# Computer History Museum

# Oral History of Edwin Catmull
# 2013 Computer History Museum Fellow

Interviewed by:
John Hollar

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**John Hollar:** We're with Ed Catmull at Pixar today. Let's start at the very beginning. Ed, you were born in West Virginia. Talk a little bit about your very earliest memories growing up and then the move to Utah.

**Edwin "Ed" Catmull:** My father was a Marine. He met my mother in San Francisco. And they later got married and then he went off to fight in Iwo Jima and I was born in West Virginia. But, my mother--- when my father returned, and my mother and my father came to Utah when I was 2 years old. So, my earliest memories are behind a child's gate porch in Salt Lake City. I grew up in Salt Lake and spent the first 19 years of my life in Salt Lake City.

**Hollar:** How was it as a place to grow up?

**Catmull:** Well, Salt Lake at this time was post war. So, while I was just a little kid the mood that I remember at the time was one of general optimism and of safety. I was aware that my parents had been through the Depression and a war but as a young child, whatever that was, it seemed like it was forever ago. The fact that it was only five years ago, right, is now something that's rather astonishing. But, people didn't really talk about it because it was over with, they saved the world. Nothing bad happened. I mean, they saved the world. So, they got their things together. Now they were building. So, it felt like a safe, optimistic environment. Television was coming out, there was the Bell Labs supporting various science programs. There was Einstein--- was this very public icon. Walt Disney was coming onto television -- another public icon. So, for me these were the two big icons of my childhood.

**Hollar:** Einstein and Walt Disney?

**Catmull:** Walt Disney.

**Hollar:** Let's talk about Einstein for a minute. What was it about Einstein that captured your attention to the point that you now would say Einstein and Walt Disney were these two great figures in your life?

**Catmull:** Well, growing up as a little kid not knowing, of course, what it meant, but there was something about this way of thinking about the universe and the world which was relativity and there was something almost magical. You can figure out the universe and he did it with a lot of thought exercise. He was very good at that. And that you could think about things in different ways. But there was still more to be done. And there something even as a little kid that seemed intriguing about that – that you could go off and do that. You could use your head to do it.

**Hollar:** Was there someone in school there in Salt Lake City that influenced you to think this way?

**Catmull:** No, I wouldn't say so actually. Certainly not up through, not even through high school. I find it interesting, a high school teacher, physics teacher that is--- he was very exciting, he was fun to listen to, but he was a little nuts. So, he built a tower outside the physics room lab to put a telescope on and so the tower was 6 feet tall. So, I'm thinking as a high school student "He just got 6 feet closer to the stars." This didn't make any sense. So, I wouldn't actually say that I got it from there. I got it from the general popular image and, of course, I read about it and tried to understand it.

**Hollar:** Was there a moment on the scientific side with Einstein and that thinking about being closer to the stars, was there a moment when you thought "Science is cool for me. Science or something technical is something I might want to pursue?"

**Catmull:** Well, it was crossing my mind. At the time, I wanted to be an animator and an artist. But, I took chemistry and physics and math and I did fairly well on those. Although, because of my schedule I had to learn algebra on my own through the university home study program. So, I took advanced algebra there. The thing that's odd about advanced algebra was that my father was the one that corrected papers for the university algebra program. So, I filled out the homework exercises, sent them into the university, they send them to my house, my father corrected them, back to them, and they sent them to me. I never actually talked to my father the whole time.

**Hollar:** That's amazing.

**Catmull:** I just got corrected papers back from him.

**Hollar:** What a great story. Was he a teacher?

**Catmull:** He was a high school math teacher at the time I was growing up. He later became a principal in Salt Lake and got his Doctor's degree in education.

**Hollar:** And your mother?

**Catmull:** My mother worked as an assistant in elementary schools. So, both of them were in education. And most of my family ended up going into education. I was the black sheep.

**Hollar:** Let's talk bout the animation side. You were growing up, born in 1945, growing up in that period where visual media, as you mentioned a minute ago, was really becoming something every house could experience. Was that influential for you in your thoughts about becoming an animator?

**Catmull:** Yes. When I saw the movies--- and that's how we saw them, of course, was only in the theaters--- I was particularly taken with "Pinocchio" and with "Peter Pan." And "Peter Pan" was very magical. It was really pretty astonishing because there was that whole world in my head. And there's an interesting thing I found which was that I had this world in my head from seeing these movies and then I didn't see the movies [again] for a long time until I was an adult. And when I went back and watched the movies as an adult what I found was that the things I remembered from the movie weren't there. That my head had actually filled in this whole world. And it was really fascinating to me to realize that certain kinds of movies can actually evoke something which goes above and beyond the movie itself.

**Hollar:** And did that translate in your mind to wanting to animate, to draw, to actually be an animator?

**Catmull:** Yes, and I guess starting--- I forget what year it started, but there was "Walt Disney's Wonderful World of Disney." Disneyland, of course, itself opened in 1954, I think. And so, I watched these programs--- everything I could, and I looked at all the animation I could--- and it was clear to me that I wanted to be an animator. I took a lot of drawing classes. All the art classes at school, everything they had. And was even selected as the state's representative to get the art scholarship and so forth. So, my path was trying to become an animator.

The problem is:  When I graduated from high school I didn't know where to go. There were no schools for animation. Disney basically, which I learned later, had gotten artists together pre the Depression and this group had grown up together wherever artists came from, but there was no other formal program. And my skill level was not anywhere near what it needed to be to be an animator. And I could recognize that and I had no way of bridging the gap. So, when I entered college at that time I switched over and decided to go into physics instead.

**Hollar:** Was that a hard decision?

**Catmull:** No. I would say growing up I don't remember my parents ever saying that we should go to college. But it was clear to me that it was absolutely the expectation,  Even now I think about it, and I never remember my parents saying "Go to college." But there was no question in any of our minds we had to go to college. And I would say that I probably couldn't have gotten into Stanford or places like that, given where we came from and so forth, but the place to go to was the school I was next to. That was the University of Utah. So, it was the only place I applied. And I got in and just decided to go into physics at the time. But, it wasn't hard because physics itself seemed really interesting. And for me, coming out of high school, the question is:  How do I get to the frontier? How do I get to the new stuff? Not even knowing what it meant to be on the frontier. Just--- wherever the frontier is, that's where I want to be.

**Hollar:** So, from the very beginning it was the frontier that you wanted to live in?

**Catmull:** That's right. Wanted to be where the new stuff happens.

**Hollar:** And at that moment, when you were looking for the frontier, how did you define what that was and the direction you'd take to get there?

**Catmull:** Well it was -- for me the frontier meant a place of new understanding. So, by definition, you were off doing something that hasn't been done before. So I never thought of the frontier as a concrete place. I understood early on it actually means you're being at a place where you don't know what's going to happen. And the question is how do you get there, so that you've got the skills to be able to operate at that frontier? And in physics the number of skills you had to acquire were formidable, both in terms of physical understanding and also mathematical intuition and expertise.

**Hollar:** Did you find a group there that you could relate to that thought in these same large terms? Let's talk about the undergraduate part first.

**Catmull:** Yes. So, I went through the program there. One of the more momentous things actually was a summer program where--- again, because of my schedule, I wanted to take a lot of things. I took the entire first year of physics in an intense summer program. And there was actually nice bonding with the people in that program. And I found there were certain elements of it where I excelled. Cause there were a lot of questions where it turns out with the right concepts, there were really easy answers. And I got those quickly. Developing the mathematical expertise took longer for me. And I slowly developed more sophistication on the mathematical side.

But, I found some interesting things there which were surprising. One was that they were describing certain principles from a purely mathematical point of view saying in some cases that you actually can't develop an intuition for it. And I felt that was wrong at the time, but I didn't know enough to know where they were wrong. The reason I think of that incident is, after I graduated, I took a free university class in Seattle, and they were talking about certain elements of the gyroscopic effect, and they gave me an intuitive understanding. It was one of those things where like--- he gives this little simple example, and all of a sudden I flash back on a number of things in college where they said "you can't have an intuitive understanding," and all of a sudden--- bing, bing, bing, bing, bing -- they all lined up. Holy cow, I now see why this was true. This was from something that happened three years before. And then I was kind of miffed. I thought, "Those teachers were wrong. They weren't helping." But somehow they were so facile with the mathematical side that they were underdeveloped on the intuitive side.

