Oral History of Jay W. Lathrop

Interviewed by:
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Rosemary Remacle: Dr. Lathrop, I'd like to welcome you and if it doesn't bother you, I'd like to call you Jay during the interview. Is that okay?

Jay W. Lathrop: That would be fine.

Remacle: Great. So why don't we start with you giving us a little background about your family, your upbringing, how you got from where you are today or to where you are today from where you started.

Lathrop: Yes. I was born in 1927 in Bangor, Maine. And I'm the only son of two wonderful parents who've of course, long since passed on. I grew up in Orono, Maine, which is just a few miles north of Bangor. I went for two semesters to the University of Maine to get analytical geometry because MIT required that and I couldn't get into MIT directly from high school. And so I went there, but then I completed my Bachelor, Master and PhD degrees from MIT, all in physics.

Remacle: How did you choose physics? How did you get to the field of physics?

Lathrop: Well, my father was an entomologist and he wanted me to go in some biological field and he thought biophysics would be a good combination since I liked machinery and things of that sort, hard things rather than soft things. But when I went to MIT, I took biology along with other subjects during my first semester. I got A's in everything except biology and I got an F in biology. And I decided that biology was not for me. And so I just moved over to physics and became a physicist.

Remacle: What was your father's response to that?

Lathrop: He said that was fine. He didn't have any problem. MIT at that time, graded A's as H's for honors and they had H, C, D, F or something. And when I got off the train coming back after my first semester, I told my father that I'd gotten an F but don't worry, I got all four H's. And he thought that stood for horrible and he was about to die. <laughter> But we got that straightened out. He really didn't care that much about what I did.

Remacle: What was the first time that you ran into computers? I mean could you even conceive of them when you were in college and choosing your field of study?

Lathrop: No. I had no idea about computers. And I really didn't know about them particularly until I got to Texas Instruments. I just had no knowledge of computers.

Remacle: So where did you, when you graduated from MIT, where did you go? Where was your first job?

Lathrop: Yes, my first job was at the National Bureau of Standards in Washington, D.C. And the reason I went there was two-fold. One is that I had avoided the draft after the war. I wasn't old enough for service during the war. But after the war they still had the draft and I avoided that by taking advanced ROTC at MIT. So I'd never really served in the military and I felt that I owed my my country something. And so I wanted to take a job doing some sort of helpful military work. And the National Bureau of Standards had a Fuze program. They were responsible for developing the proximity fuze during the Second World War. And there was a fellow who was in the laboratory where I was working at MIT, who worked at the National Bureau of Standards. He was at MIT studying and he convinced me that National Bureau of Standards would be a good place to go. He later became a director of the National Bureau of Standards, so he stayed there and progressed up the ladder. But those two things made me want to go to the National Bureau of Standards, the government service of course. And I was there for seven years. The part of the National Bureau that was doing the fuze work, was split off into the Diamond Ordinance Fuze Laboratories right at the same location on Connecticut Avenue and on the grounds of the National Bureau of Standards.

Remacle: Why were the fuzes so important and why was so much attention being paid to them?

Lathrop: The proximity fuze?

Remacle: Yes.

Lathrop: Well of course they defeated the buzz bombs that the Nazis sent over to England. And they allowed us to win the Battle of the Bulge. After the air missiles had been declassified to work on the ground, then they were used in the Battle of the Bulge for the first time. And then there were plans to send them to Japan and that war, but they didn't have to. So they were very vital. And from that time on, there was a big push in the army, Army Ordinance Corp to equip most of the missiles with proximity fuzes. My first job was with the 60 millimeter mortar, which is about two and a half inches in diameter. And that's where we realized that we couldn't work with encapsulated transistors and we had to have a supply of un-encapsulated transistors to play around with to try to make very small circuits to fit in that area.

Remacle: So you couldn't use the encapsulated transistors because they just took up too much space and didn't--- fit into the allotted space

Lathrop: Took up too much space, right.

Remacle: What was the importance of the military in supporting and funding and helping set the requirements for technology and product development in that phase?

Lathrop: I guess I don't understand the question.

Remacle: In the work you were doing, how important was the military in defining the work itself?

Lathrop: Well you mean--

Remacle: --Did they just fund it or did they help define what they wanted you to work on also and what the results should be?

Lathrop: No. No one gave us specifications of anything to do. It was just that we needed to make state of the art transistors that were unencapsulated and to try to use them then, in producing very small circuits. No one said what type of circuits. At that point it was too early in the game. As things went on, after I left the Diamond Ordinance Fuze Laboratories, I am sure that they specified exactly what circuits they were trying to build and what transistors they needed to put in them and so on. But we were just showing the feasibility of the technique at that time.

Remacle: So how much of the focus was on miniaturization or was that a step of specificity that they didn't get involved in?

Lathrop: Well the whole concept was for miniaturization and that that's the reason for getting rid of the can, the enclosure on the transistor. We didn't try to make the transistors however, extra small or anything of that sort because they seemed to be small enough already.

Remacle: So your first project then was working on these unencapsulated transistors.

Lathrop: That's right. We had to build all the equipment, Jim Nall and I. I recruited Jim Nall as a chemist to help. And he and I and the machine shop and glass blowers, put together all the equipment that we needed to fabricate the fuze-based germanium transistors, starting from just raw germanium that we purchase from Gerber Scientific.

Remacle: How long did you and Jim work together as colleagues? You had a long-- or a lengthy working relationship?

Lathrop: Yes. I would say that we worked together for at least five years.

Remacle: What was the key product out of that five year partnership or working relationship? What was the key result? What project did you focus on during that working--

Lathrop: That was it. The-- making the transistors.

Remacle: How did you get from making the transistors to photo lithography was the question I was fishing for.

Lathrop: Oh, well, yeah. Everything went well as far as making the equipment to manufacture the transistors, except when we got to defining the areas of the metal and the mesa, these were mesa etched transistors. And we had to figure out how to do this. Now in commercial operation, I'm not sure exactly how they did it. Perhaps they, in mesa etching, they sprayed wax through masks, metal masks or something of that sort. We came up with-- we could not make metal masks. We didn't have the capability for making photographic masks. So what we did was, we used a microscope to project the patterns that we needed, on to the germanium through a microscope. We used the microscope in a reverse direction by projecting the patterns down through the eye piece on to the surface and--

Remacle: Whose idea was that?

Lathrop: Oh, I don't know. I guess perhaps Jim, perhaps mine but probably Jim's. He was a chemist and he'd looked through a lot of microscopes.

Remacle: So how well did that work? What caused you to move on and try and find another reason-- another way of approaching, solving the problem?

Lathrop: Well that worked perfectly fine and that was- that was well for making one transistor at a time. The problem would come if you tried to make multiple transistors as device manufacturers wanted to do. And that's one of the reasons that I left the Diamond Ordinance Fuze Laboratories and went to TI, was that I was looking for a company where I could make more than one transistor at a time, where I could apply the photolithography across the whole slice and make maybe 100 transistors or something like that.

