Oral History of Donald L. Bitzer

Interviewed by:
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Weber: Hi, I'm Marc Weber of the Computer History Museum. I'm here on July 27th, 2022, with Don Bitzer, pioneer of much of modern computing, educational software, the flat screen display and a number of other things, who's also a CHM Fellow this year, and congratulations and thank you so much for doing this.

Bitzer: Thank you.

Weber: Just wanted to start with background. So if you could say your full name and when and where were you born?

Bitzer: My full name is Donald Lester Bitzer, and I was born in East St. Louis, Illinois, but I-- that was just the hospital. I lived actually in Collinsville, Illinois, my young life.

Weber: And tell me a little bit about your family, your parents, brothers and sisters, where you grew up.

Bitzer: Well, the-- we had a family that was business oriented. They were in the automobile business, and they always thought that that's what I ought to do, study when I go to college, but I wasn't interested in that. I was interested in engineering, science and mathematics, so it worked out well that way but they were very good. My father and my mother were-- well, my mother died very young when I was in-- a senior in high school, my father a little bit later, but everything always worked out well and they always supported me being sort of different for looking at things. I'd rather be home working on a new project than in school sometimes because <laughs> school was just sort of a waste of time, I thought in the first grade. <laughs> Probably was right. Excuse me. So things worked out very nicely and I grew up in Collinsville High School, which turned out to be a small town but it was a good high school and got me well prepared to go to college, which was very nice.

Weber: So I understand your parents had car dealerships then?

Bitzer: Yeah, they had-- I think they had four total before it was over, and they liked-- that was what they did, the whole family, my uncles and my dad and the rest, and they were good at it but it just wasn't-- I looked at it and said, "That's not as much fun <laughs> as engineering and science."

Weber: But at that time car dealerships were fairly-- and they started them early on and that was pretty entrepreneurial back then, right?

Bitzer: Yes, the-- well, everything was entrepreneurial at that time. The world was changing very quickly. That was a time when we were trying to get rockets launched. The Navy had a program which was-- they were in charge of our nonmilitary vehicle launches, but I don't think they ever got any of them off the ground and they moved it to the Army where they built the missiles to-- intercontinental missiles. It was a time when things changed. The Soviets had put up in the sky not only satellite but a satellite that first just had a little beeper in it but then pretty soon it was a dog and then a person and the U.S. was caught, they had to catch up, and they got the NSF [National Science Foundation] started and a few other places, and

it's an exciting time because science became very big in the United States at that period of time. It was a good thing.

Weber: And stepping back, could you talk about your brothers and sisters?

Bitzer: Yes. I have one sister who's still living. She's in Collinsville, Illinois yet. She's doing fine. She was not-- she's quite different than I am. She was a-- she didn't like mathematics like I did. That helped me because I would always do her homework because she didn't want to do it, and actually <laughs> helped me very quickly learn how to do math problems that -- she was two years ahead in school, so I got to work on other problems. I just loved it so much and so it all worked out well, and I just finished seeing her. She looks good, and she's always supportive and we stay there when we come out through the airport through St. Louis. We always stay at her place in Collinsville. So yes, she's fine and her interests were entirely different than mine and it was probably a good thing.

Weber: And what were-- talk about what your interests were as a kid, favorite subjects in school. What did grab [you] as a child?

Bitzer: Oh, what did grab me as a child?

Weber: Yeah. Well, what are your interests as a child?

Bitzer: Oh. I loved--

Weber: What were your favorite--

Bitzer: My interests as a child were to take things apart, see how they work and put them back -- repair them if they need it and put them back together… and I started doing that when I was probably six years old. They gave me an erector set, which was fantastic. I could build all kind of things and get in trouble. <laughs> But it was very supportive. No one ever interfered with what I wanted to do in research, and I had more fun in my basement doing research than, you know, I figured I was ever going to have at school, but turned out school worked out very well too.

So I just liked to explore things, see why, answer questions. I had a chemistry set when I was young, which was-- lucky I'm still alive after working <laughs> with a chemistry set all the time, but I couldn't wait, and even in the first grade when the class bell rang, I used to run out. They tried to get my sister to hold me there until everybody settled down, but soon as I got up, [when] that bell rang, I went home because there were [a] lot more interesting things going on in the basement in my home than there were in that classroom at school, and it wasn't until about the second or third grade I began to <laughs> feel that, "You know, I'm-- I can learn things here I can't learn at home," but it was good, and everybody was very supportive. The teachers were good. Most of them had taught my mother and father at that time and it was-- I was-- lived close. I could walk to school and walk back, or run back as I used to <laughs> from the classroom, so... But I-- it wasn't long before I started really appreciating school and the teachers that

could really teach you new things and that was that way all the way up through college, so was very lucky.

Weber: Any particular teachers that stand out that made a difference for you?

