



Recollections of Early Paint Systems

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Dick Shoup: Well, this is a pleasure and it's really nice to see all these smiling faces, some maybe even a little older than I am, but not too many. And it's a pleasure to reminisce with you about a fun time, in the early seventies in particular, when a lot of interesting things happened and a lot of things were possible that weren't possible even a few years before that. And I feel very fortunate to have been alive at that particular time and place in history. So think back to 1970. There were a bunch of young PhDs who thought that they knew everything and that everything was possible, nothing was impossible. It was pretty typical for the twenties, for your twenties, I suppose. And it turns out, like many people, later we learn that we didn't know very much at that time but we managed to accomplish some things anyway. So here are some things we did. And all of this was made possible by timing, but a fortuitous collection of events. Most of you know the story of Xerox PARC, I'm sure. But it was founded in 1970 with a mandate that had something to do with the office of the future or more particularly a speech made by the then chairman, Peter McCullough, who talked about the "architecture of information." That we were going to be the leaders and the pioneers in the architecture of information. And we didn't know what the hell that meant, but it sounded pretty darned interesting. It turned out that Peter didn't know either; it was some speech writer [who] had written that for him. But he had the cajones to go out and say it and mean it. And Xerox struggled with that for a long time. But the landmark, the stake they put in the ground, was Xerox PARC, which arguably turned out a lot of good things. So it was 1970, and we had this charter and a bunch of good people had come there. I felt fortunate to be included, in fact. And one of the first things that my manager said to me was, "I know you're interested in this and this and you did these cellular arrays, blah, blah, blah and you did some graphics. We're trying to build a laboratory here that has some very quality themes. Why don't you take a year to figure out what exactly you should do?" Great. That was wonderful. I've never heard those words since.

<laughter>

Shoup: Usually, it's more like, "Why don't you take a day to think about what you should have done a year ago."

<laughter>

Shoup: Anyway, that was a wonderful gift. It didn't take me a year at all to figure out that I wanted to build a frame buffer. What's a frame buffer? It's just a bunch of memory that holds a picture. And one of the fortuitous events was a small company, a young company named Intel that was then producing integrated memories, had decided that they could produce a chip that had the incredible capacity of a kilobyte. In fact, they made one that had the capacity of a kilobyte in a dynamic RAM form, random access form, and also more or less at the same time, one that was two 1K shift registers for a total of 2K bits in shift register form, and that one was in a chip that only had eight pins. So the density was high, the cost per bit was low. And this, of course, made possible lots of things. Eventually, the Alto, we built a [DEC] PDP- 10 equivalent called MAXC [Multiple Access Xerox Computer]. And we used some of these

chips in the SuperPaint system, and for the first time we could afford and manage enough memory in one place to do a frame—buffer [one] frame [of an] approximately television-resolution image. So that made a lot of things possible. And I'll tell you a little bit about what we built. Oh, yeah, I have to apologize that we were not able to get the real SuperPaint running. It may have seen its last boot. I don't know. It almost boots. If we have anyone here who is an expert in Diablo 31 disk drives controllers, and that 1970s technology, I'd definitely like to talk to you. And if anyone could read disk packs of that variety, RPF5 Diablo disc packs, 2 megabytes and 8 sectors. The gentleman right here.

<laughter>

Shoup: Does anyone have one in their car?

<laughter>

Shoup: No? Sold to this gentleman right here. I'd like to talk to you, sir. We may resurrect it yet again, but I have a partial simulation running on the Windows PC. Alvy has a recreation of his New York Tech paint program running on the PC which he will tell you about, and these things will be remembered I suppose in that form. But we can go see SuperPaint in the collection in a little while. You may get bored by this talk, but please don't miss the collection, okay? There's a ton of great stuff. There's 22 tons of great stuff over there, and don't miss it. Okay.

So my friend Pierre St. Hilaire says, "We have to do it while it still seems crazy." I love this. I love this guy. What was interesting about the SuperPaint hardware? Well, there was a full frame of video, 640 x 480. 486, actually. Those of you who know video know that 480 lines isn't technically enough. 2K shift registers, the Intel 2401 recirculating. One big long shift register, the entire frame of 8 bits per pixel. 83 nanosecond pixel clock makes it square pixels. Two color tables, each 256 x 3 x 8. And two sets of 3 D-to-As [Digital-to-Analog converters]. Originally, we had intended to do two full frames, but the powers that be deemed that too expensive, so we just had one, but we had two sets of outputs. So I made two pictures and displayed them on two monitors. One became the menu, the other the canvas, and each was 4 bits per pixel. This was I think the first frame buffer to have whole NTSC video compatibility, including genlocking. It had an NTSC encoder. It had its own little sync generator. And those of you who know about display controllers, you can do a phase locked loop or you can actually start and stop the entire data chain, and we did the latter, start-stop the entire data chain including all eight phases of some humongous clock, like a centipede putting all its feet down before it could stop, and then picking them up again. So that it could genlock to anything, no matter how much jitter and at the time discontinuity as well. Real-time continuous video input... about that time there became available a box for \$12,000 dollars that digitized at a video rate 8 bits. This thing had a [Data General] Nova 800 controller. This was before the Alto was invented, but not much. And it had X run-coded hardware for reading and writing. It's the only thing that made it really work with the long shift registers. By far the most contentious decision, of course, was to use the shift registers as opposed to RAM, in this machine. But they were so much cheaper, so

much denser, and the bandwidth was so much easier to get out of them, that a little napkin calculation showed that if we had some X-run code hardware so that the Nova could write a position and a run--color in a run length on every scan line, scan line is 63 microseconds, so that's not hard, we could go blazingly fast. And for simple things, flat objects, flat color objects, we could go faster than the Alto or anything at the time that was running dynamic RAM. But of course the worst case, you had to wait for the pixel to come all the way around the whole frame time, 16 milliseconds, to get to it, so random access was pretty much out of the question. It had color replace and the X part of area fill in the hardware, as well, though no one ever used it except me in my test programs.