Remacle: Well why don't you look back and talk a little bit more about the process of how you refined looking into the reverse end of a microscope, figuring out what now, today, is routinely called photolithography?

Lathrop: Well we just coated the wafer that we had grown. We grew single crystal germanium and we sliced it into wafers and then we coated that with the resist from Kodak which they had given us as a sample to try. And then we shown the pattern that we wanted to-- let's see, first we had diffused the slice so we had the n-type base all in the slice. And then we would come back and put in a gold pattern. So we would evaporate gold on the surface and then put down a little rectangle of protective resist, etch off everything except the little rectangle. We could then alloy that into the germanium. That would be the base contact. It was gold doped with antimony. And then we would come in and do the same thing with an aluminum contact to make p-type emitter and emitter contact. It was a PNP transistor.

Lathrop:. It's hard to describe it here. If I had a blackboard I could draw pictures and show you much better.

Remacle: What was the most challenging aspect of this work and how much time elapsed between where you began to say, I think this is what we want to do and here is how we might make it work? So from kind of that, the "aha moment" till actually something worked for you, how many weeks, months?

Lathrop: Well there wasn't really an “aha moment” I don't think. In this case it took us probably two years, a good two years of building the equipment and so on and gradually solving one problem after another. And things just went along and we had our setbacks and then we had successes. And eventually I guess the, the real “aha” came when we made the first transistor and probed it and found that it worked as a transistor. Then the next “aha” came when we put these transistors into a circuit and evaporated the connecting leads onto the circuit so that we had a planar circuit but not a planar integrated circuit, but just a planar circuit. The insulator between the metal, the positive leads and the germanium was the resist that was left on.

Remacle: Can we go back and have you talk a little bit about the work environment? You mentioned that you had the glass blowers and so forth. So you and Jim were not working as a closed cell. You had a team or other teams around you of people that you were working with to help move the project forward. Can you talk a little bit about the physical environment, the people you worked with?

Lathrop: As far as the transistor went, we were the only ones. We and the people in the machine shop and the people in the glass blowing shop and we put it all together. When it came to adding it to the circuit, then the circuit people did the self-screening, did the screening of the resister on to the circuits and that sort of thing. But we inserted the transistors and evaporated the connecting leads and that sort of thing.

Remacle: Was there any one aspect that was more of a challenge than others or was it just kind of solve a problem, move to the next problem, solve that problem, in a more linear fashion?

Lathrop: I can't think of anything that really held us up for any length of time that we weren't capable of dealing with.

Remacle: Can you talk a little bit about the exchange between the physicist and the chemist on this? How did that work between the two of you?

Lathrop: Well, I was interested in how the transistor was operating and what type of material to dope with and how much and this sort of thing. And Jim was interested in what type of etches to use and more of the chemical aspect and I guess that was mainly it. But we did everything more or less together. In other words, it really wasn’t a divided program. And he'd have an idea and then I'd have an idea and we'd work on it together.

Remacle: Last night there was a discussion of how information traveled within the community. Were there other people that you were aware of that were working on similar problems or projects? How did you communicate what you were doing outside of the Diamond Ordinance Fuze Laboratories? Can you talk a little bit about that?

Lathrop: Yes. I wasn’t aware of any other work going on anywhere with regard to resist. Now there may have been and I've heard that perhaps Bell Labs had been looking into it. But I wasn’t aware of it at the time. And I don't know of anybody that was trying to manufacture transistors in that sense in the way that we were. We were free-- we talked about it freely with other people. The industries were quite happy to cooperate with us because they saw that there might be some business associated with manufacturing proximity fuzes which would be in the high volume sort of thing and they were perfectly willing to talk to us. So there was no secrecy between us and them.

Remacle: And you mentioned industries or companies, which ones in particular were most interested in that you had the most exchange with?

Lathrop: Well I was trying to think of that the other day. I know that we, as I mentioned, we had talked with Philco because of Bob Noyce being there. But we had visited several others. I think we had visited RCA and Sylvania, Raytheon, people that are no longer in the transistor business. And we got tips on how to grow crystals, how to slice crystals, how to clean crystals, how to evaporate, how to alloy. We got all sorts of information like that as well as from reading books. We did not go to Bell Laboratories.

Remacle: And why was that?

Lathrop: I have no idea. We just didn't, never seem to--

Remacle: You mentioned Bob Noyce's name. If I remember correctly, you and he were classmates at MIT?

Lathrop: Yes, that's right. We were in some of the same classes. We weren't particularly buddies in the sense of doing things together or anything like that. We'd gone to some parties at professors' homes, hikes and various things of that sort. But I was married at the time and he wasn't and so there was a difference there. And we were both in graduate school of course.

Remacle: You mentioned that Bob visited or you visited him, I now have lost the train of that thought.

Lathrop: We visited Bob at Philco in Philadelphia and Bob Noyce came to visit DOFL after I had left. Somebody asked me that and I said I didn't remember him. I certainly would have remembered him if he'd come while I was there.

Remacle: Okay. If you then moved on from-- you've solved the photolithography [puzzle]. Perhaps you can talk a little bit about that, about how did it come by its name as accurate or inaccurately as that may be the description. But can you talk about how you moved from kind of the experimental level to something that is now standard process? It's quite a bit different today, but--

Lathrop: Well we presented a paper on this called photolithography, "Photolithographic Transistor Fabrication Techniques" at the PGED, at the IRE meeting of the PGED which is the predecessor to the IEEE meeting of the IEDM meeting of today. And that was the first paper that had been presented on how to do it. And it was the first use of the term photolithography, which of course it wasn't. It was not lithographic at all, lithography, it was etching. But I think Jim was the one that said photolithography sounds better than photo etching and so that has always stuck, even though it's completely wrong.

Remacle: What was the reception to that paper?

Lathrop: It was very well received and the popular press picked it up as well as some of scientific papers. We got a lot of interest in it. It was probably wrong interest in that people would say, transistors are now printed, you know. Well they're not printed. Photolithography sounds like printing, which it is. But that's not what we were doing. We were etching small parts of the transistor process and you couldn't make a transistor by printing, using our technique.

Remacle: You mentioned that it got some play in the popular press. Why was that? What was it about it, about your work that caught their attention or their interest?

Lathrop: The term printing transistors I guess. Now we never used that but when we used the term photolithography, they immediately jumped to the conclusion that it could be printed, so some of the newspapers used that.

Remacle: Can you describe the [customer] adoption process? You said the initial response to the paper was very positive. When you kind of know something is a success when people start actually doing it in multiple places at the same time or in parallel. When did it dawn on you that this was something that was going to be very useful in a very broad sense?

Lathrop: I think the thing that really made it come into being in a universal sense, was the planar process of Fairchild and that really required photolithography much more so than the alloy type of construction that we were doing. You could get by without photolithography under those conditions.

Remacle: Did you have any conversation with the folks at Fairchild?