Bitzer: Well, there's a number of them. One was a second-grade math teacher -- we started doing enough interesting things I liked staying for class and learning and that kind of changed <laughs> my attitude towards what they could do and she was always good, and then gradually as I got up farther in the school at-- when I went to high school, I had some very good math teachers and chemistry teachers. I had chemistry teachers in high school who knew quantum mechanics. They could really teach the subject very well and that encouraged me to keep going that way. I had good math teachers, just excellent. One was a Polish mathematician who used to drive over from St. Louis to Collinsville every morning to teach. When he died suddenly they brought in another teacher within a week who was driving through town, just finished his college work, wanted to talk-- he wanted-- he applied for the job but when he got there he really wanted to teach what he just came out of school learning, which was number theory and modern algebra, so he grabbed me and put me in a corner of a room and said, "You don't need to take the two math courses coming up. We're going to study this and you can study those on your own."

So I went along with it, and I have to tell you it was-- those concepts at that time were a real strain. That didn't bother me so much. I thought I would never use the stuff again, but it turned out 30 years-- 35 years later maybe, when I went to NC State, the head of the math graduate division was a mathematician in numerical theory and he saw immediately we-- students and we started doing coding theory and encryption things, and I already knew that stuff from high school, which was really nice. So we sat down and we probably worked together-- we had several students that worked together. Had maybe another dozen and we worked on problems that dealt with coding, encryption, sending messages, error correction, forward error correction. Some of them we got patents on them and some of them, they're not-- don't quite need them yet but they're going to need them soon, and if you're going to communicate with vehicles, you know, light years away you don't have time to recover from errors. <laughs> It's got to be right when it gets there, and so that got me interested in that area and I explored more of that at-- when I got to North Carolina State University as professor. I started it at Illinois, just the beginning, and I explored it lot more student, grad students when I got there, but I was really glad I took it because it was-- turned out never know what's going to be useful later.

Weber: So back then as a kid or at high school, what did you think you wanted to be when you grew up?

Bitzer: Oh, I knew that since I was five. I wanted be an engineer, and particularly [an] electrical engineer. I had gone to the stores around town and they gave me all their spare vacuum tubes that the-- partly used, so I had a little vacuum tube book and I used to love to build things. We built a short-wave superheterodyne receiver with my uncle right at the end of World War II, and it was good enough that when we got it up we could listen to the reports from London on that receiver and I said, "Oh, stuff really works." So it just-- everything worked out well and I never, ever regretted studying electrical engineering. It was-- you learned a lot. You learned mathematics. You could do things. You could build things. I liked to make things that-- build them, and nowadays it's don't build much because you design them with

a computer and they got machines to build them and wrap them and test them so fast that you don't have to worry about anything.

Weber: And if I can ask about what values you were raised with? Did politics, religion, play an important part in your family?

Bitzer: Yes. They were rather conservative on that-- my side of the family. My cousin was the editor of the St. Louis Post-Dispatch and he was much more liberal. Lived across the corner, and so I got splatterings from all sides and appreciated the different opinions which I got as I grew up. No one ever forced anything on me, and I'm still that way. I look and see what's going to get us out of trouble. I think that's part of my life from now on, to figure out how to make sure we get out of trouble and stay <laughs> out of trouble. We get in enough these days to keep you busy.

Weber: And how about religion? Was that a big part?

Bitzer: Well, did I have any particular or did the family have any particular values as I grew up in either politics or in religion? The answer to that is yes. They were very, as I said, conservative and religious, and that influence was on mostly my family side, and we had other people that were relatives across the street who were very liberal. One was the editor of the St. Louis Post-Dispatch, and that was entirely different, but it was good for me because he being the editor of the St. Louis Post-Dispatch received visitors from around the world couple times a week and he would always invite me over to sit and listen to the discussions that they had with these people from around the world, and I learned a lot just sitting there listening and while they ate and talked. So yes, I came up in a place where, in a family, where they paid attention to all kinds of things, including religion and politics and all on the-- and they were very-- everybody had strong views but we didn't fight. <laughs> We just would tell each other and that was it and worked out fine.

Weber: And were they members of a particular church or religion?

Bitzer: My family was members of the Baptist church, my side. I think, as I remember, the other side, the Dillards were members of the Methodist church, and that was essentially way it was the rest of their life, yes. They were very much dedicated to helping people and supporting churches and things of that type. They were very generous about that and they taught us to be generous.

Weber: And sports were a big part of your life, I believe, in high school. Sports were a big part of your life?

Bitzer: Oh. Well, sports and-- sports were a big part of my life but probably not my largest. I played football and I loved sports, but there wasn't time for a whole lot of things, and we were required to have sports all year if you had one sport, and so I had-- I played a little basketball in the basketball season but not for all four years, and then I had track season which followed that, but sports. Sports have always been great for me. I love them. I played until just a few years ago handball, sometimes three times a day, and just loved it. Played that for over 50 years, and so that was a-- since I've been small, and so I've

enjoyed-- I do enjoy sports. I played what I could, but there was-- I was very busy with other things getting ready for college and getting ready to-- just doing the studies, even in high school. But I did them and I loved it and it was probably the best thing I could've done.

Weber: And I understand you met your future wife before going to college, right?

Bitzer: Yes.