**Hollar:** Would you call that theoretical?

**Catmull:** Well, I'm not sure, because I've now gained a broader appreciation of the different styles of thinking. In retrospect I would say that [there are] a lot of people who think a certain way and they may

recognize that other people may not have their skill, but they're not good at understanding the skills that others do have because they don't have it themselves. So, it's a kind of lack of self-awareness, even though these people are really bright. But there are people who actually get the fact that there are those who have intuitive or understanding skill sets, or manipulative skill sets, which are actually very valuable and there's some combination of those two where you want to develop each of them. But, I look at it and say, "Well, some of these people may have been good physicists in some sense, but in another sense [they were] narrow."

**Hollar:** At that moment when everything lined up for you, did that change your way of approaching physics, problem solving, learning about learning? It sounds like a moment students have when they realize their professors are kind of hemming them in, and then you can break out and move to that frontier. Was that one of those moments?

**Catmull:** Well, although I started to feel it before, I felt like, "Gee, this is a little narrow in the way they're presenting it." And this is also true in math among a lot of the math teachers. I took a lot of courses. So, in the four years that I was there I took so many courses that I took a fifth year's worth of courses in four years. So, that's why I got two Bachelor's degrees--- one in physics and the other in computer science. But what happened with computer science was: I started to take courses there and I found it really fascinating and amazing, and I was learning it fairly quickly. And so I started to take all the courses I could while I was taking my physics classes. So, at the end that's where I got the two degrees, but I was actually starting to gravitate over towards this other area.

One of the pulls to it was the realization that in computer science we were at the frontier, whereas with physics it's like --- you had another four to six years ahead of you to get to the frontier. So, it just drew me in. It was like being in an Easter egg hunt where you're at the front of the line. And there are all these things out there.

**Hollar:** Were you programming much at the time?

**Catmull:** No, it was only the classes. I took a class and, because I did well, I was asked to be a teaching assistant as a senior. All the other teaching assistants were graduate students. So this was an opportunity for me to learn quickly. I was a pretty good teaching assistant because I had just learned so recently that I knew what was going through their minds. Now, the interesting thing was --- years later, after I went off and worked and I came back, I was again a teaching assistant, but now I had a lot of experience programming. My ratings as a teacher were actually lower than they were when I was a senior. That's because as a graduate student I programmed a lot, and there were certain difficulties that the students had that were hard for me to imagine they were having. Even though I had been through it, I could no longer relate to the difficulties they had.

**Hollar:** How did you decide what to do after you got your Bachelor's degrees?

**Catmull:** Well, initially I wanted to study programming languages. But, the primary thing at the moment when I graduated was that I had to get a job. And the draft was going on. So I went up and worked for Boeing. Now, Boeing at that time had just gone through a difficult time, and they had laid off 18,000 people. And then they started to hire again. So I was hired in this wave of people coming back in. I worked there in Boeing on the CDC supercomputer, the 6600 supercomputer, programming card decks which then got submitted twice a day into the supercomputer, working in a giant room filled with desks side by side. That was your whole working space, and the engineers I was working with sat right in front of me. So it was an interesting experience, but it was like a cartoon. It was the exaggeration of the giant room of cubicles.

**Hollar:** It sounds like it.

**Catmull:** It's exactly what it was, but it was a great learning experience. I was there for six or seven months like that. And Boeing, again, had a rough time and had to lay off 50,000 people. So, my boss called me in and he said, "You've done a great job, but I just want you to understand everybody else here has worked for 10 years and they've got children in school." So, I said, "Not a problem." I returned to Utah and then spent time basically fighting the draft. I became a conscientious objector. I was a draft counselor. And I entered graduate school. The first course I took was in computer graphics.

**Hollar:** How long had that existed when you took it?

**Catmull:** It was a brand new program. There were no textbooks. So Ivan Sutherland taught it -- there was Ron Resch… I didn't know who these guys were. Ivan Sutherland came in, he was wearing flip flops, and I thought it was one of the hippie graduate students that was teaching the course. I didn't know.

**Hollar:** Did he have a reputation? When you signed up for that course did anyone say to you, "Oh, that's taught by Ivan Sutherland."

**Catmull:** I knew nothing. I walked into that class, I didn't know who those teachers were. This was just a course that sounded interesting. So I started to take this class, and we were asked to use this rather crude program they had for making pictures with spheres and elliptical objects, or if we wanted we could write our own code to do something. Well, screw using that existing package,--- I wanted to write my own stuff. And I was completely pulled into it.

One of the things I did there was I made a model of my left hand. I digitized it. In fact, the way I made the model was--- I put my hand in plaster of Paris, and that's where I discovered you need to put Vaseline on

the back of your hand, which I didn't know at the time. So, my hand got stuck in the mold. Stuck a knife down in there to cut my hand out of that. And then went through this laborious process of digitizing, and then I wrote a program to animate it, and then that led to getting my first paper published in the ACM in Boston--- in 1972, I think is when it was.

**Hollar:** Did you have a yearning to publish? Was that part of what you saw yourself doing?

**Catmull:** Not at all. It was just, "This is a place to discover." So, fairly quickly I realized that there was incredible potential in making pictures. Those first pictures were black and white. They were polygonal. They had jaggies along the edges. They were very crude. Everything was crude. But you could see the computers are getting faster and that here's something to pursue. That's when I connected the dots to say, "Oh, I can use this for making art."

And once I took that class, everything shifted. I was no longer pursuing computer languages. Everything was about "How do I develop the technologies so that we can do curved surfaces and animate them and get us to the point where we can make movies with them?"

**Hollar:** Was realism your goal from the very beginning? You started with a hand, a very tough thing to begin to animate. What were you thinking?

**Catmull:** Well, I picked my hand because I wanted something hard. Everything up to that point, if you're going to look at it, they were really robotic, simple shapes. And in order to solve any kind of problem you need to take something which is just beyond the reach of what can be done.  I just wanted to pick my hand because I knew that the hand was hard in a whole bunch of areas, not just the fact that it's this complex shape. You've even got a hinge here that's determined or not by the joint at the bottom, but by the flesh around it also. So just pick something hard.

I wouldn't say it was realism to begin with, but I'm saying it evolved into that. In fact, the whole field after a while began to use realism as a guiding principle because it was so out of reach. In fact, for a time I would give talks and in there I would say to people, "Look at the table in front of you. Nobody has ever been able to make a picture that gets anywhere close to capturing the image that's right in front of you." And I can't say that any more, of course. Haven't been able to say that for years. But for a long time we were a long way away from it. I never believed that realism was the actual goal. It was just a really difficult problem to help guide things along. At some point, we switched over and said, "Okay, now we have other goals, and we're now moving to non-realistic areas for artistic purposes."  But, the challenge of realism was a great driving force for quite a few years for the entire field.

**Hollar:** Let me ask you just a couple of technical questions about the program that you wrote. What language were you using to write the graphics package for your hand?

**Catmull:** I believe I wrote it in SAIL. It's a variant of ALGOL.

**Hollar:** Okay. Is that fair?

**Catmull:** Yeah, I think that's a fair thing to say. But the interesting thing is I learned programming in FORTRAN and then ASSEMBLOR on the Univac 1108, and when I got to graduate school they said, "Well, here's ALGOL." So, I'd never seen any language like this. But, ALGOL was so intuitive that I didn't even need to read the manual. I just started to program in it. And I loved that about it. I realized "Oh, this is the right way to think about it." And I know programming has come a ways since then, but if you go from FORTRAN to ALGOL, that was a big step forward.

**Hollar:** And what system were you working on?

**Catmull:** We were on the PDP-10s at the time. So, this is the DEC equipment and we had the single user and the multiuser machines.

**Hollar:** The Computer History Museum would want to know those details. Next: what was it like working with Sutherland, and did you have a working relationship with him early on?

**Catmull:** Well, I took the course from him. He was on my committee. Ivan was scary smart. Still is, right? He's a really smart guy. And there was something about having somebody really smart which is to say, "You can aspire to that." A lot of times you get to the point where you realize well, you do know more about certain areas than the professors, or you're like them in certain areas, but here was a guy who was just so at a different level that you can say. "Well, like, there's still a place to reach for."

There were other pretty incredible people there, too. Tom Stockton was there and he was just brilliant in the image processing. And one of the interesting things about Utah at that time was that they had this computer graphics program of Ivan Sutherland and Dave Evans and a few other people there, and then image processing with Tom Stockton. So, it was the one place where both the fields were together. And it was part of the development of computer graphics to have the image processing side alongside it. After that, at the universities they were not together. They tend to be in computer graphics and there's image processing. But Utah started off not only with them together, but, in the middle of the department they had a photography lab. So we had a professional photographer running this lab in the middle of the program to help make some pictures.