Lathrop: No. No. I mean it was common knowledge. As I say, we presented a paper on it and were granted a patent on it. I'm sure that other people began using it. It wasn't a secret of any kind.

Remacle: When you were in the midst of it, could you… it's easy now looking back to say what an important, I don't know if you would call it a discovery or not, but what an important accomplishment it was to the semiconductor and now the computing industry by extension. But when you were in the midst of it, did you have a sense of what an important role it would play?

Lathrop: Sure. Yeah I realized that it was important and it was the way to go. We had a lot of problems in getting going on it. For one thing, at Texas Instruments we were working on making things on a whole slice rather than just looking through a microscope and putting it down in one place. And so we had to have masks, photographic masks that we could put on the coated wafers before exposing [them]. Well, to start with, there are no places to buy any masks. We couldn't make any masks. And so I went down to the local blue printers and worked with them at great length to try to reduce their masks down to something that we could use. Of course in those days, the dimensions were much bigger than they are now. But even so, when they tried to reduce the patterns down to what we wanted, they ran into a lot of trouble. For one thing, they ran into a lot of dust problems. They used carbon arc lamps to expose and the carbon arc would put off particle. And they would have to use a material called Aquadag to look at the patterns and then put the Aquadag spots on the patterns. And they would perhaps go through two steps in making the photo reduction. And each step would have these little spots in there that were dust particle unexposed. And they would have to then go through and put the Aquadag in. It was generally unsatisfactory. We did get some masks which we could play with but it was not-- they were not good masks. They had a problem with dimensional control as well. The next thing I tried was going to Buckbee Mears in Minneapolis who made metal masks. And I tried to get them to make some masks. But their masks weren't any better either. And so we realized that we had to make our own masks. We had to become involved in the photography of the thing. And so we set up cameras, we set up ways to control the resist and it became a big operation.

Remacle: So you were vertically integrated at a very early stage.

Lathrop: Oh yes, right, yeah.

Lathrop: And of course you go through the vertical integration stage like that. And then later on, not too long, people realized that there's a market here if they wanted to produce high quality resist, if they wanted to produce high quality masks. And then you no longer had to do it yourself. You would find that you could purchase better masks elsewhere and you could purchase better resist elsewhere.

Remacle: What was the time frame that people began to say, “hey there's a business here” to produce high quality?

Lathrop: Oh it took quite a while. It took maybe 8 to 10 years before that really happened. Even the resist was a problem. We had, it turned out, resist has gel slugs in it and we had to get rid of the gel slugs by centrifuging. And one centrifuge wouldn't do it. We had to have several centrifuges and we had to build a separate building to contain the centrifuges. And we would buy resist by the gallons and we would centrifuge it and to get rid of these gel slugs and purify it and so on and so forth. It was a real complicated thing, just to get the resist.

Remacle: And so was the military still picking up the tab for all of this at this point?

Lathrop: Well the military didn’t pay for that, but they supported work to make particular circuits and of course you could use some of that money for things of that sort.

Remacle: That would support the circuit work.

Lathrop: Yes.

Remacle: Okay. So talk a little bit more about the transition toTI you mentioned, from Diamond Ordinance Fuze Labs to TI. How did your work at Diamond Ordinance Fuze Labs wrap up and transition you to the TI work? Unless you have some more you want to talk about Diamond Ordinance Fuze Labs.

Lathrop: No. I left before Jim Nall left. He left a year or so after I did. He went to Silicon Valley to Fairchild. And so he was able to continue the work that I had been doing and took over that aspect of the thing. And I just went on and got started at TI.

Remacle: How did you get recruited to TI? Why TI and why not Fairchild or someplace else or RCA?

Lathrop: Fairchild particularly wasn't interested at the time and TI was interested and probably the-- in the photolithographic aspect of my work. And I almost went to RCA. They were very interested in getting into photolithography work too. Of course that wasn't the only thing that I offered. I knew a fair amount about building transistors and all the things involved with diffusion and alloying and so on. So I had a general knowledge of the subject.

Remacle: So why TI and not the others? Was that their choice or your choice?

Lathrop: It was just a flip of the coin. We'd never been further west than the Mississippi River and decided that that was a good thing to try. Of course TI had a good reputation you know. They had been making transistors with great success when other people were having great difficulty.

Remacle: And what was the reason for TI's success where other people were having difficulty?

Lathrop: I'm not sure I can answer that question. I don't know. They just seemed to do a better job of making things. They had come out with the first silicon transistors. They knew how to work with silicon, how to grow silicon crystals, whereas other people were still working with germanium. And so they were advanced. Perhaps Gordon Teal had something to do with this. He had been with Bell Laboratories and went to Texas Instruments as a director of research.

Remacle: When you went to TI, what was your area of responsibility, job title, reporting structure, et cetera?

Lathrop: When I first went to Texas Instruments I was reporting to Willis Adcock, Jack Kilby was reporting to Willis Adcock as well. And after Jack came up with his demonstration of the integrated circuit, which is only about two or three weeks after I'd joined, they assigned me to him. So he was my supervisor and I was in charge of making the circuits. We had essentially three areas. We had Charlie Phipps in charge of marketing. We had Jerry Lueke in charge of design and I was in charge of making the circuits, that is the diffusion, the evaporation, the ionized metallization, the photolithography, all of that sort of thing.

Remacle: Had you met Jack Kilby or did you know Jack Kilby before you got to TI?

Lathrop: No. I did not know Jack Kilby. I had heard that he had made some of the silk screen circuits that were being used at Diamond Ordinance Fuze Laboratories, but I didn't-- other than that I didn't know anything about him.

Remacle: Last night you described the demonstration that you watched with some of the TI's: Top Brass. Can you walk us through that?

Lathrop: Yeah I was just-- sort of got my dark room set up. I'd been there maybe two or three weeks and had gotten the dark room set up and was ordering equipment. I'd turn in some drawings to the machine shop about jigs and fixtures for our slices thing and Willis Adcock called me down to his conference room to see a demonstration, so I went down and here was this very tall fellow doing something which would cause an oscilloscope to go from a straight line to a sine wave. And there were a bunch of people standing around who were obviously very important people and it turned out they were the President of the corporation, Pat Haggerty; the Vice President in charge of the Semiconductor Division, Mark Shepherd; Gordon Teal, Director of Research, and several other people that were obviously higher-ups in the corporation. And as soon as they sort of backed off, then I could get up there and see what was going on and meet Jack and he had what appeared to me to be a dead bug attached to a microscope slide with his legs sticking up and really it was the wires, little wires coming out of a piece of germanium. And he would connect to those wires and the oscilloscope would change. And that was the first integrated circuit, the smallest circuit in the world, the great dream of GWA Dummer from England who had predicted in 1952 that something like this would happen. So it was a great moment in the history of technology. I feel and it's a shame that they didn't have a photographer from TI there to record the information. It would have made a great mural.