Here's what the data pads look like. The pinkish purple here is the main path where data comes out of the frame buffer and is re-circulated in again continually. And of course it also goes out to the displays. And we could throw these multiplexers at a pixel rate so that "video in" could be digitized at any pixel pattern on the screen, then the Nova run code interface also came into that. So the whole idea was real-time, you've got to play with the re-circulation of the display. It's not like a buffer where you store things and somebody else is displaying from them. This was much more coupled and sort of an interesting architecture from which we learned a lot, although I wouldn't have recommended it in general either then or more so now.

Here's what the menu looked like. A confusing jumble of icons if I ever saw one. But let's look at that. Painting and color functions. Down here we have the paint brushes. They could be multicolor like this one. Sixteen colors in the palette. When you selected one, a little arrow appeared as I've shown here. This box means get a color from the picture, from the canvas, like the eye dropper in today's programs. Push this button for painting. Then up here, we've got the color sliders. How we did the color space, use saturation and brightness conversion here. And that color space transformed when you press the HSB label, it changes to red-green-blue interpretation on the sliders. A pretty straightforward... kind of embarrassingly crude. Here's some file functions. Load from the disc to the picture memory. Load with the colors rather than using the ones that are there already. There's some color map and a color space mapping problems and allocation problems already here. Right to the disc. Right to the disc in a form that could be printed. Gary Starkweather had just built the first laser printers, in particular a color version of the laser printer, because Xerox had manufactured a ton of laser color-- laser color copier engines, but decided that the world didn't want them pretty much, and so they had a warehouse full of these things. It would be easy to get a laser head on a color copier for a while, and we had the luxury of color copies. Various simple imaging functions. Scale up, scale down. There's only 16 colors to work with here, so we're not doing any antialiasing thing of filtering anything, of course. This is a "copy," and this is "move." That is to say copy and erase the original. Animation functions... we've explored color table animation quite a lot, my partner Damon [Rarey] and I in particular. I'll show you some of his stuff in a second. Basically, there were two palettes, a foreground palette and a background palette, or a palette one and palette two. You could switch between them and you could set them independently, and then one at a time, step the colors from one into the other or interpolate between colors. Or you could turn them on in sequence and leave them on. We call that reveal. And then good old fashioned cycling colors, where you're simply moving colors through the palette space. I'll show you some examples. What else? Miscellaneous functions. Texts. There was a simple character generator with a couple of fonts in there.

Video in, you could [bring in] video into an arbitrary area of a picture in real-time, but it was monochrome and input of course. And make a brush out of any shape you would paint it, draw some lines, set the gridding for positioning. Area filling was written by Patrick Baudelaire. And this one was, I think replace color in an area or something like that. And this was erase a rectangular area.

People sometimes say, "Oh, you made the first frame buffer or the first paint program," or something like that. I really didn't do either of those things. And there were a number of important developments prior to SuperPaint that were inspirational and that ought to be recognized and frequently aren't. The Alto came to life about two months, two months or less prior to SuperPaint's displaying its first picture. And it had a bit-mapped display, a single bit per point bit map display as you know. And there was ... shortly after that, lots of graphics programs by various people, including Alan Kay and his group. Even prior to that, there was a character generator paint program at PARC, so this wasn't the first PARC paint program. Frame buffer, there was a frame buffer based on shift registers and soon one on RAMs, based on RAMs, by the Ramtex Corporation already on the market at that point, but it was pretty lame.

The paint program by Nolan Miller at Bell Labs where they used the memory of the DDP-225, is I think about the first paint program that I ever saw or was aware of personally. The Tricolor Cartograph by Kubitz at the University of Illinois was using a disc-based frame memory and drawing things into it quite early. And my real inspiration for being in computer graphics at all is a wonderful guy named Lee Harrison that died recently, who was doing real-time rescan analog animation in the mid-sixties. And did some amazing stuff which was on TV for a while. Let's go look at a couple of pictures while we're at it. Where would I find that? It would be right here. Yeah. Here's the back panel. Got a few problems in the <laughs> system so far. Memory cards to the left and the right with the shift register memory chips, those were printed circuit boards, and then there were three or four multiplexer datapath cards in the center which were wire-wrapped Augat cards. Here's what the rack looked like, one of the two racks. The Nova you can see in the other rack, but this is the rack that had SuperPaint in it. Here's the memory back panel that you just saw. Then the rack about to go in just below that has all the control and the interfaces to the Nova and the D-to-As and inputs and outputs and stuff. And then there was going to be a second rack of memory down here. Big honking fans right here and right here, and a power supply that's, you know, hundreds of amps, that 5 volts down here. This is the A-to-D converter up here, this entire box is an 8-bit A-to-D. Here's the first picture it ever displayed. Well, it was the seventies, okay?

<laughter>

Shoup: <laughs> The sign says, "It works sort of." This was before the Nova interface was even working. This was just real-time video going through the buffer. And I held up this card late at night in front of the camera, and I pulled the clip lead off of the back panel with my knees to get it to capture this frame. And since it had no interface and I didn't want to lose this precious picture <laughs> I had to plug in the Nova interface card, un-debugged, with the power on and debug it and its software and interface the complete interface to the Nova, it included a whole bunch of stuff, without losing this picture. And it