**Hollar:** Was that instrumental to the kind of innovation that was happening at that time--- to have all three of those elements and people who thought in those three ways all coming together and working together?

**Catmull:**  Well, I believe it was. Even at the time we knew it was special. And I would say a lot of it was driven by Dave Evans who had almost an eclectic taste in getting unusual people together. So he wasn't trying to come up with this rigorous program for how you develop this. It's more like--- I'm going to get these people who are unusual thinkers and put them together in an unusual environment, and some good stuff will happen. For me, it was an enlightened way of thinking. And I still believe that.

The other thing which I was a beneficiary of was ARPA. So, it was funded by ARPA. ARPA had, from my point of view as a student, very little interference. That is, they were funding smart people in universities around the country with the belief that if you fund a lot of smart people, good things will happen. And for a while they actually lost that, and I think they're getting back in that space again. But, it was so incredible and nobody was telling what we had to do. There weren't any sort of weird benchmarks. It was just-- do good work. And they were trusting Dave and Ivan to lead the program. And we were their students saying, "Holy cow, this is special." It's not I'm looking back on it… it's like "This really is cool."

And I remember going to a conference, a SIDs conference, Society for Information Display, and there was a floor show, so this was back in the early seventies. Level of sophistication was a lot lower, but one of the issues of the time was--- how do you get better displays? And in walking the floor I overheard somebody talking with somebody else. And they're talking about Utah, and how what they were doing was a little nutsy and these guys were a little wacko because they're doing this impractical stuff. And my feeling at the time was like--- they have no idea. You just don't know what's coming.

**Hollar:**  I'm going to ask you several times during this oral history to talk about culture--- the culture of working together, and the culture of getting really creative people together in a technical environment and living on the frontier. Did you learn things in those years working in that scary smart group at Utah about the culture of a group of people who come together to do something really special?

**Catmull:**  Well I look at Utah as the place that provided the seeds for the way I think about culture. As I say, I knew at the time it was a special place. But, besides Dave and Ivan, the truth is Dave and Ivan were off starting a company. So, we didn't see them very much. They provided the environment. They got the funding in there. They provided the bubble, and then they were out running this company. So, we had a free hand to develop on our own. So who were the other people there in the bubble with us? One was Alan Kay. He wouldn't teach a class in the morning because he didn't like to get up early in the morning. It was an afternoon class. He just was an inspirational speaker. And we had a great time in there. I don't even remember what I learned, to tell the truth--- but it was just that feeling that we're off in a new area, the new frontier,  The students were also working with Evans and Sutherland to build hardware. And so they were building it for the university. We had this brand new hardware, and so hardware was part of the development because they were making these simulators. We were allowed to pick our problems, and we had occasional professors, but it was really the students with each other, batting things around, talking with Lance Williams and Frank Crow and Henry Fuchs and Jim Clark and all these different personalities. And if I didn't understand something I'd go to one of them.

So the person that actually got my head in a different place about math was Jim Clark about B-splines because since I work more intuitively he came in with an intuitive explanation and that got my head spinning. As a result of that, then I began to think of it structurally in my head. I don't know how to describe this--- I didn't learn this until recently, because I didn't know that other people don't think this way--- but when I close my eyes I can never see pictures. So I've done all these mathematical structures but I don't see the symbolics of them and I don't see the pictures of them. There's something else in my head. Once I got that model in the head then I could apply it to non-four sided objects. And that led to these subdivision surfaces, which is a new class of mathematical surfaces, and then it was later, after I graduated, when Jim Clark was with me at New York Tech that I explained to him what these new surfaces were. And so, he implemented them. We wrote a paper on them. And now, it's the primary surface which is used in computer graphics. But, it came out of this – I remember this talk where Jim is explaining "Here's how this surface works," which can then set me free to think about it in a different way, in my own way.

**Hollar:** You were writing prolifically during that period when you were earning your PhD. Were these breakthroughs just pouring out of you at that point?

**Catmull:** Yeah. I was taking a lot of notes and there were all these things I wanted to do. So I picked out my first things which I thought were important, and then I made this list of all the things I need to tackle. And as I moved on through my career, and then I managed more, I recognized that one of the things that was happening is that the things on my list that were ideas I wanted to develop were actually being picked up and solved by other people. So, there was a question which I came back to later, but for years I wondered; "I had this really prolific time. Could I do that again?" You know it's that thing – you know, "That was really an amazing time. Do I still have it?"

**Hollar:** Were you sad to leave it when you earned your PhD and it was all done?

**Catmull:** Well, no, it's like it was time to go on to a new adventure. I loved the environment there and it was really fantastic. But it was time to try something new.

**Hollar:** There's so many questions I could ask you about Utah. I just want to wrap this section up with just two final ones. First, Sketch Pad. We haven't talked about Sketch Pad and when you saw it and your reaction to it. Can you talk a little bit about that?

**Catmull:** I didn't see it.

**Hollar:** You didn't see it?

**Catmull:** No, there was a film that was made that Ivan had done when he was at MIT. So, it was something that people talked about, but it actually, it, itself didn't have an effect.

**Hollar:** Okay. And you talked about the help that whole group was getting from ARPA and from others. Do you think the software advances that you were working on and everyone was working on in Utah were pushing the hardware? Were you pushing computer technology forward with the work that you were doing in research and developing software there?

**Catmull:** Well, yes. It was that a lot of the ideas were feeder ideas to Evans and Sutherland. And while what we were doing was public--- I mean, they knew what could be public because it was publically funded--- but it all felt appropriate because here was somebody that wanted it. And things were built there.

When I did my surface work or my mathematical surfaces for very fast subdivision of surfaces then I basically tried to think of it in terms of how I would implement it in hardware. So that was part of the mindset at the time. But, most of the work was algorithmic. And I'd even say in retrospect that I now know that the time spent on dividing the surfaces is actually today inconsequential compared to the other problems that were there. I didn't know it at the time because it was just "how do we do this really fast?" In fact, when we were making these pictures they were taking half an hour to make per picture, mine were, because I was doing these curved surfaces. So, it was the first arbitrarily curved surfaces, it was B-spline surfaces at the time. And I put on texture mapping onto the surfaces. Well, the reason I could do that was I had mathematically well-defined parametric surfaces and nobody had actually had them until then. So once I had that I could then make this mapping.

Now, there's an interesting thing that happened at the time and that is I showed my first pictures with surfaces mapped on it to Ivan. And Ivan felt it was cheap to do that. And he'd been working so hard on the problem of the display complexity, trying to get more up there to solve those problems that when this new thing came along he dismissed it. And even after that when I showed him pictures he always flipped through them quickly because he was interested in the real problems. And the reason that was significant to me was that I walked away from that knowing that Ivan was wrong. And it was actually a great booster to me because I'm so intimidated by him. And I knew he was just incredibly smart, but there was something about the fact that he was wrong which actually made me feel good because he was wrong.

Actually, there's one other funny incident that happened with Ivan. And that was I was meeting with him once at his house. And I was talking about where two planar surfaces meet and at that time we had a way of smoothing the surface called Phong shading. And so Phong shading made it look smoother across the joints. But I said to Ivan that there's still a discontinuity in the shading at the surface. And he said "No, there's not." And I was so intimated by him that I couldn't think. That is, my brain went into complete freeze and so while I'm sitting there in this freeze, I can't even think how to react, and he stares at me and then he says "Oh, you're right." And then he continues. That's how smart he was. While I'm sitting there

stammering he [could ] think it through, come up with the right solution and then move on. So, when he actually was wrong on that one, that actually made [me] feel good.

**Hollar:** Did you ever talk about this with him years later?

**Catmull:** No.

**Hollar:** You mentioned something I want to begin this section with about Sutherland and Evans and that they were starting a company; they were off starting a company using this emerging technology. Did that ever appeal to you? At that moment as you were leaving graduate school, did you say to yourself, "I could go do this too?"

**Catmull:** No you know it never did and actually they didn't approach me on it ever so I don't know what would have happened if they'd asked me, but they were basically a hardware company and I had not really done any hardware design other than classwork. Ivan at one point did want to start a computer animation company and he worked with Glen Eames, of Eames Design and talked with me and Barry Wessler and, I'm drawing a blank, Gary Demos to form this company, but they didn't get the funding for it so in the end, I had to just take another job, because they--- they couldn't get together. It never did happen, but they were going to call it The Electric Picture Company.

**Hollar:** Did you see computer animation as the direction you would pursue at that point?, Was that where you wanted to be?