Remacle: What was the response of the people in the room? Did they recognize or acknowledge what a breakthrough it was or was this just an interesting evolution?

Lathrop: That was one of the things that impressed me was that immediately, not the next day, not the next week, but immediately, they said, "We've got to capitalize on this in some way. We've got to organize." And so at that point, I became assigned to Jack Kilby, the first engineer and we went on from there.

Remacle: And what kind of a person was he to work for and with?

Lathrop: Jack?

Remacle: Yes.

Lathrop: Yeah, well, he was a great guy. He was never demanding, but you knew what he wanted to have happen and so you tried your darndest to make it happen. And he was very helpful in every sense of the word, both technically and managerial-wise. He was an eternal optimist and when the yields got bad and time-- things went, got worse and worse, he never lost hope. I've been in meetings with him at the low point when we were trying to meet a contract for the government, I believe it was Wright-

Patterson Field, and we weren't doing it. We were in a meeting with the Vice President. The Vice President got so mad, he threw an eraser at the blackboard, swore and that sort of thing and Jack just remained perfectly calm and we realized that what we had to do was not try to make more starts of wafers, but to go back and think about what we were doing and start over and do things very slowly and carefully, which we did, and the yields improved and things got much better.

Remacle: What was your first team meeting or your meeting with Jack? I don't know exactly how that would have worked. In other words, who else would have been in the room in the discussion that, "Okay, so you've had a management decision. We need to turn this into something and build some business around it." How did you come together as a team and say, "Okay, this is what you're going to do, here's the next steps," kind of begin to move forward from more of a research mode into let's get it into production mode?

Lathrop: Well, we had to find people first of all. Since I was in charge of the fabrication end of things, I had to get somebody to handle each one of the steps. I had to get a man for diffusion, a man for evaporation, a man for the photo-masking operation. I'm trying to think if I had anybody else, but then they would in turn have to get some engineers to help them. It was a question of building up the team. The same thing was true for the design people. They had to get people to do the design work. They needed to build up that aspect of it.

Remacle: How difficult was it to find the right people when you're at the very front end of a technology, an industry? How did you go about recruiting and finding people?

Lathrop: Well, many of the people came from other projects in TI, but we did hire some people from outside as well. And there was a lot of interviewing that went on. People would come in and it was almost impossible to get someone that knew something about it that hadn't worked at TI. In other words, there wasn't any jumping ship from any other place to come to Texas Instruments. So we got some new people out of school, we got some people reassigned from other projects and we had headhunters that went out, commercial people, that looked for people to help us. I didn't particularly have a particular problem as I remember, but, you know, we didn't- it didn't happen overnight. It took awhile, but-

Remacle: And you're still in Dallas at this point?

Lathrop: Oh, yes. Yeah. One interesting anecdote here is that they-- one of the things that the design people needed were people with switching experience and I don't know how I happened to do it, but I guess the design people were tied up and one of their- the people had been sent in from a headhunter who was supposed to have design, switching experience, I got assigned to get down, go down and bring him into the plant. And he was a young fellow and I brought him into the plant and the minute he got inside the plant, he said, "Oh, my goodness. This is such a wonderful place. I just can't imagine that I'm here. I've got to tell my mother that I was here." And I thought, "My, that's sort of weird." And we got down to my office and I said, "Well, now you know I'm sort of filling in for the design people, but we were looking for people with switching experience." And I said, "What sort of experience have you had switching?" He said, "Well, I'm a brakeman on the Kansas City Southern Line".

Remacle: So your headhunter hadn't done a very good job of screening.

Lathrop: Somebody, some headhunter in Kansas City apparently had gotten hold of this poor guy. I felt sorry for him and I enjoyed railroads and so we had a good conversation and I sent him back on his way, so I don't know what he ever told his mother.

Remacle: Alright, let's go back, Jay, and talk a little bit about what were the applications that were bandied about when people like Haggerty said, "Let's make a business around this," and you had to have, I'm guessing, you'd had to have had some idea of what you were trying to design for and develop for?

Lathrop: Well, Charles Phipps was telling me that he used to meet with Haggerty regularly about once a month and they would go over what sort of penetration Texas Instruments could expect into the circuit market for all circuits and Haggerty would make rather wild projections which of course were very low compared with what actually happened. He would make projections like integrated circuits might result in thirty percent of the circuits being made with integrated circuits and of that thirty percent, maybe half would be from TI. Of course, when you think about the number of circuits that are made today in digital computers and other activities,that is ridiculously low.

Remacle: What about the balance between industry customers and military customers? Where was TI on that spectrum?

Lathrop: Well, at first, the military were the only ones that used the integrated circuits.

Remacle: For what kinds of applications?

Lathrop: Well, the Air Force had a program and then there was NASA, they had a program, programs where they could buy these things that cost, you know, a hundred dollars a piece or more. But then as the cost came down, industry became interested.

Remacle: So it's the fairly normal price learning curve? When you get more volume, the price can drop down because things become cheaper to produce?

Lathrop: Yeah.

Remacle: How did you all fit into the rest of TI? Were you seen as this special group someplace or the golden kids or were you just some people doing their job?

Lathrop: Oh, there was a lot going on at TI other than this and at first, we were just a small section of it and gradually it grew bigger and then it went from a development operation into a production. At that point, I left and went into the- what they call Semiconductor Research and Development Laboratory and I got out of the main stream of the production. And the production took over large areas of the plant and they made production lines out of it, that sort of thing, rather than just having a diffusion furnace and an evaporator here and there, so it eventually became a big product operation.

Remacle: What role did competitors play in TI's thinking? How much of the work was done and the development was done of the integrated circuit as a business with an eye on what the competitors were doing and how much on just, "This is what our strategy is and that's the path we're going to follow?"

Lathrop: Well, that's something that probably management could answer. I really don't know. As far as I'm concerned, I just had technically things to do which I did and what that was for, I really didn't know.

Remacle: Can you talk a little bit about Jack Kilby's influence within TI, which I presume grew over the months and the years?

Lathrop: Influence. Well, he was always looked on as sort of the prophet, the person that would, could look far ahead and think about where things were going. And so he made presentations to upper management about different processes and products, ideas and so on. He had a very great influence.

Remacle: When did the word "computer" start to be used as a business possibility or the concept of computing, building something more than just an integrated circuit, that the circuit was going to enable something greater than that?

Lathrop: Well, of course, they made the handheld calculator. That was one thing that was made. TI never made computers as such. They just made the parts for computers.

Remacle: I was thinking specifically of the handheld calculator. and things like that. Computing devices perhaps rather than computer.

Lathrop: Yeah, they made calculators and the first handheld calculator was invented by TI; Jack Kilby, Jerry Merriman [ph?] and somebody else who I forgot.

Remacle: What about TI's place in the industry? You mentioned that TI was- they were down there in Texas more or less by themselves… and then there was Silicon Valley and the East Coast.

Lathrop: Yeah.

Remacle: So talk a little bit about TI's size, influence, how it interacted in its place within the overall semiconductor industry at that time.