sort of did that. <laughs> You can see lots of bad pixels, and I had to-- I ran a heuristic program on it which figured out what some of the bad ones were. But that was the first-- the first picture. Then I did some antialiasing. What you would call antialiasing today. I called it jaggie removal or something at that time. I didn't really know much about sampling theory or any of that. But I simulated what a TV camera does. That is to say, there's a finite spot or a disc scans across the edge, and then more and more of it is occluded. It's just a simple computation to figure out how much of that it is. And without understanding it deeply, I was able to get pretty good results. You can see all of these folks look more or less the same at arbitrary angles. And this was before anybody started pinching anything on the system. Here's two sets of lines. One of these sets of lines is actually ink on paper viewed by a video camera, and the other set of lines is coming out of the system. And they're put together by video and video. And probably you can tell pretty easily that the bottom set is the set on the paper, because the paper isn't completely flat, so they're kind of bent. But I thought that looked pretty good. And then Bob Flegal did some terrific drawings which we smoothed. And some of you at least can see the jaggies on the left and the smooth lines on the right. So this was '74, '75-ish. Well, late '73, early '74, I think. We had a lot of visitors at PARC, and one day we had a performance artist, an artist, period, coming from Iowa, come and visit us. He gave us a mind blowing multi-screen presentation which featured everything he'd ever done, including sculptures that had nude photos of his wife. It had drawings. It had natural art. It had all kinds of strange things. He took one look at the system and went back to Iowa, packed his bags and came to Palo Alto, took a job with a guard company and got a job being the night guard at PARC.

<laughter>

Shoup: He claims this was all actually accidental that he got this particular job and so on. I don't know. He's got some powers that we don't have, maybe. But anyway, his name is Fritz Fischer. Some of you might know him. And during the night when he was guarding, he would come around to paint once in a while. And we'd come in in the morning and things like this would greet us. The funny part is, this is 256 colors or all 8 bits, and the run-code hardware wasn't working yet, so brushes could be of any height but only one pixel wide. <laughs> So that's a challenge, I guess. Let's see. A terrific artist and designer named Bill Bowman decided he wanted to do an animation of the laser scanner that Gary Starkweather was building. And about that time, we acquired a one-frame-at-a-time recording videodisc, like an instant-replay type disc. Four channels of analog video times 300 frames. And even though the tools were incredibly crude, the paint program was really pretty crude at that time, Bill sat there and painted a number of frames of this SLOT animation which I'll show you. This SLOT animation, Scanned Laser Output Terminal is the acronym, which I'll show you a video in a little while. So that was the first frame by frame animation. Let's see. You've seen a menu. KCET, the PBS station in San Francisco, got interested. Heard that we were doing something exceedingly weird, and some people came down to take a look at it. And among them was a guy named Damon Rarey, who is a terrific graphic artist and animator. And we began to collaborate on this stuff and then Damon produced graphics for this television series called, "Over Easy," with Hugh Downs. It was running, originating at KCET in those days. And we, Damon and I went on to collaborate on lots of other things. In particular, we got asked to come over to Ames [NASA Ames Research Center] over there. Is that the right direction? During Pioneer Venus in 1978. The Pioneer Mission to Venus had no imaging on board. A lot of scientific instruments, but they weren't going

to get any pictures, at least not any real-time or near [real-]time pictures. And so they were desperate for some way to explain this to the public and make it interesting rather than having the scientist stand up and talk about their dry data. So thanks to a terrific PR guy named Waller, we brought the entire SuperPaint system over here and set it up near the press room and near Mission Control for Pioneer Venus. And Damon did a whole bunch of animations and things, which I will show you, for Pioneer Venus. And we fed them live to NASA TV and they were seen pretty much around the world at that time. During the encounter, here's one of those graphics. This is by the way an actual scanned picture of, a video scanned picture of Venus taken by another spacecraft, Mariner spacecraft, which we colored and put into place there. You'll see all of these. One of the probes landed and then quickly stopped transmitting, so Damon and I thought maybe this was what happened to the—

Shoup: Let's see. Why don't we go to some tape for a moment. If I can push the proper buttons here. I actually don't know how I did this one, but it was all done in the system. It's a slightly different menu than what I showed a minute ago, a little earlier. Choose a color, choose a brush and go over to the canvas and draw. There were several modes that you'll see illustrated here, including the two-monitor mode and the one-monitor mode where things were overlaid or switched on to a single monitor which I could easily do because of the extra output. Okay, we don't need to see a great deal of the tale about this. It draws a tree. It draws some stuff. It makes a brush and draws all over the place with it. A demonstration of color changing. I think it was just red, green, blue axes at this point, before Alvy did the transform. And I think we're going to do a little animation here. One nice thing is that you could set the speed and then you could continue to paint while it was cycling. Forward and backwards. It goes slow. It interpolates. That's the magic carpet effect there. Okay. Let's go ahead. There's a video in. Capture that little hand. The ever popular bouncing ball demo. All the balls are in the picture, of course. Only one of them is turned to the foreground color or the pink color. The rest are white or background. So you can't see them. Of course, you could have two of them or any number of them if you like. It's amazing how much you can get visually out of ten animating colors and six fixed colors. Okay, let's skip over this. A bit more animation. And here's the SLOT animation. A frame at a time onto videodisc. Here come the bits flying in there from the upper right and appearing on the drum. Various artists worked on the system at this point, including Alvy.

[Sound of Holst's The Planets, video is of "Vidbits" See:
<https://www.youtube.com/watch?v=47GSOspoTGo>]

Shoup: That was Alvy's.

Shoup: Here's Pioneer Venus Mission Control. [Audio from Mission Control and flyby animation video clip.] They're waiting for orbit instructions. And here's our animation, done by Damon. A lot of these we prepared in advance, but then there were various things that happened during the mission, during the encounter. And Damon was able to create graphics from the elements he already had or draw something or changing animation to reflect what the scientists were actually learning, getting back from the probes.

And that turned out to be really useful. In fact, we were invited back the following year, a year later, for Pioneer Saturn in '79.