**Catmull:** Yes; so when I went out to interview at various places, I told them I thought this was going to be the future and so I interviewed at a number of universities and they weren't interested in it. So basically I didn't get any offers from universities. The only offers I got, <inaudible> a more academic bent were from IBM. There's a research lab in Yorktown [Heights] and then one in San Jose, and I turned those down because I didn't want to go down that path. So I ended up taking a job offer at Applicon, a small company outside of Boston, doing computer-aided design. I figured, well, at least I get a little closer to it and try to understand some of the issues there. So I went there in 1974 and just moved there, and I was there for several months when a call came out of the blue, it was from a woman Roz who said… who wanted to schedule a meeting with Alex, and I had no idea what she was talking about. And she said, "Oh, didn't they talk with you?" "No." Click. <Laughs> So that was my introduction to New York Tech. But anyway, I was invited down because Alex Schure wanted to fund computer animation, and he had been to Evans and Sutherland and ordered the frame buffer and the Evans and Sutherland picture system, their calligraphic line display system, and then asked Dave Evans who we could hire to program it. And Dave said, "You're too late. The person you wanted has just accepted a job at Applicon." So he called me up to see if I wanted to go down and do computer animation. And I said yes.

**Hollar:** After just a few months. And how was that?

**Catmull:** Well, it was really intriguing because Alex really wanted to do it. He had this space which used to be a garage. It was a garage for an estate. He had accumulated a few estates, he had this school funded by government money for Vietnam vets returning from Vietnam, so that's what got the school going. And it was, at that time, not a particularly strong technical school except that he was willing to fund this lab, and we weren't really connected with the school other than being on the same property. The equipment arrived, and one person came down from Applicon with me who had been at Utah, Malcolm Blanchard. And then the equipment arrived and we set up a computer room there and started programming. Then two more people showed up, this is Alvy Ray Smith and David DiFrancesco, who'd been out at Xerox Parc and at that time Xerox had told them they weren't interested in color so they went to Utah <laughs> and it was recommended they come out to New York Tech, so Alvy then became my third hire. It was a while later before I even hired David. So we had this equipment, and Alex would come in every day because he was just so excited about it. He also had an animation studio where they were working on a hand-drawn conventional film.

**Hollar:** Was this with the Max Fleischer animators?

**Catmull:** Yeah they worked -- a lot of them had been in New York so they worked with Fleischer. They were quite old, so in retrospect I wish I'd asked more about the old days. We'd ask somewhat about the old days but these guys were in their 70s and they frankly were just trying to get the money and they horsed around a lot. He [Schure] brought a few people from other places, but he didn't know what it meant to make a film and these guys were all really cartoonists from the old era. So they started working on this property which was Tubby The Tuba, and it was pretty much a really bad mess.

Alex wanted to be the new Walt Disney, and the reason we knew this was that every day he said he didn't want to be the new Walt Disney. It was continually on his mind, but at the same time, he viewed us as the artists of the future--- as the new animators--- and we knew that we actually required other kinds of skills. He would tell the animators over there that "as soon as the computer guys are done, we won't need you anymore." And we were just wilting over this <inaudible>--- don't go there. So we established a rapport with the younger ones, cause the younger ones could look at the computer as their assistant. The old animators had no interest in us because they had these assistants to do the in-betweening work for them, so it was actually the younger guys who would say, "Okay, now I've got somebody at the computer to be my assistant." So they ended up being the ones that were responsive. But as we tried to develop, there were a lot of passive aggressive views towards the computer work. They didn't want us to succeed. So they were outwardly friendly but they'd do anything they could to sabotage what we were doing.

**Hollar:** Was this really a clash of the animators of the future and the animators of the past?

**Catmull:** Yeah, but never outwardly. It was always sort of inwardly, like <inaudible>--- you just sort of get the lay of the land of what was <laughs> really going on here.

**Hollar:** What did you learn from that?

**Catmull:** Well, I started off with some theories about how to organize this group, and we brought in a number of people and it was again really exciting. I wanted to have a lot of the elements that were at Utah. The fundamental thing at Utah was you have this umbrella, and you basically bring in smart people and they solved the problem. So I started up with that same approach, and I had a very flat structure. We got up to at one point like 35 people, all reporting to me, so it was very flat. And my other theory was, I only wanted to hire people who were entirely self-motivated and didn't need managing so that I could do my own work, because I was writing a rendering program and I wrote an animation program called Tween for doing hand-drawn animation.

Now as we got into this, like, about five years into it, we were producing a lot of really good stuff. We had the first real significant paint program. We had this hand-drawn animation in-betweening program. We had rendering. I did the first work on Motion Blur, to try to solve that problem. Garland Stern solved the problem of coloring in hand-drawn cells, which was fairly transformative when he did it, but certain elements of it weren't working.

So I had this structure in place, and I recognized as we got there that some of my theories about managing were a crock. One of them was this notion that I'm only going to hire highly self-motivated people. There are two problems with that. One of them is--- you actually can't tell ahead of time <laughs> whether or not that they're that way. The second is--- there are a lot of people who are actually quite brilliant -- they just need some managing. We were actually cutting out a large segment of talented people if you think of them only as highly self-motivated. So it was actually when I went to Lucasfilm that I could rethink those theories, and looking back at the time, I thought, "Well I've got 70 percent right and 30 percent wrong, and I'll probably do the same going forward." But it was a pretty amazing time over there.

Jim Clark was there. Jim Clark had a fairly amazing run-in with Alex Schure.

**Hollar:** Did he follow you? Were you sort of a magnet for a lot of this talent that was ending up...

**Catmull:** Well it was, I mean at that time, I wasn't that well known, but there were a couple decisions we made early on one of which was a very right decision. I felt it was right at the time, and it was. And that was that we participate fully in the SIGGRAPH community. Over the years we had intellectual competitors who were working on ideas and they would get ahead in some area, but they didn't want their competitors to see it. So they were secretive about what they had developed. My view at the time was--- we're so far away <laughs> that anything we have right now is not nearly enough, and that we have a much greater

advantage if we engage fully and completely into that community and we disclose all. So the result of disclosing all and publishing freely was that we were well known, and people knew that if they came, that they could get their work out into the world. So that was part of the magnet.

The second was that Alex Schure was willing to fund it. So we actually had funding for developing computer animation at this place where we were open and, I'd say, had a really collegial spirit. There was a really high energy there. Anybody that would come in and see it would recognize that high energy, and that was part of the spirit of Utah, which I think we did capture going forward.

**Hollar:** You were starting to talk about the run in between Jim Clark and Alex Schure, and I didn't want to stop you from telling that story if you were about to tell it.

**Catmull:** Well, Jim had graduated, and then he came out to New York Tech, and that's when Jim and I did this work together on the subdivision surfaces. But Alex was just, you know--- he's an unusual character, sort of like he was a dreamer, but he didn't actually know what he was doing. And it was always a little odd for any of us that was there because he was such an unusual character. Jim didn't have a lot of patience for things that didn't make any sense, so part of the run-in was to realize that, like "I'm dealing with a guy that's just a little little weird. It's odd. It doesn't make any sense." So there was kind of a collision there, and he [Clark] realized that he needed to go somewhere else and so he wrote a letter to, I think, Dave Evans saying, "This place is a little crazy. I need to move on." Alex saw a copy of the letter, which meant that, number one, somebody in the lab was capturing what Jim wrote and forwarding it on to Alex. And he didn't have the sophistication--- so it was a rather disruptive thing within there to realize, number one, there's sort of like a tattler inside--- that's really discomforting. It caused a collision between Alex and Jim, so Jim ended up leaving over that, Then he went back to, I guess he went to Santa Cruz next, then ultimately went onto Stanford. Jim and I remained friends, and we did things after that, so from his point of view it was just purely Alex. It wasn't even anybody else there at the lab.

**Hollar:** Did you and Alvy Ray Smith form your working partnership there?

**Catmull:** Yes and the interesting thing is--- when Alvy first came, it was exciting to have somebody else there, but, honestly, I was intimidated by him. To be honest, when I was younger I was intimidated easily.

**Hollar:** <Laughs>

**Catmull:** I thought at the time that Alvy was probably more qualified to run the lab than I was. So I felt that fear at the time, and I didn't quite know how to process it. But I went in and hired him, and we ended up becoming best friends. We collaborated on the fill algorhythm, and I focused more on animation, he

was focusing on painting and various other aspects of filmmaking. So we formed a long-term collaboration which extended all the way through Lucasfilm to Pixar.

**Hollar:** Let's move ahead to the Lucasfilm chapter now if we can unless there's something else you want to talk about with respect to New York Tech that we haven't discussed yet.