Lathrop: Well, that's very hard for me to answer. They did very well. They prospered. They made money. They sold product. They were looked on very well. They had plants overseas. We had plants in England, we had plants in France and in the Far East and so on. They did as well as other plants as far as I know. At one time, they had a hundred percent of the product from integrated circuits and a hundred percent from transistors, this sort of thing, then it gradually went down, down, down as other people came into the business. So they were a leader in many respects, but other people quickly overcame that.

Remacle: Did you collaborate either through industry meetings or groups, I'm thinking IEEE, organizations like that, that you collaborated, shared information and ideas with, that helped move the overall integrated circuit forward?

Lathrop: No.

Remacle: Or did- at that time, had everybody hunkered down to create their own business?

Lathrop: No, not during my time. Later, that came through places like the Semiconductor Research Laboratory which is a group of industries that got together to cooperate with universities on projects. But that was- that happened after I went to Clemson that that occurred.

Remacle: So at this point, TI was holding their work pretty close to the vest, as was Fairchild and the other potential-

Lathrop: That is correct, yes.

Remacle:. Which company did TI and you and the Kilby team view as your most concerning competitor?

Lathrop: Well, I would guess it was probably Fairchild. Motorola was also one that we were concerned about. Motorola I think nowadays has sort of fallen far behind, but in those days, Motorola was a rather important supplier. In fact, one of the people that worked for TI went to Motorola and sort of took over the operation down there.

Remacle: So would the competitive concern for Motorola be the same as the competitive concern for Fairchild? In other words, did Motorola and Fairchild, were they kind of co-equal in where they could flank you or did you have concerns about each of them for different reasons?

Lathrop: Well, that would be a marketing problem. I-- we were interested to hear what new ideas and technologies came out of these companies, but as far as which ones we were really concerned about because they were selling more than we were or they were penetrating markets better than we were, that would be a question for marketing people to answer. I did not keep up on that.

Remacle: I was thinking more about either design or process reasons that they might have a step ahead, be a step ahead of you in some area.

Lathrop: Well, other than the planar process which changed everything, I'm not aware of any specific things that any company did that made a big difference.

Remacle: Can you talk a little bit about how, when you say, "The planar process changed everything," how did it change the game so dramatically from your point of view?

Lathrop: Well, it changed all our processing. We no longer had to etch through the material to make all sorts of weird shapes which is rather difficult to do. We could do it all in a planar fashion, much neater, much cleaner, no more wires that had to be strung from here to there, that sort of thing.

Remacle: And as the planar process came out of Fairchild, how was that shared with the rest of you guys in the semiconductor industry?

Lathrop: Well, I'm under the impression it wasn't particularly shared, it was just developed. We developed our planar process knowing that it had been done by Fairchild.

Remacle: You had to create your own TI version of it?

Lathrop: Yes, right.

Remacle: Okay. And how did that happen? Can you explain that a little bit?

Lathrop: How did what happen?

Remacle: How did TI develop their planar process?

Lathrop: Through trial and error, I guess. We just-- you know, the ideas are simple. Implementing them complex. And so it just took some work and effort to build up the infrastructure that was necessary.

Remacle: This is a question I asked you relative to your work at the Diamond Ordinance Fuze Labs, but let me ask it here, too. When you were in the midst of it, did you all have a sense that you were- that the integrated circuit, the solid state, the solid circuit, would have the impact that it has had today? Did you have any sense that it would be as immense?

Lathrop: No. No, we had no idea and it grew every year and but still, we had no idea how big it would eventually be.

Remacle: Talk a little bit about your work life,[the TI] environment. I remember in my own life, at a semiconductor company, we worked pretty hard, long hours, but with a great amount of enthusiasm. And sometimes families took second place and the rest of our lives got set on the shelf for awhile. Can you talk about that at TI during this period?

Lathrop: Well, that was certainly true and there were many long days and a lot of weekends. When I first went, first joined TI, the standard work week was five and a half days and it took about six months I guess after I'd been there maybe a year, but they dropped the half day on Saturday. That had nothing to do with integrated circuits, of course. But the work ethic had already been established at TI and when we tried to get the integrated circuit production going, many nights I'd stay until seven or eight o'clock at night and go in at seven in the morning, a lot of twelve hour days. So it was a tough life during those periods.

Remacle: Did you then and would you now, looking back on it, would you consider yourself an entrepreneur?

Lathrop: No, I'm certainly not an entrepreneur. I'm far from it and I don't think Jack Kilby's an entrepreneur either. I think one needs to define entrepreneur maybe, and maybe I would change my mind, but the question last night at the forum was "do you think Jack Kilby was an entrepreneur?" and Charlie Phipps said "yes", but I would disagree with that. To me, an entrepreneur is someone that has an idea and then goes out and capitalizes on it personally by setting up their own company, by getting capital to invest in it and so on and so forth and I'm not that type, Jack is not, was not that type. We just want to succeed, we want to do the best we can, but not try to throw everything personally into it the way Robert Noyce did. Now he was a real entrepreneur.

Remacle: You say that Jack wasn't an entrepreneur. What interested him--- and I'm thinking about your discussion in the IEEE interview--- between problem solving and innovation and so can you talk a little bit of Jack in the context of that and yourself in the context of that?

Lathrop: Well, problem solving is where you work- you try very hard to do something and so you- and you're usually under sort of a deadline, so you work towards solving a particular problem by doing the best you can. If it's to make something small, then you reduce the size of everything. You don't come up with novel ideas. Innovation is where something-- you get a bright idea and it just so happens that it solves a particular problem. When Jack Kilby invented the integrated circuit, he had a background in miniaturization, but that really wasn't the primary thing he was trying to do. He wasn't trying hard to make a small circuit by a certain length of time for a particular application. He merely had the time available so that he could try out an idea that he had of making all the components out of the same material he made the semiconductor and he was able to do that and that turned out to be the integrated circuit. And that's innovation because it turned out that when he did that, it was the smallest possible circuit.

Remacle: But he wasn't out to make the smallest possible circuit necessarily?

Lathrop: That's right. If he had been-- if somebody said, "Make this the smallest way you can," he'd try to shrink everything down. That was the logical way to do it. If you do it the logical way, that's not innovation, but that's the way to solve a problem is to solve it logically. Now, you can't count on innovation solving a particular problem. Innovation just sort of happens, in my opinion.

Remacle: Your opinion is the one that counts right now. We're listening to you. Going back to you said you left the semiconductor business group or development group that focused on industry and went into a semiconductor development lab group at TI after the initial work with Jack. Can you tell us what you worked on in that period of your career?

Lathrop: Well, the same sort of thing basically. I worked under Dr. Richard Petritz who is now deceased. He left TI quite awhile after I left and set up his own company in Colorado Springs, which had marginal success I guess. Anyway, he had the SRDL Research and Development Laboratory in Texas Instruments.