So we had a great deal of fun with that and Damon and I went off to start a company called Aurora Systems to do this commercially. And we built some interesting systems and eventually had painting and animation systems installed at dozens and dozens of places around the world. TV stations and post-production houses and video producers, industrial video producers. For a while there, every-- all the graphics that you saw on CNN and Turner and TBS Headline News, over the shoulder graphics, were coming from Aurora Paint Systems that were essentially descendants of this. Aurora wasn't a success ultimately as a business, but we had a lot of fun and did some interesting things. So backing up to the Xerox PARC story, at one point I had a visitor who I had met through our interest in-- mutual interest in cellular automata and mathematics. He was teaching at NYU at the time and had a very strong interest in art and in science and mathematics as well. And Alvy will tell you his story, but he became a very important part of the story of SuperPaint and of my life from then on, in fact. And it was a distinct pleasure to win a couple of awards with him. And Alvy's going to tell you his part of the story.

<applause>

Shoup: Let me get your--

Smith: Gordon and I were trying to think what the parallel architectures did accomplish for me other than Stanford. And we came up with two things. One was I got a cover on "Scientific American" that I'm still proud of. And second, it got me to Dick Shoup. He just sort of mentioned it that we met because of a mutual interest in parallel architectures. Mine was mathematical. It was also cellular automata theory. And I put together a conference at the National Computer Convention in Boston one year on that subject, and I looked around for somebody interesting to be on the panel who actually built hardware. And I was pointed by several different pointers to this freshly-minted PhD student, Dick Shoup at Stanford. We met and we hit it off on all kinds of levels. Technical, but mostly as friends. We've been solid friends ever since. Shortly after meeting, he takes off to join this outfit called PARC and he starts building this machine. It has something to do with art and I couldn't figure out what he was talking about. You know, I was interested because I paint pictures. I always have. But I honestly couldn't figure out what he was talking about. Now you have to remember, back in those days, there weren't any personal computers yet. The notion that you could move a mouse or stylus down here while looking up here and not get confused, people found hard to believe. And I used to spend 15 minutes of every talk telling people that was really not a problem. That it was a very natural thing to do, in fact your hand wasn't in the way. Okay. <laughs> So I was being a professor at NYU. Dick was building this whatever it was out in California. And then I broke my leg skiing. And I was in this full body cast for three months. And if I suppose, completely helpless, but it turned out to be one of the best times in my life. I could do nothing but think. And I'm still astonished at how much of our brain is taken up with just moving the body around.

<laughter>

Smith: You turn that off, that need off, and it's just a vast cavern of thought space opens up. And I had a wonderful time in there for three months.

<laughter>

Smith: <laughs> I thought about everything. I decided I'd done professoring. I'd done it. I didn't even like cellular automata theory anymore.

<laughter>

Smith: <laughs> And I wasn't doing anything about my art. So I resolved, while I was lying in bed, to drop out of academia and go to California where I knew something good would happen. <laughs> And today I'm astonished, you know, now that I'm raising teenage boys, at how impulsive I was.

<laughter>

Smith: That I just knew something good was going to happen. A little more context, is this is the Vietnam War time, and I felt like I was training people for the war and I didn't like that association. And I wasn't using my art. So I get out to California, and basically I'm a hippie in Berkeley during this time. And I'm bumming off-- rooms off friends. And I run out of money finally, and I get a job offer to write a survey of cellular automata theory as the introduction to the German edition of John Von Neumann's "Self Reproducing Machines" book. So I went, "Great." It had money attached to it. So I was like-- <laughs> "I'll write down my swan song of cellular automata theory. Everything I know. Get that off my, you know, that will be the end of that era." I did that. I could write it all. I was very fluent in the subject. I just wrote it off the top of my head, but I didn't have the definite references. I needed to go to the Stanford Library, the Computer Science Library, with which I was very familiar. I knew it had every reference I needed. So I called my buddy Dick up, over on the other side of the Bay, and said, "Can I bum a room off of you tonight so I can check out the library?" "Sure." So we do this. I go over. I do the library. We have a great time seeing each other. The next morning, he says, "Well, come over and see what I'm doing." And I felt obligated.

<laughter>

Smith: <laughs> He had put me up for the night. And I said, "Well, I can only stay for a little short time. I've got a lot of stuff happening back in Berkeley," you know. I can't imagine what, but. <laughs> Well, of

course, what I saw blew my mind, as we said in those days. It was a machine for making art. It was exactly-- there couldn't have been anything more perfect for me, art and computers together. And I knew that's what I had to do with my life. That was the thing I'd known was going to happen in California if I was to leave the professorhood and go out there. So the next trip was to get hired at Xerox PARC. <laughs> Now I was a full, you know, hippie in full regalia in those years. Didn't really care about working for a large corporation, which may amuse you if you know my most recent employer.

<laughter>

Smith: <laughs> But I wanted access to that machine. I wanted to make art on that machine. I didn't care whether I had a job. I didn't care about the salary, any of that, the title. I just wanted to have access to that machine to make art on it. Dick wanted somebody to make art on it to show it off to the world. So he and Alan Kay and Bob Fligel and some other friends, I think Dave Liddle was in on that too, put together this scheme to get me inside. There were no slots to hire me with. So they hired me with a purchase order.

<laughter>

Smith: <laughs> Which I still have. <laughs> Basically as a purchase order to come in and make art on this machine. So that's how I got in there. And I worked very hard. Made a piece called "Vid Bits." You saw little bits of it, and I'm embarrassed by it now so I asked Dick not to show very much of it, which I later used to get me started in the art scene in New York City. So it turned out to be a pretty interesting piece of video, even though I'm not sure if the people at Xerox PARC really appreciated it. I just want to say something. I think Dick is a little too modest when he says, you know, it wasn't the first paint program, there were other frame buffers before his and so forth. Yes, there were. But SuperPaint was the first really serious artistic paint program with all the goodies. Color maps and palettes and image transformations and image save and restore, and video in and out, and brush changing. You know, it was a full-blown thing. Yeah. Crude, perhaps, but it had all the basics that are in still in every modern paint program. And that's what he did first. Eventually, Xerox PARC made the decision not to do color. Which of course at the time I thought was an absolutely foolish thing of them to say, much less execute against. Because I used to argue that color was the future, and it was obvious and they were in there first. But long story short, they pulled the rug out from under me and cancelled my PO.