Weber: Can you tell the story?

Bitzer: Well, my wife was a-- well, the lady who became my wife-- was a sophomore, 14-year-old sophomore in high school and I was a senior in high school, and she was studying-- she had-- was taking geometry from this new math teacher and I used to play tennis with him now and then and I had already had geometry and he said, "You know Maryann." I said, "Well, I see her." He said, "I think she could use some help in geometry. Would you be willing to help her?" Well, I had been looking at her anyway. I said, "That sounds good to me." So I talk-- got a hold of her, called her up and I said, you know... She said, "Well, that's fine." She said-- she gave me her phone number to call her, so the-- I did that for some time but then it turns out that geometry is not just a course you can discuss over the phone. It's a lot of drawings and things, and she was convinced of that, so I started going out to see her to help her with geometry.

Before you know it, we were dating and she's right up front about everything. She said, "If you want to keep dating and stay with me," said, "you better learn to travel." I said, "What do you mean?" She said, "Well," she said, "I--" she was a librarian everywhere she went. She loved it, and so she said, "I've read about all these countries and the people and I want to go see them now and visit them, not just have read about them in the library books," and so I said, "Sure, we'll take care of that," not knowing <laughs> what I was saying. But it turned out to be what happened. Millions of miles and everywhere in the-- country in the world we went, and she too made presentations. She was in the field. Maryann, my wife, was in the field of teaching computers, teaching nursing by computer. She was very nice about and very good at it. She got an award for that, the first award in that area ever given, and so she used to travel and give talks and I travel and give talks together with us, and we spent the rest of our life flying until the recent-- when COVID hit I cut out-- I tried travel as little as possible, so... But that was very nice and she's never forgotten that, that... She took pictures of everything up and I appreciate what she did, and she helped with the trip.

Weber: But then you went off to college when she was still in high school, so I guess you were long distance for a while?

Bitzer: When she was still in high school, I started-- it was my senior year. I started the University of Illinois is-- at that time, and she went on, finished two years of high school, then to nursing school and then St. Louis University while I finished the last two years in college, and then-- and we'd see each other all the time but it was a decent drive, St. Louis to Champaign every weekend, <laughs> so finally she said, "You know, we just ought to get married," and I said, "You're right," so we went and got a-- I got a

place for us and we got married the summer that I graduated from my-- got my B.S. degree from Illinois, and she joined me up there and it was a time when things were really different. It was very hard for women to get scholarships. They were-- if you go in and ask, they say, "Well, we're probably just wasting our time," and so... Because you'll get married, have children and all, so she couldn't get-- they wouldn't take-- let her finish her last year of nursing school after we were married, but she-- I was her advisor. I never explain how it happened but since we were living together and I was authorized to be an advisor, they made me her advisor, and I couldn't wait when I got that letter, to see her, because I was a-- I'm a pretty tough advisor.

[I've] advised students before, and I made her post her grades on a lampshade at night so nobody'd cheat, and I was-- she wasn't going to fool me if she was having trouble, and to just make sure she didn't want to go out all the time I gave her 26 hours of instruction per semester. That was about two times normal load, and then I told her take proficiency tests if she could as fast she could. In two and a half years she finished her B.S. degree and entered for her M.S., and the next year she finished her M.S. degree and then finished her nursing degree. They [were] quite willing to take her at that time and made her a nursing instructor in a hospital, and that's when she got the contract for teaching nursing by computer, where she had to subcontract to me because I had all the systems, and that's something I learned a lot about. She wanted the best programmers. Because she was paying me, my division, to do everything. She wanted the best people. She took her tests seriously and she did a great job. Well, only had number of projects, probably 20 projects going on, and everybody wanted the best of everything. They would come in all day and talk to me and explain and argue why they should get the best person, including my wife, and I treated them all the same. The difference was that when the day was over I went home, they went home, and my wife went home with me and never stopped <laughs> until she-- so she finally got just what she wanted and it all worked out well. She did get the best person before it was done to help her. She was happy about that and she did a great job. Was very successful. She actually used it for a thesis of her work. It was probably the most definitive report on how computers can be used for teaching, remote teaching, and still do a good job.

Weber: So you had already started PLATO when she was finishing her degree then?

Bitzer: We started PLATO in really 1960.

Weber: Right. Well, let's circle back to-- because I didn't realize-- right. Because she was younger than you she was still in school when you were starting PLATO. She was getting her master's then, right?

Bitzer: That's correct.

Weber: Okay. So let's step back then to your-- so how did you choose U of I, Urbana-Champaign?

Bitzer: Well, how and why did I choose the University of Illinois? I had offers to a lot of schools out East, and good ones, and a full scholarship

Weber: And you were valedictorian, correct?

Bitzer: Yeah.