The Research and Development Laboratory included many ideas. There was work on gallium arsenide, there was work on diffusion which I was involved with, there was work on different processes and how to improve these. It wasn't particularly manufacturing devices as such, it was developing processes.

Remacle: Another loop back. Someplace along the line, things change from germanium to silicon. Can you talk about that transition?

Lathrop: Yes, germanium is a nice material to work with in that it is easy to etch, it's easy to make, it solidifies, it grows crystals at lower temperatures, but it's not as durable. It won't operate at high temperatures the way silicon does. And TI always had a mindset that it doesn't matter how well you do it in germanium, it's unless you can do it in silicon that it really counts for anything. And this comes about primarily because TI was the first company to come out with silicon transistors. And there was the famous meeting of the Electrochemical Society where there was a session devoted to silicon transistors and whether they would be around in the future. Speaker after speaker said, "Well, it would be nice," but they didn't know how to do it, they doubted that it would be available within ten or twenty years. And Gordon Teal was from Texas Instruments, was the last speaker and he came up and he threw out a handful of silicon transistors and said, "Here we are, they're commercially available," and to demonstrate how they worked, he heated up a hot beaker of oil and he connected that to a phonograph and put a germanium transistor in there and the phonograph died and then hooked up a silicon transistor and put it in and the phonograph kept right on playing. So that was really a star performance and from then on, TI concentrated on everything silicon.

Remacle: What about the early concerns about, this is true of almost any new product that gets introduced, but concerns about reliability, length of mean time between failure and life and all of that kind of thing?

Lathrop: Yes, of course failure is very important and that was one of the things considered in integrated circuits and people were really worried about the possibility of integrated circuit failure. In the early days, it would be easy to test devices for failure, but much more difficult as the devices got more and more complicated and the only really way that they are tested nowadays for failure is through a computer simulation. The people don't put these on life tests by heating up or that sort of thing anymore. They're just not a possibility to get enough devices to make it worthwhile going through.

Remacle: Just for comparison, at that point in time, do you have any recollection of how much a wafer cost, how much the finished circuit or as it came, once it was sliced and diced, cost?

Lathrop: I've forgotten all that data. It's pretty well known, I just don't remember it.

Remacle: Okay. What caused you to leave TI? Can we talk about the transition from TI to Clemson if you would?

Lathrop: Well, some of it was personal. Some of it was technical. The personal things were that my parents had retired to North Carolina and were not in the best of health and I felt I needed to get back closer to them, so I wanted to move back east. Another thing was that my children were growing up and Dallas had become a difficult place for children to grow up in because of the various things, drugs and racial problems, the things of that sort and I wanted to move to a smaller place. The technical things were that I had been involved for the past year, or maybe two on this wafer scale integration. This was an approach that Jack Kilby had come up with to try to avoid the yield problems that we were in. If you have a whole slice, at the time we were talking about, there might only be ten or twenty out of fifty or a hundred that were good integrated circuits. And so his idea was to probe the integrated circuits in slice form, select the ten or twenty good ones and to draw a pattern to interconnect these, to make whatever you wanted to make, and then do that via evaporated leads, vacuum deposited leads and so we generated the patterns using projection TV type of instruments. We had a very knowledgeable cathode ray individual who worked on this with us and we were able to come up with cathode ray generated patterns that we could then apply to a slice. Each slice had to have a separate complicated pattern for interconnection and that required a lot of software that went into generating the patterns and a lot of hardware to get the cathode ray alignments proper because you had to have tremendous tolerance problems. So it was a very difficult thing to do, but we could do it. The problem was that it just wasn't economical, particularly after the MOS transistor came out and it was easy to make high yield devices in volume. It just wasn't practical to do this over a whole slice by probing and then going through the pattern generation and then doing the depositing of the leads and interconnecting. So this wore me out really, physically and mentally I think, trying to get through this and so I decided I would go into some other activity, namely university teaching for awhile.

Remacle: You just mentioned two things that I would like to have you expound on a little more. One is children, when you talked about your personal life at the very front end, we didn't get to the children part. And you said you have two children, male, female?

Lathrop: I had four children. **Two** boys, two girls. One boy is now dead, but they seem to be doing fine.

Remacle: Did any of them follow your footsteps into the semiconductor industry?

Lathrop: No, the closest was one girl became an engineer. She first became a teacher because in those days, girls usually became teachers or nurses or something like that. She became a teacher first and tried it out in an inner city school and decided that it wasn't for her and then she went into engineering, got her engineering degree, became a certified engineer, took the test, whatever you call it and she's now Director of System Security Protection for the Duke Power System. This involves all the transmission lines, keeping them up, the relays that are connected with them and making sure that they don't fail. So if she's doing a good job, nobody knows her and if she does a bad job, then all hell breaks loose.

Remacle: The other word you used was software. When did software start to be something that you as a physicist had to start paying attention to?

Lathrop: Yeah, so of course software came in in the design of the integrated circuit. I did not have much contact with that, but the software with regard to the interconnection and the large scale integrated slices we did have contact with and I had someone working on that part of the problem. And that is difficult because you never know where the bad units or the good units are, so you have to make your patterns come out to do that, to interconnect it to make what you want. You have to do it without any intervention by people. You have to do it by taking the probe data, having that information go into a computer and then having that probe data generate a set of patterns. So it was an extremely difficult thing and we had people in the software group of the Research Laboratory. And they would work hard on this and almost get it right and then you'd say, "Well, okay, when are you going to have it?" Well, they didn't know when they would have it and I understand why they didn't know, but nevertheless, it's hard to plan if you don't know when you're going to get something done. And so that was a very difficult runaround.

Remacle: So you came to the conclusion for your personal and technical reasons that you wanted to move into academia, wanted to move geographically.

Lathrop: Right.

Remacle: Move to a different location geographically. How did you end up at Clemson? Was it just a serendipitous- because your parents-

Lathrop: Well, my father graduated from Clemson in the class of 1913 and much of the Lathrop family including several of his brothers had gone to Clemson. It had a good reputation in South Carolina and he was always very proud of the school, so I applied to go there and they accepted me as a full professor..

Remacle: Did you go directly to Clemson from TI?

Lathrop: Yes, right. **I** drove. The question in your sheet there said how did I get to Clemson and the answer was I drove my pickup truck hauling a trailer with two horses in it.

Remacle: I should have known better than to ask it that way, shouldn't I? So what did you have to do when you got to Clemson? What was the state of their School of Engineering?

Lathrop: Well, it was pretty low. As far as electronics went, they were still teaching vacuum tubes. There really was no mention of transistors, so I threw out the vacuum tubes, much to the chagrin of the professors teaching vacuum tubes because they knew all about vacuum tubes and knew nothing about transistors, but anyway, we made the transition to transistors.

Remacle: This is what year? I'm sorry to interrupt you, but what year was this?

Lathrop: That was 1968.

Remacle: And one more backward step, so how long were you at TI in total?