<laughter>

Smith: <laughs> Which I also have. In fact, I have a copy of it right down there. But before that happened, I met some interesting people other, in addition to the very interesting people at Xerox PARC. A very, very important person in that frame of time was David De Francesco who was a video artist in San

Francisco who saw the demo of SuperPaint and flipped out and had to be-- had to have access to that machine. Jim, did you know Dick Shoup before he showed up?

Jim Bland: <inaudible>

Smith: And David, oh. David De Francesco? Yeah, yeah. Okay. All right. By the way, Jim taught me my video. A very important contribution. David just hounded me for days and days and days and was so persistent that finally I said, "Okay. Come over and we'll spend the night jamming on SuperPaint." It turns out he and I hit it off fabulously. Because he loves technology and art. Okay. And in those days this stuff was so tedious that you had to know where the technology was going to go or it would drive you insane. And he could see the future, and so he just put up with the all that hard stuff, distractions, videotape machines that didn't do what you want. Think about that.

So he and I hit it off and we decided to apply for an NEA, a National Endowment for the Arts grant to exploit this new medium, this new artistic medium. And we knew it was a new medium, no question about it. David needed a job. He never got hired at Xerox PARC. He was just coming in at night and playing with me. And he said-- I said, "Oh. I don't want to write a proposal." See, my experience of writing proposals was with the National Science Foundation where the proposal would be 40 pages thick, half of it financials, and you would submit in 20-plicate. No joke. He says, "Oh, no, no, no. NEA, you submit one page and your work." So that's what we did. And we cast our lots together there. Why? Because we needed this new medium, frame buffer, to execute our art. So that's when Xerox came in and says, "No. You're out of here." Well, David and I said, "Well, what are we going to do? We have to go to find the next frame buffer." And the next one was being built in Utah by Evans and Sutherland. So we went there, and I'm going to skip through this part pretty fast, and basically they were Defense Department-funded at University of Utah and they didn't-- we couldn't use the "A" word, "Art," around them. In fact, they did lose their funding for artistic things, as I recall. But we picked up one very interesting piece of information, and that was that this, and this is the word, this madman, Alex Schure from New York Institute of Technology, came through here and bought everything in sight, one of every piece of equipment. Now, he has 100 animators from Hollywood out there on this estate in Long Island, and he's going to make an animated movie. "You should check him out." <laughs> "Okay, sure."

Martin Newell, whom some of you may know because of his teapot which is in the Computer [History] Museum around here, was at University of Utah, and he said, "Look, I'm going to go out to New York Tech next week and I'll call you when I get back and tell you what the scene there is." Well, what he said was when he made the phone call to us was, "If I were you, I'd get on the next plane." So that's what I did. I spent my last money in the world and got on the plane-- David and I got on the plane, actually, and we stayed with his father in New Jersey-- to visit this "Uncle Alex." And the reason I call him Uncle Alex is because one of the biggest coincidences of my life that I still don't understand is this. While working with Dick on SuperPaint, I was living out in Los Altos Hills at a house with Richard and Sandra, his roommate. I came back from my first visit to New York Tech. I was all excited. I'd just seen the future. It was exciting.

I could talk art. This guy was-- he was going to make movies. This was it. And, oh, wait a minute. Some of it's in the wrong order. First, Richard had gone to New York for a family holiday and he had come back telling me about this uncle of his doing what I do. He said, "He's doing the things that you're doing, Alvy." What's he know? He's an economist. He doesn't know what he's talking about. Because I thought we probably knew everything in the world-- everybody in the world who was doing computer graphics, you probably would have heard about, just through the grapevine. I hadn't heard of this guy. So I make the trip out to New York Tech. I meet this guy, this Uncle Alex. This guy was Alex Schure. I come back and I'm telling my roommates all about this wonderful guy and Richard, that's when he says, "Alvy, I've been trying to tell you, that's my uncle."

<laughter>

Smith: <laughs> Which has still got to be one of the most bizarre things of all. So we called him "Uncle Alex," not to his face. We called him "Alex" to his face, but "Uncle Alex" amongst ourselves for the whole time we were at New York Tech which was about five or six years. I did go out there. It was as advertised. Alex Schure was a creative madman. He didn't quite know what he had. I called him an accidental visionary. He knew that this was going to be the future. He just had his timing off quite a bit. He also--

[recording ends abruptly]

Smith: One of the things that he bought us was a frame buffer. He bought us the first commercial eight-bit frame buffer from Evans & Sutherland. So the first thing I did, having been trained by Dick Shoup, was sit down and write a paint program for it. So that's sort of the one sign of SuperPaint that was, that figures in the story. And then a few weeks, a few months later he came around and he said, "Well, what do we need to do to stay ahead?" And I said, "Well, if you've got two more of these eight-bit frame buffers we can gang them together and make a 24-bit frame buffer, one for red, one for green, and one for blue". And that took a lot of talking to. You don't know what this guy-- he doesn't talk rational like most of you and I do. He was a non-linear thinker and a very bizarre way, isn't quite well to describe so I won't do it tonight, but I eventually got the idea across to him that [with] 24-bits you could do all this, you could mix colors instead of having a select set of colors. That's 16 million colors, which is simply a continuum to human beings, and it can do all sorts of marvelous things. He goes away. We think he's got it, but we don't know. Two weeks later he shows up and says, "Well, I got you five more of those frame buffers". So you could have two RGBs [Red, Green, Blue frame buffers]. Now, what that meant was, financially what that meant was this: the first frame buffer he bought from Evans & Sutherland was \$80,000. Eight-bit frame buffer, video resolution. The next five we got a deal on, \$60K each.. So \$200,000 1975 dollars, for one RGB frame buffer, which is \$1 million in today's money, easy. So he, what he said was I've just spent \$2 million to give you this thing that I barely understand to do what you said you could do with it. These kinds of guys don't come along too often. Well, what we do is we just blew out the, blew out the envelope. We knew we were the-- it's like what I imagined what an explorer landing on a newly discovered land feels like. Gets to name everything. First guy there. We felt like that. We knew we were there first and that

everything we touched, every moment of the day, was the first of something that was going to last a long time.

