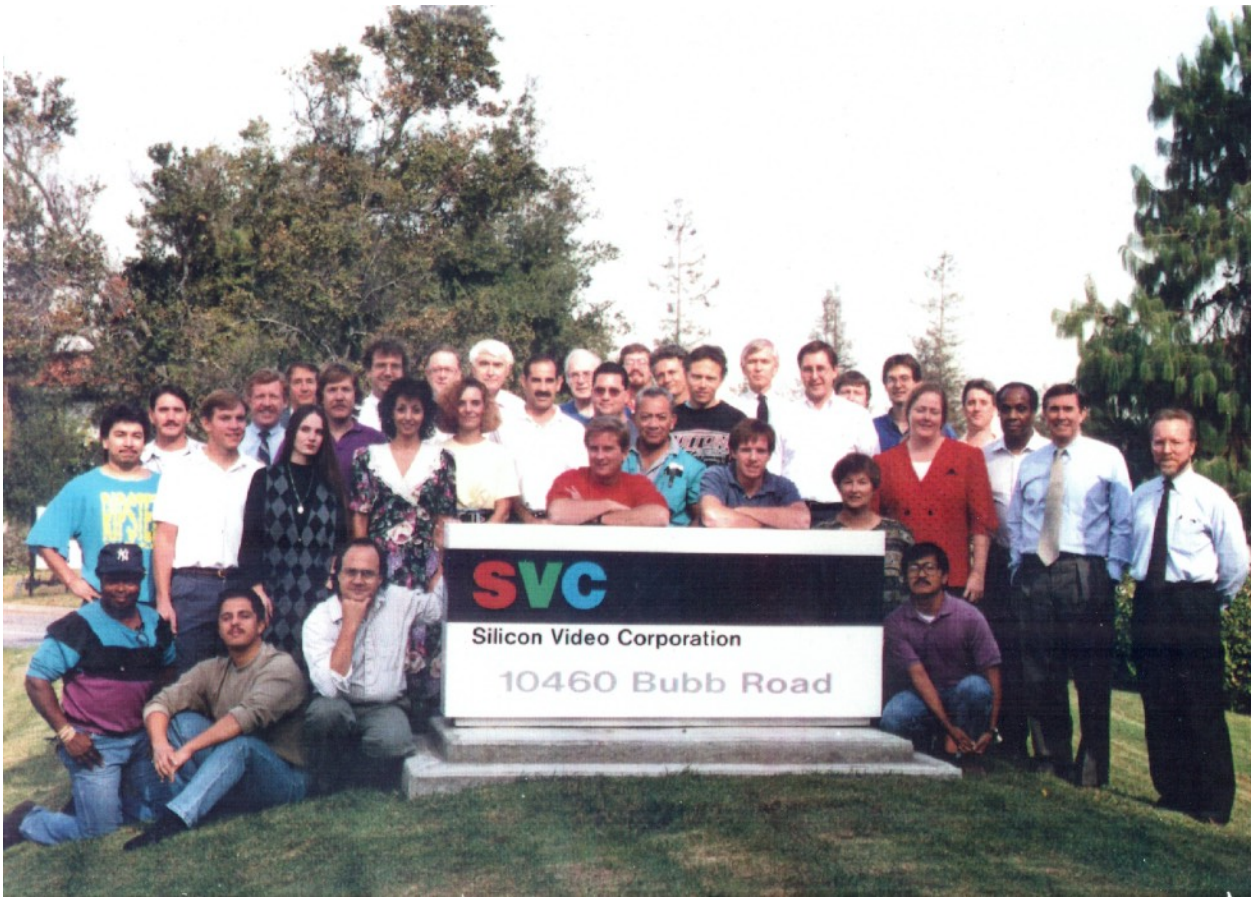
This is a picture of me accepting the million dollar check!

We moved our equipment from above the insurance agency to our small Bubb Road space. We grew to 10 people before we ran out of the first Bubb Rd. space. Carl owned a much larger building on the other side of the road. This building had previously been a semi-conductor manufacturing facility. It still had trenches running throughout the building floor where the chemicals necessary for semiconductor fabrication chemicals had been piped around. The piping had all been removed, but no one really knew how much or what had been spilled in the trenches over the years. It could well have been a Superfund site!

The building was the right size for us and Carl and I agreed to fill in all the trenches with concrete and not worry about what might still be under the cement. We moved to that location and remained there for quite a few years. I have to admit that this was the shortest commute in my entire life.

We eventually employed quite a few people, as seen below.

The years at this location were spent in solving the technical and physical problems of our display. We worked with various ceramic companies to develop a flexible ceramic material that was thin enough, had the right coefficient of expansion, and could be coated to prevent charge buildup on its surface.



We investigated multiple types of field emitters and finally invented a new field emitter fabrication technology using the particles emitted from an accelerator to make tiny damage spots in the pixel area which could then be etched to enable fabrication of our very small sub-pixel emitters.

We purchased a scanning electron microscope and other high-technology equipment to examine our results. We kept improving and inventing enough to obtain continued investment by venture capitalists.(The year-by-year sequence of investments and employment are covered in the next chapter.)

After about five years of continued inventions and improvements, the law firm Wilson, Sonsini and Goodrich

convinced our Board of Directors that we would never get major funding as long as Craig Johnson of Venture Law led our legal team. We did continue to get major investments in multiple rounds of financing over the next four ears.

Around the same time, the Board of Directors decided that the company needed a more salable major executive with better financial contacts than I had. They initiated a search and hired venture capitalist Harry Marshall to take over. I continued as president, but became less and less involved in the organizational and the manufacturing details. Marshall renamed the company “Candescent” and moved it into a larger facility in South San Jose where it initiated pilot production of displays. Our financial burn rate was now approaching several million dollars a month. We negotiated with Carl Berg to build a manufacturing facility further south in San Jose that was a 300,000 square-foot tilt up building. We never occupied it.