Lathrop: I was there ten years, from '50- let's see, I was there from '58 to '68 and at Clemson from '68 to '89..

Remacle: So you threw out the vacuum tubes [when you got to Clemson]?

Lathrop: Yeah, threw out the vacuum tubes, got rid of all the vacuum tube test equipment, got rid of the textbooks and started teaching transistors. And that was very good. I enjoyed that because it was something that I hadn't done. I had concentrated mainly my thoughts on the devices and how the electrons went and how the holes went and how the band gaps were and that type of thing and I had gotten out of the circuits and so this gave me an opportunity to learn how transistor circuits worked and how the transistor functioned. And I learned a great deal and that brings up one of the great regrets that I had. You had a list of what do you regret, and one of the things I regret is that I had not spent more time early on learning about circuits in addition to learning about holes and electrons.

Remacle: What is the role, talk a little bit about the role, the intersection of the roles of government, academia and industry in developing new projects, new technologies, new processes? How do those groups interact, good, bad or indifferent from your experience and perspective since you've had this unique opportunity to work on all three of those legs, if you will?

Lathrop: Well, that's a very general question and one that's rather hard to answer. Since I know only specific aspects of each one of those and not the whole industry, I've never taken a survey of where new products come from, which part of the industry or academia or whatever.

Remacle: Well, maybe instead of products, I should say ideas. Kind of how do things burble up out of those three and do they cross-pollinate each other or not? I'm looking for just your own experience with it.

Lathrop: Well, I think that a lot of ideas come out of universities. There have been a lot of design activities in universities. This is a very nice thing that universities can get into. There have been a few ideas in the way of devices. I had one at Clemson in that sense. One of my students came up with a new device that he thought would shake the world and we went down to Motorola and sold it to Motorola for I think $250,000 to allow them to try it out. And they tried it out and said it wouldn't work and he felt that they didn't try it out right and that started a big argument and so on, so forth. Nothing ever came of it, so I suspect that maybe Motorola knew what they were talking about. But anyway, devices are harder to come by out of universities, I think. Devices probably generally come out of the industries. I am not familiar with very many semiconductor ideas or concepts that come out of government research.

Remacle: So beyond teaching, can you talk a little bit more about the work at Clemson? You threw out the vacuum tubes, brought in a new curriculum and what else happened at Clemson? You were there for twenty years?

Lathrop: Well, then of course there were a lot of other things going on and I taught other types of courses and one of the types of courses that I was most proud of was the senior course in which I got the students to try to solve a particular problem. I would give them a problem that was sort of far-fetched and they were to come up with ideas on how to solve it and then make presentations. So in addition to solving a technical problem it gave them some experience in generating ways to come up with proposals, experience in public speaking, and also in writing. An example of this would be one time I gave them the job of figuring out how to pay at the pump for gasoline. This was back, you remember, in 1973 or '75. It was before these things had really occurred. Nobody had ever paid at the pump before with a credit card.

Remacle: Also I was going to say, before the real proliferation of credit card usage.

Lathrop: Yeah, right. And so they had to come up with the circuitry that would do this and then think about other aspects, the privacy, whether it would be secure, whether people could account for it, and then they would have to talk about it. The class was divided into groups so that the senior class had maybe five or six groups. I've forgotten how many. Each group would make a presentation in which each member of the group had to participate. In other words, it wasn't a question of, "Well, he's the best speaker, we'll let him talk." So each person had to present part of it and you could see the stage fright that occurred, you could see the "ands" and "ers," you could see all the things that went wrong and then they were told about this by a panel of professors immediately after the presentation in the hopes that it would show them how to improve the next time. There was another aspect to that course in that I didn't allow any grade inflation, so I told them at the start of the course that there would be a certain number of A's, certain number of B's, and a certain number of D's. I didn't say anything about F's.. And that it would be dependent on each group's presentation and written report. Three professors would do the evaluation. They would assign the groups a certain number of points and that number of points determined the number of points that each group got. Those points were then assigned to the students by the student group leader who had been elected by the group members. So the group leader had the responsibility of handing out the grades and those grades had to be standard in the sense that only a certain number of A's for the whole class, certain number of B's, certain number of C's, certain number of D's, so somebody had to be in there to get the D's, somebody had to get the A's and so on. And this went over very well, I thought, although some of the students didn't like it.

Remacle: The ones that got D's?

Lathrop: Yeah, right.

Remacle: I can imagine how that might be. What about Clemson's work with industry? You mentioned that earlier that you had partnered with industry consortia.

Lathrop: Yes, we had several contracts. We had a contract with Semiconductor Research Laboratories to study the reliability of integrated circuits and we had a mentor from, I think, Texas Instruments and he would meet with us regularly and tell us what was going on. And the information then was sent out in reports to the Semiconductor Research Corporation who then distributed this to each one of the members of the corporation. And all the Semiconductor manufacturers were members so that everybody got to know what was in here and so there's a little bit some of the companies didn't want to tell us exactly what they were doing for fear that that information would go to other people and be compromised. We also had a contract with the Jet Propulsion Laboratory to look at the failure of solar cells and that was an interesting one and I had quite a number of graduate students that got their degrees based on that work. As part of this, we were able to get the university a state of the art electron microscope which they hadn't had and we got several other pieces of equipment.

Remacle: As you look back on your career experience, professional experience, what- you came out of school as a physicist. You didn't come out as a businessman or an MBA, a newly minted MBA kind of person. What are the biggest lessons that you had to learn to adapt to a money-making, capitalist business environment versus a research, more academic approach to business?

Lathrop: Well, I guess each one was sort of different. The government laboratories, there was no problem with funding particularly. In industry, there was really no problem with funding of the material that we needed. I didn't worry particularly about the finances. We had a budget that we had to work with and we spent it and went on to the next year and got a new budget and spent that. At the university, we got nothing. There was no support. Probably at other universities, it's different, but at Clemson there was no support other than our salaries and so if we wanted a piece of equipment, we had to get some kind of a grant or get a contract or something that would buy the piece of equipment. So that was quite a bit different.

Remacle: What was the- I don't know whether you'd call it a lesson, but what has stuck with you that you learned from Jack Kilby?

Lathrop: Well, I guess I learned not to get too excited about anything, that everything would work out in the end and don't sweat the small details and everything is a small detail, He was a very calm person.

Remacle: What about from working with Jim Nall? What did that experience teach you?

Lathrop: Well, Jim was a very talented individual. He sort of changed, though. He went to Fairchild and then started his own company, Molectro. Molectro was taken over by National and they kicked out Jim and he became a very bitter person at that point, bitter towards most everything as far as I could tell and he wasn't, didn't appear to be the old Jim that I'd worked with at the Diamond Ordinance Fuze Laboratories who got along well with everyone and we never had any problems.

Remacle: If you look back on your Clemson years, what was the most challenging part of that? Was it just the coming in and discovering that they were kind of behind the times, to put it gently and you were going to have to change that or was it something else that was a fairly sizeable challenge that you had to deal with?