An extremely, extremely exciting time. In fact, we did not sleep until we had to. There were maybe ten, 15 [or] 20 of us. People kept adding on, David De Francesco is certainly one of them. You would start the cycle. You know, you'd work until you drop, sleep a minimum amount of time, get up and work until you drop, and get into a kind of a natural... whatever your natural body cycle is... and mine turned out to be 26 hours, so you slide in respect to the normal world in a kind of an interesting way. But basically we just wrote everything we could. And one of the things I wrote was Paint 3, the 24-bit, first 24-bit paint program that I'm going to show you in a few minutes here. It was really easy to write, which David Barkan, here from the team of legal people who helped build a major lawsuit against [these] patent suits... against Quantel, who insisted that they had invented this notion of airbrushing, soft brushes and so forth in the 1980s whereas, we knew that well we have done it in the '70s and how was that? It was easy. So easy it never occurred to us that it was worth a patent. Turned out to be remarkably hard to prove without any evidence. And, of course, during this highly creative time in the '70s, we weren't writing anything down. We were just going with everything, we were programming so fast you couldn't believe it and making art. And every so often I would, you know, get called for this, the annual meeting of SIGGRAPH, I'm sure everybody here knows about. Write something down to show somebody at SIGGRAPH. I wrote some, one paper in 1978 called "Paint" where I just quickly described how the eight-bit program worked, and then I added an appendix on the end about how Paint 3 worked. Just sort of a list. But it was actual textual evidence that we had done this. And it was sort of the only thing in existence during these patent suits decades later. In fact, I was helping-- I tried to help one small company in England win a similar patent suit against Quantel and we lost. The English court basically, the Yanks standing up and saying we did it first and the English Quantel company saying no, no you didn't. And we had no proof, except our word, which we couldn't believe they wouldn't take, and we got, we lost. And I basically felt like I'd been called a liar, and I knew I wasn't a liar, I knew we really had done it first. So when Adobe came along 'in 94 possibly, and asked me to help them in the US version of that patent suit. I said "Well, sure, I'd be happy to help but I want to win. This has got to be taken off the backs of the computer graphics community. I don't want you to settle out of court, for example. I want this thing to go all the way, and you got to get some evidence. What evidence could there be?"

Well, the program itself would be the best evidence. Much to my amazement, I don't know, David, who's responsible, but somebody actually found the code at New York Tech and it was all written in C, universal language. And a third-party, couldn't be me, of course, a third-party implemented my C code on Windows. And I showed this paint program in court. Slam dunk win. So let me show you what I showed the court. Okay. First let me tell you what this really looked like. We had a color mon-- at New York Tech we had a color monitor to show the picture, the painting. And we had a, they were a variety of different realizations of this idea. But we, at first we had an Evans and Sutherland Picture System 2, black and black calligraphic displays that we used for a menu monitor. Real overkill for a menu monitor, but it was there, so I used it. So this menu you see here would have been on a menu monitor. And that left-hand black area would've been on the, you know, on a center video, RGB video monitor, studio monitor.

Really, Paint 3 was easy to write because I just took everything in Paint, a good version and just tripled the code. Did the same thing in the red channel, the green channel, and the blue channel. It might've taken me a week just to, if it took that long. I went through the menu for paint and stuck a "3" in there and that's my funny name for it there. But with that addition of those two channels a whole world opened up that has made computer graphics real. But under Windows well, no, the only thing that's been rewritten here was the display. And all the software, you know, I actually looked at the software and verified it was my code, it was exactly, [it] had my comments in it. There's even a secret button in here. I think this is one of the winning arguments. And said there's a secret button in here I don't think the guy who wrote the code, you know, compiled the code for Windows even knows it's here, and we showed the secret button. I don't remember where it is now. <laughs> it's up here somewhere. Okay. You know, what's selected here already?

Shoup: Yeah.

Smith: Okay. I'll pick a brush. And one of the concepts in this paint program was that any picture could be a brush. Any shape can be a brush. And I had a whole [bunch] of them pre-saved and a brush directory. Let's pick out these here. And let me just be sure of the color map here. Okay. Now the one paint type of painting I want to spend time on tonight is "wet 3 paint." This is what I call-- this is what I should've called air brushing. I call it wet paint for reasons that don't need to concern us now and that was actually a major legal battle over those words. But wet paint is what we would now call air brushing. Let me show you how it works. Press on the menu button, palette pops up. Now I move over to that screen. I was actually changing screens and moving the mouse across the tablet. Select a color, palette disappears and you <inaudible>. Well, let me just tap once and you'll see that that brush is taking the center and increasingly transparent as you get towards the edge. Another thing that Quantel couldn't do was that I could draw stroke. We not, no, you can't-- you did this to make a stroke. No, that'd be stupid, but no. We had to actually draw, you know, a stroke on a screen and show that it really worked. Use another color. Sorry. Some of the words I recall that I used in the trial when I was a witness was that when we showed this, we demoed this to thou-- hundreds if not thousands of people at New York Tech. There's no big secret that we'd done this. So, you know, one of the comments was that it felt like painting with ice cream. And let me see if I can actually make that happen. Let's see, magnify or... let's choose it. Oh, I choose the paint from anywhere on the screen. That's another part of our legal argument. Okay. Now just set a video magnification by four you'll see as I paint around the color just kind of "swuge" in.