**Catmull:** No, I think that's probably it.

**Hollar:** Did they find you or did you find them?

**Catmull:** George had made *Star Wars,* the first one, and it was so significant that he wanted to bring more technology in. So from George's point of view, he had funded this group which was located in San Rafael, which is ILM [Industrial Light & Magic], and they were really just starting, but they used computer technology to help make the film. Now, a lot of the process was optical, so it was shot against blue screen. The problem, though, with special effects is that, in general, special effects up until this point didn't have motion blur in them.

So think about Harryhausen movies. They were all in perfect focus, and there's a physical, physiological phenomenon that happens where your brain can see the fact that it's in perfect focus when [the image is] moving across a screen. And it's only the motion blur which actually cuts down on the high frequency of the edge. But how do you do that with special effects? It's something moving against a background. So they had worked out a lot of sophisticated techniques, optically, in order to hang onto the edge with the blue screen. But it also meant that they had to have these models under computer control. So the key thing is--- they're using computers to control the cameras and the objects, and the result was this monster leap-forward in the effects to go along with the story of that movie. So George wanted to keep pushing that, and he was also not happy with the way Hollywood thought about a lot of things. So we wanted to be up here and invest more in technology at a time when nobody else in the whole industry was willing to do that.

**Hollar:** And when you saw *Star Wars,* were you like the rest of us? Did you say to yourself, "This is incredible?"

**Catmull:** That's right. It's like, it's one of those things where I remember the theater, and the seat that I was in <laughs> when I saw that ship fly over. And when that thing came onto the screen, it was like, "Holy cow!" I had never seen this before, and it kept you all the way through. If you just walked out of that, it's like, "Okay; everything's changed." So it's very exciting.

**Hollar:** And did you find yourself thinking, "I want to know more about those guys?"

**Catmull:** Well, I wanted to know that, but I knew it was optical at the time, so there were press articles and so forth about it, but it was in fact a different world. But because George wanted to do it, he had one of the guys who was actually managing his property acquisitions--- and his name was Bob Gindy I believe--- and he said, "Can you go out and find somebody?" So he started to poke around, and he ended up going to Carnegie Mellon. The professor out there was Raj Reddy, and then he pointed him to Ralph Guggenheim, who had graduated from CMU, and Ralph was working for me at New York Tech doing our first commercials group. So Ralph pointed him to me.

And so I got the call, and then we chatted, and then they sent out to Richard Edlund, one of the great pioneers of computer graphics. So Richard came out to check us out, wearing this great big *Star Wars* buckle, and we're trying to keep this secret <laughs>. Then they flew me out to meet with George, on some sound stage, in LA, and we chatted, but the thing I remember at the time was that they'd asked me--- as they had asked other people--- who else should they talk to? So I gave them the names of all the other people that I thought would be appropriate for the job. And in doing so I gave them the names of every person they, in fact, had found and were talking to. But when they talked to the others, because they wanted the job, they wouldn't give any other names out. So they hired me because I was the only person willing to give out the names of the other people.

**Hollar:** That's incredible. And so this theme of openness--- it's a recurring theme throughout your career. We must have talked about this in five or six different ways in the hour that we've been talking. Why is that so important to you?

**Catmull:** It took me several years to get this totally refined, but the foundations were put in place in Utah and then confirmed at New York Tech. And that was the realization that the ideas that we were coming up with at any one time were one of millions of ideas. Literally the number of things that it takes to put together any development is just vast. If you look at it that way, what is the important thing you want? It's actually the people that keep coming up with ideas. And when we participated in the broader community, the computer graphics community and the film community, we were connecting with people. We were sharing ideas. We may be giving away some of our secret ideas, but what we were getting back were ideas from other people. And a lot of those great people wanted to come work with us,  So when we came to Lucasfilm, I'd say a lot of people said they were coming not because it was Lucasfilm or even because it was *Star Wars*. It was because of this open group.

Because coming to Lucasfilm, we continued to publish, and the company and George never had a problem with that. They bought into this entirely--- that it's actually the community of people coming in and sharing that makes the difference. So we published lots and lots of papers. There were several years when more papers were from Lucasfilm than any place else. And just--- get it all out there. The result was these personal connections which we still have to this day, and great personal friendships, and it's still true.

And we still do this at Pixar--- publish this; go out to the conferences; invite people here. It's bigger than any of us. Let's enjoy it.

**Hollar:** Who did you bring in first when you went to work with Lucas?

**Catmull:** Well, the first year I wasn't allowed to bring anybody. They wanted me to look and--- they'd only had one successful film, and they didn't want to overreach. So they were working on *The Empire Strikes Back*, and for the first month I was actually using George's office because he was off in London shooting. We were making plans, and the company headquarters was actually down in LA, although George was up here and ILM was up here and so I would commute back every once in a while down to LA for core purposes. But we were setting up things here. Finally, we were allowed to hire people, and so I brought in Alvy Ray Smith to head up the graphics group. And I brought in Andy Moorer to head up digital audio, and then Ralph Guggenheim from New York Tech to head up video editing. So this time I realized, okay, I need more structure in place, but our charter initially was to address those three areas. And in those areas, they then began to hire people--- in the graphics side, it was to address the issue of digital compositing as well as computer graphics, and with audio Andy Moorer built a digital audio processor, and then with Ralph we built a digital control editing system. And these were each phenomenal projects with really great leaders in charge of them.

**Hollar:** Did you have the technology you needed, and was the mindset "whatever it takes, we're going to get that and we're just going to push the envelope?"

**Catmull:** No, the technology was not there. With video editing, we knew we needed a new kind of computer, and we needed random access to the video. At that time we didn't have random access to video. The closest you could get to it were the optical disks that you could buy, and with some difficulty you'd get random access to the optical disk. Other than that, it was videotape. You could move around videotape, so we had to build something around optical disk, knowing that it wasn't actually practical at the time. We figured at some point it's going to come, so let's build around the thing that's coming.

We probably made a mistake on the computers. I'd felt burned by the fact we lost so much energy programming a 16-bit computer, which was a PDP-11. So we went with a small company, Three Rivers Corporation in Pittsburgh, because they had a bigger address space. The truth is, we probably would have been better off staying with the PDP-11 because we were just on the verge of moving into the new systems that were coming so there we got a little wedged because of it.

**Hollar:** So you had to do all of that yourselves?

**Catmull:** Yeah, we built an audio signal processor. We designed and built a machine for digital compositing, because there wasn't anything near fast enough, so the thing that we designed ended up becoming the Pixar Image Computer, which was then the product when Pixar became a company.

**Hollar:** And how did that happen? Can you tell the story of how you're in a division, you have to build a box; you build it and it becomes yours and it becomes such a platform for so many things. Can you talk about how that came about?

**Catmull:** We brought people in to take on different projects. So one of them was just plain painting, so Tom Porter, for instance, came in to advance painting to another level. We spent a lot of time on digital compositing, so Tom and also Tom Duff and Alvy Ray Smith were working on systems for doing the equivalent of what we were doing digitally with the blue screen. Alvy and I had actually worked out the original concept of the alpha matte--- which is now the terminology that's there but it's only because I stood up at a white board, wrote the letter, the Greek letter alpha, and that was the origin of the use of the term. And so they worked on that. And we realized, though, that if we were to ever have digital compositing, we had to be able to work at frame rates and then have an immense amount of compute power, and the computers at that time were nowhere near what we needed.

So we hired Rodney Stock to come in and design a special purpose computer. Now the fact is, at that time, the frame buffers, that is the things that held the images, were made by a small number of companies, and we knew the engineers. So the leap of going from this company where they've got this guy as he was designing something, and building it, to actually hiring a person to do it ourselves was not very large. So it was just like this fearless thing of, well, we need something special purpose for us. We don't see a big market for it so of course we'll have a designer -- we'll do it ourselves. So we built that.

We had some ambitious plans. Some of them didn't pan out. Some of them were-- we were a little ahead of ourselves, but that was an educational process, too. Even at the time we felt like, okay, that plan didn't work out, that's okay, that's the nature of being on the edge. Some stuff works and doesn't, and I'd say, "No big deal." And for that matter, the people we were reporting to, Lucasfilm, they got that. We didn't get any push back saying, "Well, that project didn't work. You guys have failed." It's like, okay, you're giving us some good stuff, and that's good, and some stuff doesn't work, and so we buy into that. I personally feel lucky that we had so many people who got that and understood it. I don't think it happens every place. That's one of the benefits of this career path.