Lathrop: Well, people always talk about a lot of the politics at a university and that was true. There's much more politics for some reason at a university than there is in either government or industry and people always seem to be concerned about who was out to get them or something

Trying to think about what caused this, I guess one of the problems is that remuneration is not based on your teaching skills at a university, it's remuneration that is based more on your contract acquiring skills. It always seemed as if no one seemed to care much about how good a teacher you were. They were only concerned about whether you brought in a certain amount of money to the university. This was a big problem, a frustrating problem that younger professors particularly have. They don't have any contacts, any way to get money and they have a great deal of difficulty with this.

Remacle: When did you leave Clemson?

Lathrop: 1989.

Remacle: So that's roughly twenty years ago.

Lathrop: Yeah.

Remacle: What have you been doing in the last twenty years?

Lathrop: Well, I took early retirement from Clemson after I'd served there for twenty years because my wife was in poor health. She had Alzheimer's and I spent the next ten years taking care of her. When she died, I decided that it was time for me to give up living by myself and so I moved into a retirement community in Asheville, North Carolina, where I've been for the past ten years. So I've just been sort of retired in the sense that there are a lot of activities that I'm into there. I'm in charge of the computer laboratory and teaching some of the elder citizens how to use the computer, that sort of thing.

Remacle: Okay. When you look back at your rather extensive life and careers, I'm going to put an "S" on careers, because you stayed with more or less the same field, but have done different things, distinctly different things with it.

Lathrop: Yeah.

Remacle: Which have you found the most exciting, rewarding, challenging? Kind of where did you get your most energy from or can you pick from those three?

Lathrop: Yeah, I saw that question in your list of possible questions and I decided that each one was challenging in itself. I was challenged in each particular area for a different sort of thing and I wouldn't say that I could pick one as most challenging or most satisfying.

Remacle: So let's talk about what was the big challenge out of each of those.

Lathrop: Yeah, right. The most interesting one in Diamond Ordinance Fuze Laboratories was building the transistors because I had never had experience and neither had Jim Nall had experience in how to build a transistor and to build the equipment to make it and to watch it work. That was fascinating and very satisfying. At Texas Instruments, it was getting the integrated circuit to be able to be manufactured and we went through all kinds of problems with yield. You could make a single integrated circuit, but to try to make ten or a hundred of these things was very difficult and that was a real challenge. It wasn't awfully satisfying to do that in that it was just a hard job and you were happy when things worked out and you were unhappy when they didn't. At the university, probably the most satisfying thing was working with the kids and seeing how they could learn and become interesting students. I met a former student last evening that I hadn't seen for thirty years and he was here and still remembered some of the things I had taught. I regularly correspond with them, particularly at Christmas-time, when we exchange Christmas cards, and they come to see me occasionally so that's very satisfying. So each one is in a different sort of category.

Remacle: Related or maybe even the flip of the question I just asked you is if you could redo anything or any things, would you have restructured your career in any way or?

Lathrop: Well, yes. I think the one thing that I would mention there was that the circuit business, I would have spent more time becoming involved with circuits, learning how transistors work in a circuit. and how the circuit works.

Remacle: Kind of one step ahead of where your work was?

Lathrop: Yeah, right. That's a very important thing.

Remacle: Why is that a regret? How do you think things would have been different had you taken a more in depth approach to understanding how the circuits work?

Lathrop: Well, for one thing, I think I would have invented the integrated circuit!

Remacle: Now that's a very modest answer. <laughter>

Lathrop: Yeah, right. Well, I had all the parts there. All I had to do was think about how the circuit worked and I think anybody could have done this, really, not just me. And that's one of the things you wonder about, if Jack hadn't done it, somebody else would have and I think that's probably the case, but nevertheless, he did it and that set the ball rolling.

Remacle: Back to the young people, if you had one piece of advice that you could give to young engineers, either software or hardware engineers, technical entrepreneurs as a class about how to proceed once they've got that degree in their hand, what would that be?

Lathrop: Well, what I would advise them before they get the degree in their hands is to take public speaking and to learn how to write. This is something that has always bothered me with regard to engineering students is that they don't know how to present their ideas in front of audiences and they don't know how to write things about them for other people to read. They're way behind. They know mathematics, they know calculus, but if they ever get an idea that they need to sell, it's important that they know how to sell it. All you have to do is look at our President Obama and what a wonderful speaker he is, how he's able to say things in a way that captivates the audience. He could sell icebox to Eskimos if he was about it. Now, the engineers in general don't have that talent and nobody has ever spoken to them about the need for it. I think it should be a very valuable part of their training.

Remacle: Is there anything that we haven't talked about or captured about anything that you would like people two hundred years from now to be reading about?

Lathrop: Oh, yeah. One of the things that I think you mentioned in there was a question regarding my invention of photolithography. Photolithography is not an invention. It's just an application. We got a patent on the use of it, Jim Nall and I, but it's not an invention. The invention was made by Kodak when they developed the resist**.** We only applied it. You can come up with a better analogy perhaps than I, but consider buttermilk pancakes. Buttermilk pancakes were not invented. They occurred because some time in the dim, dark past, somebody ran out of milk and the only thing they had left was buttermilk and they just tried it out and it worked and that's what we did with our photo resist. We tried it on germanium and it worked and we became the first people to use it. Everybody used it from then on.

Remacle: One last question that's not related to your career, why do you think the Computer History Museum or a place like this is important?

Lathrop: Ah, yes. Well, it's a place where scholars, first of all, scholars can go to find out about who did what and I don't know why scholars want to do this sort of thing, but they do, so it's a place that has this information. Engineers can come here. There may be a thing which they're doing, for example, like patterning wafers or something of this sort and a new technology comes out like lasers. They want to come here and see what has been done in the past regarding patterning with regard to lasers and the answer is probably nothing, but maybe some of the limitations that people went through in the old days don't hold anymore because of the new technology and this would be valuable, so there are things of that sort. And thirdly, it's just a way to recognize people and what they've done.

Remacle: And preserve it.

Lathrop: Like George Washington had wooden teeth or something, you know, it's just the satisfaction of people coming through here. And I guess a final thing would be to try to encourage students, young children to come through and look at this and see how things have progressed.

Remacle: Jay, thank you so much for your time. It really has been personally very satisfying to me, but I know that this is really valuable, so thank you.

Lathrop: I'm not sure that this interview did much, but I thought the presentation last night was well received and we'll see. Put a whole bunch of these interviews together and scholars can come in two hundred years.

Remacle: Well, and that's why we're going to be talking to Charlie [Phipps] and LJ [Sevin] and Gene Frantz [ph?], a different generation, but.

Lathrop: How can you know what sort of device will project this in two hundred years, you know? Things are going to change, so you have some way of keeping these things up to date?

Remacle: And there's a whole effort within the museum community in general thinking about this problem.

Lathrop: Yes.

Remacle: So again, thank you so much.

END OF INTERVIEW