Bitzer: I was salutatorian. There was a young lady who took hard-- didn't bother me because she took some hard courses too. She just beat me out. That was fine. Didn't make any difference, but yeah, I was-- I had no trouble in school, I had no trouble getting good schools. I think some of them now, they wanted me to play football with them too, but that I was-- I had already determined I wasn't going to. I was going to just knuckle down and study. I wasn't going to play sports, scheduled sports like that. I do intermural sports but I didn't want to do the college sports. But I went one time before then. I went up to the University of Illinois and to interview them to see, to talk to the faculty and see what they did, see what the school was like, and when I got up there they were really terrific. They had the professors there. I talked to all the professors. Not just my department I was going to go to but physics and math.

They took me over to the physics place, laboratories, where they were building the Betatron and explained to me what they were doing and how they were going to use it. They went through everything and took a long time doing it. I thought, "This is what I like," and so I said, "I think I'll go to the University of Illinois," and I did, and it was not a mistake. It was a good thing to do. I didn't have a scholarship there because my scholarship was for tuition and the tuition at the University of Illinois was $25 a semester. It's hard to remember. It just wiped out my tuition pay. <laughs> Didn't need it at all, but it was the right school. They were that way when I got there. I even joined in. I said, "Whenever you have visitors, call me up. I'll take them around where you took me and I'll show them things that are going on around here," because they were really, really first-class and first-class people. That worked out and that-- course, I expected to stay there for-- until I graduated. Then I decided I was going to graduate school and they decided I shouldn't go somewhere else, I should stay there.

Normally when you go to graduate school they like to have you go somewhere else, but they wanted me to stay, so I stayed, and then I stayed on for the PhD, and pretty soon I was out of school and I was helping run a laboratory, <laughs> so it was the right thing to do. It all built up. I was able to-- I did a lot of work before I started PLATO. I was-- what happened to me there was very interesting. I was working in a-- this was during the Vietnam War, and I can remember distinctly that in order to get deferred just to finish my undergraduate [degree] I had to take the Graduate Record Exam, but I did fine on it, and so I went on that graduate school program and when I got married I needed a job, of course, and I got a job at one of the laboratories. It was partly supported by the government. We did some work and it worked out just fine for a year. I worked on a project where they get radio direction finders for—[they] tell you where a signal was from, how strong it was, everything about it all the time in a panoramic form, and they liked that, and one day I walked in, it was about a year later, and my advisor was there and a very different person I'd never seen before was standing there, and my advisor at the time said, "I hate to tell you this but I've lost you. They want you over in this-- they got a problem, technical problem, they want you to solve." They dragged me out and I said, "When do we start?" They said, "Right now." They marched me down the block down an alley to the building that was all locked up. I knew about the building. Never knew what was going on. Marched me through to the police department across the street, got me my badge, fingerprinted me, did a few more things <laughs> and then took me up the-- up and introduced me to the problem, which I then helped them solve over a few years, and the people in that laboratory were absolutely fantastic. Some of the brightest people, professors I had ever dealt with. We learned how to

do everything. How to attack problems for which no one knew the solutions. I decided, "That's a lo-- that's more fun just solving problems that, you know, aren't answers in the back of the book. These are real problems," and so I worked on those until I-- for 39 years really, and--

Weber: But the Korean War, when you were an undergraduate, was--

Bitzer: The Korean War-- that's right. The Korean War, as I remember, I was undergrad when that blew up, mm-hm. Junior or senior, and oh, yes.

Weber: So the deferment, are you talking--

Bitzer: I--

Weber: You're talking later than that, right, which--

Bitzer: Well, after-- well, then, course, that was followed by the other wars as well.

Weber: By Vietnam, yeah.

Bitzer: Yeah, and so we-- there're lot of-- it was a turbulent time. The campus was filled with riots but they never touched my building where I did my research. They had a sign up, "This is-- leave this--" That was because the students-- I always enjoyed working with young students. I had students from high school, undergraduates. All of them were very bright and I used to design projects with them that they could work on and get publications. They were very, very good and they still are. Today several of them are out there yet, heads of departments and doing the same thing, advising graduate students, and that was very nice because I was very young. I'm surprised they paid any attention to me, but they did.

Weber: And we'll-- but we'll get to that. I'm just trying to be clear. So you were taken to do the secret work right after you were an undergrad, right, as a PhD candidate?

Bitzer: That's correct. Actually, I'd just finished my master's degree, which was-- I guess it was confidential work but the real secret stuff was done after my-- finished my master's degree. That's when I went to the other laboratory and found out all the interesting things that had to be solved.

Weber: And can you talk about what you were working on?