That's the part where it felt like painting with ice cream, I think we actually of people. Do we have-- David, do we have people stand up in court say they remember saying that? Well, anyhow he had a picture from that era. This was when I discovered the-- oh, the proportions are wrong, by the way, 'cause this was the original pixels were written into a video monitor which has non-square pixels and, of course, this Windows monitor has square pixels, so the proportions are a little squeezed but, you know, just sort of in your mind stretch it out. This is about the time I discovered what became, still my passion, and that's compositing, making parts from compositing other pieces together. Which I think was another thing Quantel claimed to have invented was visual compositing. No. No. And I think we used this picture as an example of how we

did visual compositing as an art form in the '70s. Didn't think twice about it. Here, for example, Jim Blinn had made the sphere program and I glued some of his spheres together to make this flying saucer with a 3D rendering program. And Paul Zander was our background artist, the Hollywood-trained background artist for the animation studio there. He painted the back, the clouds and I think he came in and painted the grass later as a separate element. And my buddy David had taken a photograph of Stonehenge and he digitized that photograph and [did some] color map shenanigans to make it look like a brass or chrome, "Chromehenge," I think he called it. <laughs> And I had come up with this French, I call it a French curve, this mathematical function that divides the screen up symmetrically and so forth. And there's a lot of components in here, but it was all put together to make this piece I call "time.warp," which back-and-forth everybody puts <inaudible>. You know, we were using the Internet a long time ago. And also UNIX and the C-language kind of inspired the notion to put dots in names, so we've used dots in the names for a long time. I used that kind of have to explain no, the dot is supposed to be there. <laughs> And then there's another picture you might enjoy. I think it's no, there. Again, in your mind take the "squeeze" out. That's a picture of Alex Schure, the crazy madman patron of New York Tech. That source of pride, find the picture here in this program when he showed up. So anyhow, that was the program that, that demonstration that you've seen right there was the one that this-- won this court case slam dunked five, the thing was five patents got thrown ... The patents were found invalid, it was that strong a case. And in fact, the jury wanted Quantel to be found guilty of defrauding the Patent Office.

And I think the judge threw that part out, but clearly the jury got it. And this was a jury that was high school trained at best, so there could be no technical talk. You basically had to say this is what we did, you know. About halfway through my testimony I said "If it's up to me I know we're going to win 'cause all the jury is smiling at me". <laughs> I went off to, I went off to Italy. I remember somehow we had to move schedules around 'cause I had an Italian holiday scheduled and I wanted to do this testimony and so I gave it and then we jumped on a plane and went to Italy. So I didn't know how the trial came out. Ed Catmull, my colleague of many years, chased me down some little village in Tuscany with the word, you know, I've already given it to you that the jury had come back in with this tremendous win, made my, it was a great vacation already, but that really put the icing on the cake. So that's I'm basically going to stop my history there tonight. I'm not going to go for hours. So I'd just like to add that, you know, my take on things is that here's the father of the paint program, wrote the first serious eight-bit paint program. I wrote the first 24-bit program. I went to Lucasfilm, started up a Lucasfilm computer graphics division in 1980, and one of first things [I said] was well, we need to have a paint program here. I hired Tom Porter, whom I knew. New York Tech had sold the eight-bit version of this program to Ampex. And, in fact, that was in '76 and, in fact, I came out and spent a month in December '76 getting this eight-bit version of the program working at Ampex. Okay. And by the way, I was in this horrible motel in there and just sitting there bored out of my mind. I finally said, "When I get back to New York I'm going to write the 24-bit version of that program." So I did it. I even found some notes since then that say that, but I didn't have it at trial. Tom Potter worked at Ampex on the son-- it called Ava a son of Paint, which is son of SuperPaint. And so I knew Tom knew my style and so I hired him, one of my first hires at Lucasfilm. He wrote the first 32-bit program, includes an alpha channel and everything. And that's why the three of us shared the Academy Award, for being original contributors to painting systems. Okay. I'd be happy to take questions.

<applause>

Smith: Yeah.

Q: _____?

Smith: Well, the computer graphics at NYIT petered out after several years. Well, part of it is 'cause a whole bunch of us left and came to Lucasfilm. You know, Ed [Catmull] and I came first and then we slowly started pulling in some of our favorite people, you know, but over time. It was a contingent there for a quite a while. Pat Hanrahan and I did an overlap, for example. He was at New York Tech. And so it continued to be a lab for, I don't know, 10 more years? But I believe it's kaput now. Alex Schure got booted out of the presidency by his son. But he showed up at the 25th SIGGRAPH [conference] for what was called the Digital Fireside Chat, something like that, Digital Campfire, where that was devoted to New York Techies, and they all sat around this digital campfire. And there was Uncle Alex himself and a lot of us hadn't seen him in decades probably on the stage just as whacky as ever. I don't know where these words are going to go, you know. It's true. I mean the guy, he was a very strange man. I mean I think he actually thought that if you poured money into these machines that... if you poured programming into these machines, dollars would just pour out of the other side. You could just sort of skip the move in the middle. And maybe that'll become true, but he was way ahead of his time. And he, you know, we have to give him lots of credit no matter how zany he was 'cause he, he did it. He let us build the first world-class computer graphics laboratory in the world. It was a Mecca. Everybody in the world who knew anything about computer graphics found their way to that lab. And that's why it was so funny when Quantel tried to stand up in court and say, "Oh, it was a secretive place. They wouldn't let anybody in." Are you kidding? <laughs> We wanted to show everybody what we were doing. It was so exciting. As far as I know Alex Schure is still alive and well and there's no computer graphics research at New York Institute of Technology. New York Institute of Technology by the way, was kind of a 12th-rate institute of learning with this first-rate computer graphics laboratory. And the best example I have of its quality was [that] its bookstore sold auto parts.

<laughter>

Smith: Tires, batteries were in the window display. I'm not kidding. Because kids who couldn't get into, you know, regular colleges on Long Island, would live with mom and dad and drive in. And so cars were a very important thing. Now that may have changed a lot since then, but that's what it was like when I was there. Question for Dick as well.