Our production yield was now high enough so that we could calculate the finances needed for a factory to make our one meter square commercial displays. We had completed several stages of financing and had come to the point where we needed to have an initial public offering to raise the cash to go further. We wanted to bring television manufacturing back to the United States and thus build the factory here.

We prepared all the legal forms, corporate projection in finance plans, and government documentation necessary to file for an IPO. The final requirement was a sign-off by our legal council, Wilson, Sonsini and Goodrich. They balked at putting their name on the IPO proposal unless we were able

to convince Sony or an alternative Asian firm to sign on to build a manufacturing plant in Asia. They argued that any major semiconductor manufacturing operation had to be in Asia. I was never able to convince them that the manufacturing could be done in the United States.

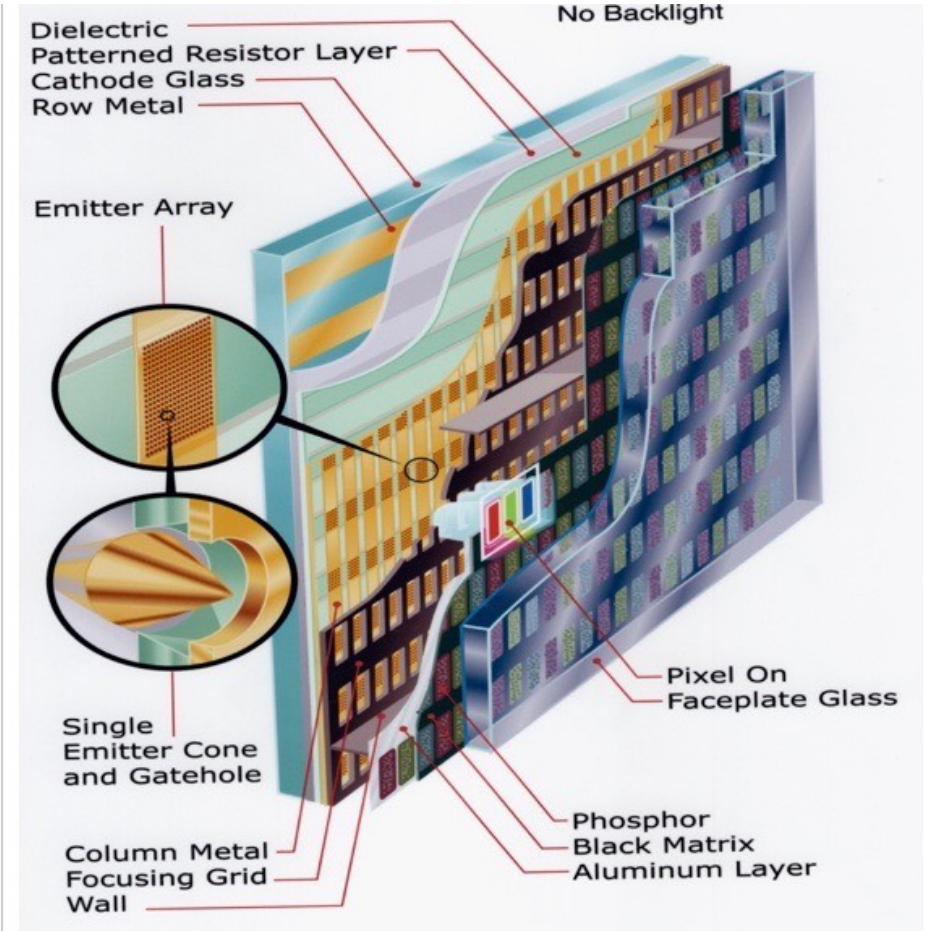
In retrospect, we would have required an immense amount of money to set up a flatscreen manufacturing plant in the United States. Our best estimates were that it would have required almost $2 billion. Instead of becoming multimillionaires, our family lost a couple hundred thousand dollars. Other investors lost much more

With this bad news of no IPO, the investors holding notes against the company called them in and Candescent became bankrupt. The complete boring staffing, technical, and financial details of this amazing rise and fall are in the next chapter.

In retrospect it was a good decision on the investors part because there were new alternative technologies that were coming along rapidly and one of them is in the television set I have downstairs. It probably cost 1/3 as much to make as ours would have cost. There was no way we could have competed. I think the investors continue to support us over these years as we had continued technical successes. We absolutely believed that we could manufacture these displays in the United States. Ultimately, a new unexpected technology obsoleted us.

Life Goes On

While we did not complete any larger operating tubes, Japanese firms did continue our technology and manufacture some excellent displays. I will copy the photo of their final result here. Notice that they did not use spacers, but used thick glass.



This was about five years after Candace, but it's kind of nice to see that the technology, or at least part of the technology was developed all the way to make beautiful display. It was obviously expensive to manufacture, but beautiful.

The next chapter gives a more detailed account of the growth and collapse of the company. It can will be skipped unless you are interested in the details of starting, growing, and raising and spending three quarters of a billion dollars in investments.

I also put some of the details of the fun early days in the next chapter. Some of it duplicates this chapter.
Candescent was an example of a company outgrowing its founders. All of us were replaced by professional managers and all of us lost whatever investments we had made in the company. It was a great technical ride though.

We did a great job of improving existing technologies but finally were obsoleted by a new and cheaper product.

Technology moves on and we could not move fast enough.

This is the big screen organic light emitting diode based television that I now have in my home. It is far bettor and far cheaper and far larger than any vacuum tube based display could be.

It was an amazing nine years.