Bitzer: I want to be little careful about it. Some of them are still in-- well, most of them are still in use, but the-- I can remember sitting up all night watching the raid on-- when we-- in I guess the first-- in the sand raid out there, the first one, and making-- worrying about, "Is all the stuff working right?" Make the-- "Are the planes going to get through without getting hit and so forth?" I slept better after that was over because it, fact, worked everything and that was just one thing. I worked on things from three different departments. The one that I ran [ph?], then the theoretic and applied mechanics department and electrical engineering and some in physics. But I was-- the problems were always problems that they

couldn't solve. Sometimes they contracted for a problem and then they found out that they couldn't solve it. That bothered them. The one I remember most was when the-- before the first underground nuclear explosion. The Soviets were complaining because the work to find out what was going to happen, how the land was going to cave in, whether it was going to vent, things like that, with radioactive material that was being studied, no one had solved. They kept trying to solve it with computers but they overlooked a few things. So I was playing handball once with the people. I said, "You solved that problem yet?" They said, "No. We got a week to get it done because it's supposed to go off in a week and we got to get it done." I said, "Well, you been at it two years. What's this week going to be?" They, "We're worried." I said, "Well, quit worrying. I'll take it on for you and I'll make a deal. If I solve it-- if I can solve it in two days, I want a good fraction of the money you got left because you can write a short report. If I can't, I want nothing because you're going to need it all to write an explanation." But I lucked out. I figured out how to solve it in about two days and they immediately put it out and the Russians quit complaining the next day and the bomb went off on schedule, and that was kind of a surprise, and I didn't realize how critical some of these things came.

They contracted for--the Theoretical and Applied Mechanics department, they contracted to explore stress in wing spars because they had to put wires in the fuel lines and things. They wanted to have as large of holes, as many as they could, without weakening, causing the dangerous stress, and they said that they would cut holes in plastic parts to do this examination, which they did by deflecting the plastic and putting infrared. That was technique for looking the lines for stress. Problem was that they hadn't calculated how long the machinist was going to have to spend cutting holes to a thousandth of an inch on a regular milling machine, setting it up 10,000 times. They couldn't. They were in big trouble, so I said, "I'll take care of that," so I built a device for them and wrote programs in the computer, which would calculate how to punch five-hole tape which the reader would read and run the-- had motors, I put motors on the controls so they could just leave, turn it on and we'll go back four times to reset on backlash at the-- each corner, they could cut the holes, and that worked out very well.

And my wife and I got a lot of time and degrees and other things off of that because they got the-- the contract was renewed. Everybody else in the government wanted it and now this time I told them to put in enough money for what I needed to go back and punch holes. <laughs> They were expensive holes <laughs> for them to touch, so that was another one, and I worked on another one that was important. I don't know if it's important anymore. Solid fuel rockets. People don't know much about them but solid fuel rockets control their propulsion by how much area's burning in the back of them, and the problem is that the heat causes pieces to crack off, and it does at that time. Then you change the whole map of the propulsion, <laughs> which-- where it's gonna go and everything. So that was a problem that had to be solved that they had taken on and they had a requirement-- I'm sorry. Go ahead.

Weber: And sorry. And you were using computers-- you were already using computers, you said.

Bitzer: Oh, I-- when I was there and I was with an undergraduate they had started building the ILLIAC I. They finished the ILLIAC I. I was there with them when they did that and immediately learned to program it and I was one of the few people who was that excited about learning it. It was-- I still know the code. People, they still teach that kind of code because it's necessary for coding small chips and so forth for--

that are embedded in different devices and you have-- it's different coding than when you can push a button that does everything for you. At least if it's a mistake, you know you've made it <laughs> and where it is. I love that kind. I still can-- I still wish I were doing that kind of coding. I, course, had to graduate to the stuff where it makes a mistake you don't know where it was made, but-- and I learned to-- the code-- I coded things for the professors in my class because they had problems that they wanted to see results of so yeah, and I loved it and I did a lot of, lot of work on the ILLIAC.

I got lot of time on it, and the laboratory I joined got every afternoon as part of the program in the secret laboratory. There I really had fun, so little-- computers were-- and I still love computers. We built our own computer for PLATO. That came along later, but we built a computer and it was a big machine. It was as big as they were turning out, and I had a great crew of people. Everybody I hired over the years, and it got up to be like, oh, 50 people at one time, 25 or 50, everyone was professional and good at their job, and I trusted them. They trusted each other. The software trusted the hardware and the hardware trusted the software people, so much that they bet on things when they put them together didn't work, the loser had to buy Cokes for the rest of the year, <laughs> so... But they were good people and I always appreciated. Said, you know, I wanted to make sure that they were always appreciated in the work that they did and they have been, and they've all become very successful. Some of-- you probably know Ray Ozzie, and he was one of them there and he did software work and communications and I can tell you dozens of others who were just terrific.

Weber: Yeah, and we will get-- we'll get there.

Bitzer: Yeah. Go ahead.

Weber: Let's go to though the beginning of PLATO. So how did that come about and how were you brought in?

Bitzer: Okay. How did the beginning of PLATO come about? It came about because I finished the secret work. Had done my thesis, gotten my PhD and was looking down, looking at a new project in the laboratory, and the dean had written a letter to the head of the laboratory I was in asking what could be done with computers now for helping with education, and so they had this big meeting where they called in the educators and the engineers and everybody and they used to meet every night when I was in there working on some projects right across the way from me in a conference room and I would see them, and they'd be fighting and arguing. So when that was over after a while, I got called in by the head. He said that, "I just got the report from the committee. They said there's nothing we can do," because, they said, "the people who know how to teach don't know how to do engineering. The people do engineering don't know how to teach." It was kind of silly. So he said, "Do you agree?" I said, "No." I said, "We got the equipment upstairs to immediately connect to the ILLIAC. We can get things going." I said, "Give me two weeks and I'll have a terminal up running for you and the modem we're talking about." So he did, and they made me the head of it. I got-- I hired two more people at that time. A software person and an engineer. It all worked out very well and--

Weber: And what were their names? Could you talk about them a little?