**Hollar:** And then how was your work showing up on screen in the next two films?

**Catmull:** Initially since we were wrote a renderer, we knew that we had to solve the motion blur problem. So we started a project to come up with a new renderer. And the thing I believed at the time was that if we're going to do something that was big, we had to start from scratch and rethink it. So we started a

project with Rob Cook, Loren Carpenter and me to render exceptionally complex pictures. So at that time, the kinds of pictures that people were making had 10 to 40,000 polygons in them. All right. We said, okay, that's not going to cut it. And you don't want to just extend those underlying principles. It's to say--- we want to do 80 million polygons. And there's a path we went through to come up with that as being our magic number in terms of the number of how small the polygons were and how much picture and the depth.

**Hollar:** And the state of the art at that time was?

**Catmull:** Forty thousand.

**Hollar:** So taking it from 40,000 to 80 million.

**Catmull:** To 80 million. We said, we have to think that way, so that--- we did that to force ourselves to redo everything. And the other criterion was that -- there were three criterion. The second criterion was that we had to have motion blur solved. And the third criterion was that, basically, the artists need to be able to control the shading and lighting [and for it] not [to] be a technical programming job. So that's what we set out to do. And we didn't have all the solutions, but we did decide [on] a structure, a way to think about it.

And we took two different approaches. One of them which was initially proposed by Rodney Stock, the hardware designer, which was a random sampling, or he said a dithered sampling. Rob Cook took that on, and he turned it from dithered sampling into random sampling. My belief was that it probably would have too much noise in it, and what I wanted was an exact solution. So I worked out an exact solution, and then we competed. We met weekly and we had a friendly competition. I'd come in and I'd pull ahead of them, and they'd come in and pull ahead of me, and so we're like this, and we viewed this as like goading each other forward in the positive sense. It was in this process, initially this was this dithered approach they were taking. It was during this that Rob went from the dithered to the random--- the Gaussian-shaped random noise--- and then all of a sudden this thing extended into depth of field, and basically when he did that, it kind of blew past my solution. I tried to come up with something that would match that, but just then they pulled ahead of me. So in the end, they won the race. But I got the like-- you know, I win either way <laughs>. And so that then became the foundation of the new renderer and then...

**Hollar:** Did you give it a name?

**Catmull:** At that time it was called REYES, which I think-- my guess is that Loren Carpenter coined the name: Renders Everything You Ever Saw. We made a picture. It was called "The Road to Point Reyes," because Point Reyes is also a place out in Marin County. So it was a pun on this. It was, for that time, a

very complex picture, which we then published, because it had a complexity way beyond anything anyone ever saw. It was very crude by today's standards, but then it was mind-blowing. So then we kept pushing on that to get more complexity, but we solved the motion blur problem--- we got the complexity in there. I wouldn't say the compute power was up to 80 million, but the architecture would scale up with processing power. And that was all Lucasfilm, so we were working on that.

We were also building the compositing box for the Pixar Image Computer. Once we built that, we started to do some medical work. This is still while we're at Lucasfilm. We got some CT scans from Johns Hopkins University, and we did a 3D reconstruction of a volume. So this was the start of volumetric work. It was Bob Drebin who originally did this and--- actually, Pat [Hanrahan] was on it but the industry got changed because of that. So all these things are pouring out of this group. It was a lot of fun. And they built a laser film recorder because we need to be able to have better control over the placing of the image on the film.

**Hollar:** What led to the transition then of the computing division out of Lucas and eventually into the hands of Steve Jobs? Can you talk about that and your personal role in it?

**Catmull:** There were two things to that. One of them was that George and his wife got a divorce. The result was that they had to split up the assets. George wanted to keep 100 percent of the control of the company, which meant that the cash basically went to his wife and so that meant they [the company] were cash poor. They weren't in jeopardy, but they had to be wise about it; and we were still just spending money. That's all we were.

**Hollar:** This was an R&D…

**Catmull:** Yeah.

**Hollar:** …function.

**Catmull:** The computer division was basically R&D. We were not part of ILM. We really were a separate division there. And the other was that we still wanted to do animation. George at that time did not want to do animation. I think if we'd said we wanted to fold into ILM, he would've been fine with that. But that's not what we wanted to do. So as a group we had come together to do that.

We had made some special effects. We did a minor special effect for the third *Star Wars* film, and then this major effect, which was for *Star Trek 2*. And then we did a short-- this is when we brought John Lasseter in to do [The Adventures of] *André & Wally B*. So John was part of the group. But this is what we wanted to do.

So I met with George and said that's what we wanted to do. The next day the president of Lucasfilm came back and said, "You know, George really doesn't want to do an animated film." So at that time it was decided that we would spin this off as a separate company. And since we had products in three different areas, I thought, okay, there's some basis for doing a Silicon Valley sort of startup. Around that time we were introduced to Steve Jobs by Alan Kay. So Steve came up. He met with us. It was-- it all went very well. Steve went back and he disappeared from the radar. He was completely gone. We couldn't get hold of him. The reason we learned later, of course, is that this is when he was in his battle inside of Apple, which resulted in his leaving. So at that time we were off looking at other places. But the deal that Lucasfilm wanted was actually not a practical one, because it--- they wanted the venture capitalists to buy us out of Lucasfilm. Well, venture capitalists don't take their money up front and buy somebody out. It's not their financial model. From their point of view was--- this is risk going forward. You invest from this point, and we'll invest money, and we'll share in the ownership going forward. So they had a mismatch of the models and it ultimately didn't work out. We almost had General Motors and Philips buying us. They'd actually reached an agreement to buy Pixar, and we were within one week of the deal being finalized. It was in that week that the differences between General Motors and EDS blew up, and because of their internal conflict all the peripheral deals, of which we were one, got blown up.

**Hollar:** Were you talking to Disney?

**Catmull:** No.

**Hollar:** Did you feel that was impractical?

**Catmull:** Well it's-- I think at the time we actually did have a conversation; but none of the studios had that kind of mindset. This was not the kind of thing they did-- at all. So it's not surprising nothing happened.

**Hollar:** And when you talked to Steve, was your pitch to do animation?

**Catmull:** No, the pitch was--- we had a product, which was the Pixar Image Computer, and we were going to sell that. So he knew we ultimately wanted to do animation. So we brought--

**Hollar:** I'm sorry, could just start again with "When we talked to Steve Jobs."

**Catmull:** When we talked to Steve Jobs, he knew we wanted to do animation. But the pitch was related to the product that we were selling, the Pixar Image Computer. And we brought along this group doing short films. John [Lasseter] was part of that; and Ralph Guggenheim was going to head up that group. One thing to note was that the entire graphics group came over to the new company; that is, nobody

would stay with ILM, because they believed in the vision. So there was this high-risk startup and they all wanted to go with it. After Steve started NeXT, we then reconnected, and Steve negotiated a new deal with Lucasfilm, which bought them out entirely, basically, for five-million dollars. And then he invested money in the company; and then we started it in 1986.

**Hollar:** Why did he ultimately agree?

**Catmull:** It's an interesting thing, because it's the only thing outside of NeXT or Apple that he did. He ran NeXT and before and after he was a key part of Apple. So we were this thing to the side. There was something about us which intrigued [him] and-- that's how he described it. He liked what we were doing. But he didn't do it with anybody else. He wasn't out looking for other groups that he liked. But he started with us.

And then we proved right away to be this enormous pain in the neck. And it's one thing I don't think people quite realize, but Steve had never run a high-end company before. Apple started with a certain product which was to go out to the masses. He grew up with that to try to reach out to the broad public. We were an entirely different kind of company. Manufacturing was entirely different; sales and marketing were very different. In other words, Steve didn't know anything about how to run our business; and neither did we. None of us had ever done this before. And because we didn't have venture capitalists involved, nobody knew how to find the right people. We didn't know what it meant to find a good sales or marketing person. We were all completely ignorant; and in a high-stakes game. So we had to learn a lot. And we made a bunch of mistakes. I learned a lot, a great deal, and Steve learned a lot. Each of us were learning. And with all these mistakes, we came close to failing. There were some really difficult times. And there were times that any one of us almost gave up; and there were times it was, "Okay, I can't believe this is happening." There were some people that did leave. But John stayed through it; Steve stayed through it. And what we had by the time we finally figured out what our business model was, was people who'd been through rough times together and had had each others' backs.

**Hollar:** You were talking about venture capital a minute ago. There's this famous phrase in venture capital about the pivot, when a business pivots from one thing to another. Did you pivot from the hardware of the image computer to being a full-on animated film studio? Was that the pivot for Pixar--- when all the mistakes and everything else resolved themselves and you became what Pixar is?