Q: Do you have any idea _____ icon-based menu _____ jumped out of your head as well _____.

Shoup: Icon-based menu? I don't know. It just seemed natural. Seemed like a good idea at the time.

Q: Obvious.

Shoup: It was obvious. I don't know. I'm sure we weren't the first ones to think about it either. They're a lot of things like that that just seemed natural. And not just to me or just to us. I mean there were a lot of things that were obvious to do at this point. And as I said, it was a confluence of events. There were a lot of ripe fruits, low-hanging fruit on the tree made possible by the progress of integrated circuits among other things by the presence of a place like Xerox PARC and New York Tech and so on, which we benefited from. And I don't think any of these things that were done in that period were profound or even very hard. They were in many cases just the obvious things to do next. And someone was willing to support people who wanted to do those things that they saw was the next obvious thing that we were, you know, we benefited from that. But someone else would've done it next within two weeks probably if we hadn't. So I don't know about the icons, it just seemed like a natural thing to do. I was getting awful tired of typing commands by that time, as we all were for many years thereafter as well.

Smith: And then PARC was kind of... [the] whole push at Xerox PARC with the graphic interface...

Shoup: Right. You know well, that was one of the big things [at] PARC... was a graphical display, a two-dimensional display, and interaction through pictures and gestures and so on. Damon. Damon Rarey.

Q: <inaudible>.

Shoup: There were a bunch of these things. It's an obvious idea in general, the paint system. There was - there were a number of them that made their way into the video biz because it was clear that the high-end of the graphics world was in television graphics and people were willing to pay for such things, so Ampex had the first commercial paint system called Ava that Alvy mentioned. [It] was basically his code. And then there are others that followed. Quantel had been working on this kind of thing, [on] image manipulating frame buffers around the same time and they made a very successful paint system. But there were lots of others Dubner is one of them and New York Tech had a little company, which made, or a spinoff, which made paint systems for graphics, graphic arts as well.

Smith: Let me just say [about] Quantel... That system they built was beautiful. And what made it so beautiful was it was done in hardware back in the days when software just couldn't go, couldn't do what they did. They put it into hardware and it was a beautiful implementation, which is one of the points I made in the court cases. And this is not against [Quantel], they deserve full credit for that. It's just that the notion of soft edge brushes isn't there. That's all. They did a great job, though, and they deserve all they got for that. They made a lot of money off of that, for one thing. _____ at least.

Q: <inaudible>?

Shoup: <laughs> I'm working at Interval Research, a think tank founded by Paul Allen and David Liddle. And so I've been working on reconfigurable computing, something like my PhD thesis was about cellular automata. Once in a while people give us credit for thinking far ahead in the future, but hardly anybody asks "What are you thinking about now?" You know?

<Laughter>

Smith: So that's one of the things, reconfigurable computing.

My latest thing is I just got a Nikon B1, if you know what that is. It's Nikon's first serious professional level digital camera and I'm totally in love with it and I can't stop taking pictures. I think my natural... loving photography as I do and being the digital whiz as I am, it seems like a natural place to go is to make art in that world. And I think I have some new ideas to bring to it. Just try one out on you: it's that with digital photography there's no longer any need for a rectangle. And I think just that one idea might keep me busy for the rest of my life. By the way, I retired from Microsoft three months ago. I'm not working there anymore. <applause>

Smith: I think it's a great company, even though it's politically incorrect to say so, I guess.

Q: <inaudible>.

Smith: Yeah. I thought a lot about digital television. In fact, one of the things I did at during my five years at Microsoft was go to Washington and try to fight for some sane digital television standards. One thing that's insane is interlace. And they're still try to foist interlace on us. It's just unbelievable that we finally got a chance to get rid of that nightmare and well, the one thing I've learned is that it's frightening to see how Washington makes technical decisions.

<Laughter>

Smith: It's made with economics and politics in mind rather than good science. It's really scary. I mean every scientist stands up and says this is nuts to have interlace, but we were losing.

Q: <inaudible>.

Smith: I'm not the least bit surprised. I mean to me the expense is the interlace, you know, it's they keep building this-- they keep trying to foist this extremely expensive old technology on the American public whereas, I look, most probably everybody in this room probably looks at a piece of non-interlaced digital

video every day, it's called a computer monitor. It's well understood, it can be made cheaply, especially in mass quantities. But there's this, you know, people, economic interests, that I won't name that I pretty sure that I know, that want to see this old interlace idea shoved down the consumer's throat. My fear is that it's just going to wipe out digital television before it gets started because people just won't pay ten grand for a box, or six grand. I, you know, to me it's a fat pipe in everybody's house, a digital pipe in everybody's house that's 20 megabits. Wow.

Shoup: Broadband. Think about broadband. Anything else? I think we better let you go see the collection.

Q: <inaudible>.

Smith: Well, I mean you're right. They-- you couldn't patent software. Although, there were ways around that if you really, really wanted to patent software back in the '70s... there were people who... and I forgot the tricks they used. But there were ways to do it. But generally you thought if it's software I can't patent it, so you just didn't think about it. The reason we didn't think about it was because we thought the ideas were simple and didn't deserve patents. We still think that. Should people patent now? As a person who started a company on intellectual property, you know, I can certainly see the point of a little protection so you can get out there and exploit it for a while.

Shoup: That's an invitation to a long discussion we better not start, I think.

<applause>

Shoup: So thank you very much. Thanks to the Computer Museum.

Karen Mathews: These stories and insights are priceless. Thank you very much. It was a great privilege to have you come and share them with us tonight. Appreciate it. Now I would like to tell you how to find SuperPaint. Once you walk out the front, you turn right and it's about one city block walking up the street. And you'll see our warehouse. And you will also have a chance to talk not only with Dick and Alvy some more, but there are three members of the [IBM] 1620 Restoration Project here, Joe Fredrick, and Dave—

[recording ends abruptly]

END OF INTERVIEW