Bitzer: The one was a technician, and I forgot which one it was because he worked for me later. Another one's a mathematician, Peter Braunfeld, and then the two physicists who asked the question in the first place of the dean, were very good. Chalmers Sherwin was one and the physicist, another physicist who was one of the brightest people I ever worked with. Just could do anything. He was good anything machine shop or in theory, and he was a-- he helped do a lot of projects that I can't talk about. <laughs> But they were done very well and amazing things that you couldn't believe, and you learned things from these people. I was young, like I say [ph?]. They sent me the first time to Europe to help in the-- a French company and who was building some more stuff for the radar and I was only, my goodness, 26 maybe, and it was early on, but that was nice. So yeah, things just built up. Go ahead.

Weber: And with-- so with PLATO, you and these first people, tell me about PLATO one and what you were working on.

Bitzer: Yeah, okay. Well, I'll tell you how PLATO the name even got started, in the first meeting. It took us five minutes. We all sat down and said, "Hey, we need to get a name." Being a military laboratory type, you always had to get abbreviations for your projects. That's the way they do it. So we decided we would pick one, and we decided that the name PLATO would be good if we could work it in. And right off, we came up with Program Logic for Automatic Teaching Operations. The four of us in the room, and we agreed and that was it. And so that's what it became forever. And that was the story of the name. And then PLATO one, we had to do it in a different way. The problem was that you didn't have-- memory was so expensive in those days. Memory was, like, two dollars a bit. By now, of course, it's so cheap.

So we were worried about what to do for memory. And we looked around, and the only thing we could figure out how to do right away was to use storage tubes that were built for the flight controllers at airports. And the idea was that they wanted to scan the radar and put it in a TV format so they could distribute it to all of the controllers. And they had built a QK-685, I think it was Raytheon, that had two guns. You could write with one of them, you could read with the other. All the characteristics that would be nice, but they were expensive. And so we got one, we put it together right away. We programmed the computer output, which we had access to in our building because we were right above it. And we did other experiments at the computer live, so we were ready to connect that up.

We put the thing together. It worked right off, just like we wanted, and had lesson material running on it within a couple months or so. And original lesson material was things that I didn't find too exciting, but then they wanted to teach French on it to see how languages would work out. And they taught some type of mathematics that used geometry characteristics. Because we wanted to be able to do complete things of drawing, everything that one wanted to do, and we wanted to do it over as narrow a bandwidth as possible. So we had erase in these tubes. And so we didn't have to retransmit everything if we wanted to change something. We just sent the change. And we stuck-- we used that one for, oh, about six months, maybe a year. Then we decided that one terminal was fun, but we weren't going to learn much from it because one student at a time was not going to get us anywhere. So we went to multiple terminals, multiple storage tubes. Eventually just a couple, but they were very expensive. And it led to interesting problems, their expense, because we had a psychologist in the laboratory. And he wanted to do psychological education experiments. For example, he wanted to know if the material excited the student

when they sat down in the terminal. Well those tubes were so expensive, we turned off the high voltage on there-- a high voltage tube is like a TV tube-- just to protect them until we were ready. And then we'd bring the student-- I remember, even two at a time, and then sit them down. Tell them-- we'd wire them up, because the psychologist wanted to measure their heartrate and breathing as they did the lesson material. And lo and behold, when we sat them down, every time we looked at the results, the second they saw the material, their heart rate doubled. One second. It was just fantastic. And we said, "Something's wrong. We know the material's not that good."

So we examined the procedure. And this tells you how careful you have to be. What we wanted to do was protect the tubes. So we had a technician standing by upstairs to turn on the voltage when we were ready. And the person downstairs, when we saw they were all set, would get on the intercom and call up loud enough that they heard, "They're all strapped in now, you can turn on the high voltage." And their heartrate doubled instantly. That was one of the funny outcomes. We corrected that one right away, so we'd get some real data from it. So it led to some interesting results, but as fast as we could, we knew we needed a display characteristic that had its own memory, it could read and write, see through the project images, all that had to be in it if we really wanted to get moving. And that's what led to us thinking about how to build the plasma panel.

Weber: And before that, you were starting to talk about multiple users, which is really the beginning to timesharing.

Bitzer: Yes, we did that.

Weber: Tell me about-- that was a new concept for the time.

Bitzer: I was a real proponent of that, because I did a lot of coding. And we used to have to go down to the main computer at code-check time and read in our codes. We got two code checks a day. And they'd print out the-- the things would never work right, and they would print out what was in the memory and you'd go back in the next four hours and study it. And I thought, "This is silly. Everybody ought to have their own computer terminal for doing this." And so we made sure that when we wrote the software that we were able to do that right of, which was nice. And so we put the multiple terminals up, but we eventually got to lots of the terminals, like maybe seven thousand on one system. But at the beginning, we grew solely from four to twenty to eighty to a hundred, and then up to a thousand and maybe several thousand. And the government was very interested at that time in getting systems.