**Catmull:** No, we pivoted twice. The first pivot was to go from hardware to software; and that didn't actually work either. And then the last pivot was-- oh then we tried doing small jobs, and that didn't work either. So there was like three of them. But it wasn't until Disney came to us to do a feature film that we found the thing that worked. And the thing about pivots, frankly, is they're a thing in retrospect. It's sort of like this notion, which you sometimes hear--- focus, focus, focus, which just turns out to be drivel. Only people don't think it's drivel. They think, well you've got to focus. The problem is--- what do you focus on? And the reason you have to do pivots is because you're focusing on the wrong thing. The problem isn't

focus. It actually is figuring out what you're supposed to do. And that's really hard. And it's really easy to focus on the wrong thing.

**Hollar:** When did it become clear that animation, which had always been your dream was the way through?

**Catmull:** Well it had been the dream; but I would say initially it wasn't practical. And we-- it wasn't until we were just getting started-- that I'd also say it became about economically practical. And others actually wanted to get there at the same time. But you had to have a lot of things lined up. And they lined up for us; and they were somewhat accidental. But there was the fact that the team had been through a lot together. So we actually had an established rapport for something which was still going to be difficult in its own right. The second was that when we got out of the hardware business, the fact is that we had people, customers, dependent upon us; one of them being Disney. So we should've backed out of the hardware business two years before we did. And the reason we stuck with it was--- intuitively, I knew that if we backed out too soon, we would screw Disney. So we went through a long and painful process to transition all their software on to the new generation workstations coming out; which was at that time Sun Computers. And in doing that, we helped them make the transition; and then we could sell the hardware business to somebody else.

**Hollar:** Did they realize you were doing this?

**Catmull:** Well I don't think they-- I mean, obviously they're doing a transition; they knew at some point there was an end. So they knew at that level. I don't think they fully realized that we put ourselves at risk by holding on to the business longer than made economic sense. But the consequence was that we had an ongoing good relationship with Disney. So when they looked at broadening their animation suite, going with their conventional animation, then they would say, "Oh, well, we have a good relationship with these guys, and they stick with us." So it was just part of that-- it was our own karma really-- right?-- to set this up for activities in the future. And it paid off. Steve was willing to fund this in what was-- I think most people thought it would be an unlikely thing. When Disney signed up with us, basically they were doing extremely well with the hand-drawn animation, and they wanted more product. And the first thing that they did outside of the studios was actually here in San Francisco with Skellington, and they made *Nightmare Before Christmas*, which was stop-frame animation. But in their minds that was a boutique film. And it was a moderate-- didn't cost them-- a moderate success. And they thought computer animation looks like it might have a future. It is—and this is their words-- "it's a boutique film." So they approached this as--- we're going to fund this at a very low level, and we'll probably have another thing like stop-frame animation to supplement the real thing. So they didn't know what it was going to be. And I would have to say almost everybody thought that at best it was a boutique notion. It wasn't something we believed of course but-- but we had their support. The point is they did think that way, and they were willing to do it. So we had the benefit of Disney opening themselves up at that time. So all those things kind of aligned to work in our favor. And we were ready for them.

**Hollar:** There are products that you developed for Disney that they used in traditional animation. Can you just talk about those quickly; and say what they were and what they did and now they used them?

**Catmull:** Almost as soon as Pixar was born, as we formed as a company, we were approached by Disney. So Disney wanted to bring some technology into filmmaking; and the reason was that several years before, Eisner and Katzenberg and Frank Wells basically came in and reformed the company. But the thing that initiated it was Roy Disney, Roy Disney Jr. So the deal was--- Roy wanted to revitalize the animation, and he thought bringing in technology would help bring some spirit back into it. So it was Roy's suggestion that they go out and look for some ways of bringing in technology. So they did a search, and found that while there was this New York Tech that had done cel animation, some of the guys that worked on it were actually at Pixar; and we had developed this box for working with high-resolution images. So they started talks with us; and then a company was formed and that allowed us to then enter into a contract to write the painting program for Disney Animation, which was called CAPS. And so we worked on that; and three guys here did that. It was actually a great project. A phenomenal group working on it. And then the database part of it was done down at Disney. So it was a collaborative effort.

And the first movie that we used it on was one shot at the end of *Little Mermaid*. And then the next film was *Rescuers Down Under*. So *Little Mermaid* was a huge success; and what it convinced Disney of was that animation was now back, so it could be a big deal for them. When we made *Little Mermaid*- excuse me, *Rescuers Down Under*, it was a big success from the point of view of the imagery because we had the best looking imagery really ever in terms of the quality of it there. But the film itself wasn't a big deal. But the next movie was *Beauty and the Beast*. So *Beauty and the Beast* used all the software that we had written for CAPS, which is what they called it, and it was an incredible success. In fact this movie came out in 1991. So the whole world noticed that wow, this is a huge success; and it uses computer technology. '91 was also the year that *Terminator 2* came out; which also used our technology, although it was being used by ILM. But these were two pivotal films-- talk about pivots-- that changed the industry. So all of a sudden the two big moneymakers of the year made heavy use of technology; and that's the thing that took the enter—the whole industry--- just like yanked their head around and says, "Holy cow, something is changing here." Two years later, in '93, *Jurassic Park* came out; again which used the RenderMan technology. And that was actually the last domino; and then that was the headlong rush to switch everything over to digital. So it was like our 20-year-long goal was actually reached in a short period of time; and it was the overnight success -- from '91 to '95 when everything completely flipped over.

**Hollar:** Can you talk about the origin of RenderMan?

**Catmull:** Well of course we had this relationship with Silicon Graphics, in particular with Jim Clark. We had built this software, the REYES software. So Jim came to me and said, "Let's think about the future. Can we help come up with an interface that spans everything from real time through high-quality imagery?" And since we had built the software in a certain way to do that, we then entered into a

relationship with them. We formed a group of about 19 companies to figure out what an interface ought to be. Five of the companies were very active participants. So it was us, and Silicon Graphics, and Alias was one of them, and a defense contractor; and I forget the other one. So we worked on that. But one of the things we did was--- we made one person, Pat Hanrahan, who is now a professor at Stanford University, we made him in charge of the effort. And we gave him final say-so. He was the architect, and nobody could override him. There was no committee decision. It was Pat's decision. So Pat threaded that though, and Pat designed the RenderMan interface software. And when it was done, we then started to prioritize. We took REYES to make it fit against that. And then Silicon Graphics started thinking about what it would mean to build hardware against it.

But then what happened was--- Silicon Graphics came out with a new generation, and they got over their head. They were doing too many things. So they actually had to withdraw to focus on that little purple box they were building. So basically it meant that we were the ones--- we were the only ones actually providing a renderer for it. Ultimately we just said, "Okay, it's--- you know, there's that thing that's out there; it now becomes our product." So we then started to sell it into the industry. And our relationship with ILM was that ILM actually got to use it for free. That was part of the buyout from them. And then we separated out the group and said, "You're responsible to the industry only." So we were set up so that-- they made changes to it and I don't tell them what to do. Nobody tells them what to do. Because we need that sort of wall between them so that people feel like they're responsive to them. And  the result was almost all the films that are out there are using that software; and it's just grown over the years. And they've blown way past the 80-million number. They don't even count in terms of polygons anymore. It's just it's not a relevant number anymore.

**Hollar:**  Is that another success story for the openness approach that you've talked about?

**Catmull:**  I think so; I mean, it just-- it's trying to be inclusive. You just really win that way.

**HOLLAR:** We've got about two minutes left and so I want to ask you about *Luxo Jr.* and then talk about a couple of final things if we have time. You mentioned a moment ago how you were powering so many other films; the two breakthroughs *Beauty and the Be*ast and *Terminator 2***.**  But then it was really *Luxo Jr.*, in the minds of the public, that seemed to put Pixar on the map. Can you talk about that and how that happened?

**Catmull:**  The first film that John worked on-- and he wasn't even formally the director of it-- was [*The Adventures of* ] *André & Wally B*. He came in as the animator for it as sort a temporary employee. And that was, for me, a breakthrough in a funny kind of way, because we didn't finish the film in time for SIGGRAPH. SIGGRAPH was the only deadline that ever meant anything for several years in the [computer] animation world. And we showed it, and about a third of it was in wireframe, because we didn't have time to finish the film. And what I found afterwards, when I apologized to people for being it being in wireframe, was that half the audience didn't recall that we'd actually switched into wireframe. That was a

powerful lesson for me--- that if somehow you got the story and the character, it mattered far more than the imagery itself even though we'd been working hard to make this great imagery. Something actually had transcended it.