And they did, so it spread very quickly. I had no interest in-- although we started the media problems. I can remember sitting there, and even when we were young with maybe a couple thousand terminals out there, we had people online who were pros in different areas … psychiatrists and doctors and all. And I used to get these calls at two o'clock in the morning telling me that they found somebody online in anonymous notes that was going to commit suicide. But they had to break into the code to find out where he was, because that's in anonymous notes. And they couldn’t do that without my permission, they said. Well, at two o'clock in the morning, I didn’t think too clearly, but clearly enough. I said, "There's no human life worth keeping that code secret. We can change it, break it." And they did. The man was, oh, 150

miles away and they did get help to him. So from then on, I said, "In the morning, I'm going to appoint a committee they can call at two in the morning, not me. And they'll form, answering questions like this and make sure that security exists." We didn't have any problems with security after the first year.

The first year, we had given a set of four terminals to Springfield High School. A month later, I get a letter from them with all the codes of everybody, all the passwords. They said, "We didn't do any damage, but we thought you'd like to see this." So I hired every one of them and they worked with me for 20, 30 years. No one ever broke in again after that. They found out how to stop that. They still did. That was very nice. The only people who could get anywhere was the people who were system programmers. And if they made a mistake, and some of them did, I walked downstairs with the outputs. We recorded it all. Said, "You just violated the rules." They'd pack up their desk drawer and leave. They knew it was coming, but they couldn't stand not to do it. And almost every case was a boyfriend/girlfriend problem. One of them wanted, since they had access, to see what the other one was writing to and from. And they couldn't resist it, and they knew what was going to happen. They knew I was going to bring that recording down. That happened to about three or four over more than 20 years they were doing that. But we had all the problems that they have now. People getting online, doing things they shouldn't do, it was all coming up. You could see it, and I was not interested in that part, but we had a lot of people who were. They were very good at solving these problems.

Weber: Having security and having logins, passwords. As soon as you went to PLATO II with timesharing, is that when you had to start to get people-- once you have multiple users, you need to have different logins and all of that comes into play.

Bitzer: We had that on ILLIAC before we were done.

Weber: Okay. So you just transferred it over?

Bitzer: Well, we transferred the ideas over. How to hash-code these things and store them away, and make sure that no one broke them. You see, you couldn't get into our main computer operations because that was reserved for just the programmers, the coders. But your program was all by itself, run by itself, partly read in and then read out. Running back and forth from each user, you got so much time, then [it] interrupted and then the next one. And the idea was we wanted to get results to everybody within about two tenths of a second. The two tenths of a second response time from when they pushed the button to when they got the result, no matter how many were on. And that was a challenge. But we got that done.

Weber: And some of that, you were-- I mean, having quick feedback was a general goal for educational…

Bitzer: That's right. People didn't think you could give quick feedback. Most machines didn't. Most machines rolled something by, tape or-- and it took time and it was hard to change. But this was nice, because the program allowed you to put in-- to use functions that were written for that part of the computer. As a teacher, you could put that in. You couldn't touch the system, but you could use that particular part in your program. For example, if you had an answer, an algebraic answer. We had an

algebraic judger. So they could put it in, and within a fraction of a second, they got the responses. Or they could all use other kind of judges, but you couldn't change those judges. You couldn't change anything in the system itself unless you were a systems programmer. And everybody wanted to be a systems programmer, but we didn't do that.

Weber: The figure of two tenths of a second, how did you arrive at that as a goal?

Bitzer: Because we had done the calculations on the original set of terminals, when we got the four to twenty terminals, we had enough statistics on how long each instruction took. We optimized the code so that those that were used the most were the fastest, and the display codes, for example, we would make the slowest. Because they were going to take-- wait maybe three or four tenths of a second. Actually, I wanted the goal to be a tenth of a second. And most of the time, it was that or better. And then, of course, you run into other problems when you're halfway across the world, because we had to use telephone lines for connecting them up, and you had to do echo suppression on regular phone lines.

We gave shows around the world, even in Italy, out on the coast. And they all worked fine. Tenth of a second response times, and you could tell what kind of lines you had, because if you got a line that went through the satellite on one direction and through the cable in the other direction across the ocean, you could tell that from one that was both cable or both satellites. Both satellite connections were three or four tenths of a second remote when you ran. And I get off those, because that was like going through mud when you try to type and show things. So we got it done, and for most users, it was a tenth of a second. And you could run bigger and longer programs, but they would run in the background and you'd get your share. And if a load dropped off, you got more and so forth. It was well thought-through by a lot of really very good people who had a lot of experience.

Weber: And you talked a little bit about [how] you were analyzing how people were using it. You had some sort of analytics checking how people were using it from pretty early-on, right?

Bitzer: Yes, we did.

Weber: Was that on PLATO I?