So John didn't want to move on to the next step-- and this was our animation. So we were trying to drive our animation software forward, and several people designed a next generation of animation software; so it was Bill Reeves and Eben Ostby and some other people, too, who designed that architecture. So this was a little piece to test it. So this was John working with a lamp, and it's going to be very simple. He produced that, and it was this phenomenal success. We knew we had gotten to a different place when people came up and asked, "Was that a father lamp or is it a mother lamp?" Right? They weren't asking about the technology. So it had shifted over.

We always felt like the ultimate success is actually when the technology is not the issue. We've always felt that way. But it was noticed. It was nominated for an Academy Award, and in fact it didn't win because it was only two minutes long. The branch at that time hadn't really seen computer animation, other than a couple of experimental art pieces from Canada, so they didn't know what to make of it. So they didn't give it to it. In fact, it was the milestone piece of the year. The following year John had another piece in there, which was *Red's Dream*. Arguably two other films were of the same quality; any one of them could've won. *Red's Dream* won, and I actually believe the reason was that they recognized they had really screwed up the year before and they had actually missed giving the Oscar to the milestone piece; because it really was, in the entertainment industry and in the computer apps industry, a milestone piece. [Correction: this anecdote refers to Pixar's 1988 short film, *Tin Toy*]

**Hollar:** Then did you know at the time when *Toy Story* exploded onto the scene that it would be-- because of this storytelling over technology lesson you'd learned-- did you know that it would be as big as it was and revolutionary as it was?

**Catmull:** Well I knew as we were working on it that the way everybody was thinking about it was in terms of the quality of the story. So while it was this great and wonderful challenge, and everybody was just really diving into it, we knew what their focus was, and we took a lot of pride in that. But the trigger I knew-- because it opened well and Disney did a great job of marketing it-- but when I read the reviews, almost all the reviews only had in it one line that it was generated on the computer. And these were good reviews. But as I went through [them]--- because I was looking for it—it was "Have we succeeded?" And there was this immense feeling of pride, and everybody was like, "It's about the movie. That's what we wanted." And so that was part of the pride at the time; we said, "Okay, it was really about the story."

**Hollar:** Let me ask you two final questions Ed. Talk about building a creative culture for engineers and storytellers and artists who have to work so closely together in such a collaborative way.

**Catmull:** I have this great advantage at Pixar—in that I work with world-class engineers and world-class artists-- and I can tell you that statistically they are the same. They're both creative, very creative. When it comes to organizational abilities, there are artists who are extraordinarily organized and there are some who are disorganized. It's the same with the engineers. That is, I can't see a statistical difference between the bell curve of these two groups in terms of either creative abilities, organizational abilities or personal abilities.

I do believe in terms of environment-- and I know we've only got a few minutes left here-- but I think the fundamental issue is that everybody has the potential to be very creative. And our problem isn't how do we make somebody be creative. It's how do we let them be creative? Most of the things that happen in most companies are blocks to creativity. There are people trying to control the process; there's fear; there's fear of [the] unexpected; people want to look good. All sorts of things that get in the way. And what I look for in any environment is--- how do you get rid of the blocks? They arise all the time. They're part of human nature. They happen here. They keep coming up. And you're looking around; there's another reason why somebody is afraid. And if you keep picking away at them, pulling away at them, then they will solve the problems. Our job is to let people solve the problems. And solving the problems means, by its nature, that a lot of the things they're doing will not work out.

And there is this notion you hear – it's like: you've got to have failures and you have to allow them. Most people don't believe it. People viscerally have got to understand that if we don't have a number of failures, we're not doing our job. It is absolutely critical; we must have some things that are going on that go wrong. We must allow some randomness in our process; that is, the response to the randomness that happens in the world has got to be that we have an organization that is--- there's all kinds of randomness in it, and it allows unpredictable response at the lowest levels.

**Hollar:** If you ask people around Pixar if they thought they could find this environment anywhere else, what do you think they would say?

**Catmull:** Well, a lot of people have been other places. Right? We don't lose people to other studios. There's some who maybe go to academia or different things in their life and so forth. But I think most of them know that it's a different environment here. Some have only been here, and so they don't know. But they talk with others. At the same time we have our flaws here, too. So that those human things that come up are still here, and they will always be here. The trick is not to believe the hype that's written about us or the stories that are told about us and realize that we continually have to reinvent ourselves. It's a never-ending process.

**Hollar:** What excites you about the future?

**Catmull:** There are a number of big challenges -- sometimes people focus on what a technical challenge is, and for me the technical is just part of what we do. I do fundamentally believe that here the technology is embedded in the culture. And one of the difficulties in a different culture is they may say, "Well we live in a technical society. So how do we hire technical people or how do we bring them in?" But they're thought of as a group that will come in, or a technical group; they're not deeply embedded into the fabric of the organization. And right from the beginning we have tried to keep them deeply embedded together. I believe it's the way society is; but there are these pockets where they don't understand it and it causes dysfunction. The fact is change is happening, and the more we understand it and embrace it as part of our life, I think the better off we'll be; and we'll be in a better position to solve a lot of the formidable problems that are in front of us.

**Hollar:** Are there specific things about filmmaking or storytelling in the digital era that you looked at now that you think are really exciting and may even bring about as much change as we've seen in the last 15 years?

**Catmull:** Well the primary thing is just we're trying to get individual visions out; because people are trying to communicate with other people. That's what storytelling is; you know, it's taking some metaphor of the world and putting it in a way that people can grab on to. And that's a hard thing to do; and it's unpredictable, which means you want to be able to give people the ability to do that. Quite honestly, what we have now is a great big unwieldy system where you've got two or three-hundred people working on making a movie. Well two or three-hundred people are not light on their feet. So it actually gets in the way of more adventuresome stories. So the challenge is--- how do you bring high quality down into a lighter group? How do you use the technology or the processes or the discipline or the social factors to turn yourself into a lighter group? And that's a big challenge; and it's one we've got.

**Hollar:** Great.

**Final question:** At the beginning you talked about the group of people who grew up together, which is the Disney group. And it seems like in some ways the Pixar group is similar to that. You grew up learning this stuff as you went along; there was no manual when you started out. Can you just talk about that?

**Catmull:** Well I recognized it at Disney, that they put together this phenomenal group. They had the nine old men-- it was led by Walt Disney-- and they produced a succession of great films. They actually stopped growing and so they just had that group. Then years later, after Walt died, these guys started to retire or to die off. And it was a rather famous group; in fact, there's a picture of them up there on my wall. And as they were dying off, some of the new generation started to come in. And there was an interesting phenomenon, is that between the new generation, which included John Lasseter and Brad Bird, there were these guys that had been there for many years at a secondary level. And when the new guys came in, they felt like these guys coming in now have to earn their way up, as we've been doing all these years. So as the old guys retire, we go up and replace them. So that was the concept that these new grads ran

into; and they were very frustrated. Because the reason there weren't ten old men, or 11 old men, is that none of that group in the middle was good enough to get to that level. So they actually had this impediment in the middle.

I'd also say that Walt Disney actually, because he created this company, identified with it very strongly. The result was there wasn't a lot of thought of what was going to happen after Walt died. Now we have the benefit of looking back on that. Steve Jobs looked at that. He said, "Okay, I'm the founder of Apple; you know, I'm self-identified with my own company. But when I die, will the same thing happen? So what do I do to try to prepare Apple for what happens when I die?" And he talked with them about that. Now in our case, we've got-- there's John, Steve and I founding the company. Steve is now gone. But we have to ask: What happens? So we've tried to be thoughtful about that. How do we generate the talent, and how do we make it so that when we're gone they can do it? Because they can't repeat what we did. And that means that they have to do something new, and that means we don't even know what it is. That's what doing something new means.

So that's part of our task. Is taking these guys here -- and it's not necessarily an easy thing because we lived through a thing and we have a certain set of experiences, and our environment, our conditions that we went through, don't exist anymore. They cannot live through what we went through. And that's one of the reasons why I don't mind having a crisis; every once in awhile we have a crisis. Throws us for a loop. Every once in awhile something happens. And you don't want them to happen all the time. But thank goodness when they do happen, it means that whatever those problems are, they're our problems today. We own them and we experience coming up with the solutions to today's problems. That's why you always want to have something which throws you for a loop.

**Hollar:** That's great. Thank you so much Ed.

**Catmull:** Thank you.

END OF INTERVIEW