Bitzer: Beginning with PLATO I, we actually tape recorded all the inputs. And you could play them back from the tape and all the terminals would behave just like the person who was sitting there again. So we had all the data. And we processed that data, as I say, to find out how to build. When we built our own computer, we built it specifically to give optimal performance and speed for the instructions that we were running when we were teaching. And if you really sit down and think about it and calculate it, you don't make real big mistakes. You can pretty well hone things down to where they work like you think they should work. And if you find a mistake, you fix it, because it's your mistake, if it doesn't fill out the model that you had started with. So we spent a lot of time doing that. We built computers in the laboratory. We built terminals in the laboratory. And we also had terminals built outside.

And the big break in the terminals came in 1964. That was interesting. We had drawn up a picture of what we thought a terminal would look like when we had it. It had this glass plate front, it had a voice output. It had all kind of things, graphics on it, a place to project from behind. And that was what we wanted. It turned out, it looked an awful lot like that when we got done. And the plasma panel was the most difficult part. And the reason the plasma panel was difficult is you couldn't get memory. Memory would have just broken it down. In this case, the plasma panel had memory right on the glass. We'll get into that.

Weber: Yeah, and I'll ask you about that, because that's a very significant..

Bitzer: Breakthrough, yeah.

Weber: ... Invention of its own. So in '64 you were on PLATO II, right?

Bitzer: '64, we were on PLATO II, yes. Yeah, '64, PLATO II. Multiple terminals.

Weber: So you were thinking that this was projecting ahead of what you wanted to …

Bitzer: We knew what the problem would be if we tried to expand, and we needed to find a way of inexpensively expanding and [the] computer efficiently expanding. And this did everything for us, if we could do it.

Weber: And multimedia, I mean, having sound and being able to project, what? The slides?

Bitzer: Yes.

Weber: But that came in in PLATO III, though, right? Some of that?

Bitzer: The slide projector came in in PLATO III, but PLATO II, we did it differently. We had a scanner, a TV scanner, which you could load up [with] I think it was 128 images maybe. And it would then scan them all. We had a scanner that was scanning them all, and to connect your output to the output which is the slide that had been selected, and then superimpose that over the top of the graphic output. So that's where the superimposition took place in PLATO II, and some in PLATO III. PLATO III actually had plasma panels, the first ones.

Weber: Right. The beginning of it.

Bitzer: The beginning.

Weber: And going from the beginning-- and you had quite sophisticated code for the answer judging. Right?

Bitzer: Yes, yes. As an author, you had a lot of tools so that an expert in nothing but his course could do a good job of programming any way he wanted it taught on the system. And the Latin teacher did a great

job. I mean, he didn't know anything about computers, but he knew what the lessons should look like and how to do it. And we did that with all of them. We wanted to make it very easy on the user. And we ended up with thousands of lessons written by the professors themselves. And in the most difficult subjects, in chemistry and in chemical engineering, and all areas of mathematics, physics and other areas as well. Psychology, political science even, because anybody could program that wanted to. And we made it possible for them to do it.

Weber: And similar to the fast response time, you had the text echo back on the screen so people could see what they were typing very quickly?

Bitzer: That we really serviced first. That had a tenth of a second response time, unless you were caught by satellite somewhere. Couldn't do anything about that. But otherwise, yes. The faster you could type, it would show it up.

Weber: And what was the thinking behind that? Why was that important?

Bitzer: Oh, because people don't like to use things where they push a button and wait for a response, push a button, wait for a response. They're typing it in, they expect to get performance. And I have to tell you that when we demonstrated from Hawaii, once I ended up for one start of a show with two lines that were through the satellite. And in the middle, I stopped and I said, "I'm going to switch lines. This stuff is-- this is terrible. I can hardly give you a show with this response time." And the head of the computer department there at the University of Hawaii said to me, he said, "Let's not talk about that." He said, "They're complaining to me about my response time, which is much worse than yours, right across the street." And that's a software program they got, not a communication program. But then they got terminals right away, and hooked up properly.

Weber: And speaking of Hawaii, you were friends with Frank Kuo…

Bitzer: Yes, very good. Very good friends. We were friends in college, my freshman year in college. He was over here because his father, I think, was ambassador from the Republic of China, and I got to know him. We had some of the same math classes together. He would come over and we'd talk about things and became very good friends. Frank Kuo. And he's out in California there.

Weber: Oh yeah, I've interviewed him for his role in ALOHANET.

Bitzer: He did the ALOHANET. That's what he-- and he did other things, too. But the ALOHANET was the big thing, hooking up Hawaii so it worked well. Yes.

Weber: Yeah. He said you stayed in touch over the years, so he… I mean, he was one person in Washington that you knew and that sort of thing.

Bitzer: Yes, yes. And he was good at it. He was good in school work, too. We did a lot of labs together. He was there the whole time. He did his graduate degree there when I did mine. So it was a long time, and he knew the whole family and I knew his family.

Weber: And then so the response time was a real design goal from the beginning. And to go back to the sort of stages, so PLATO I was single-user, but you already had these ideas about the fast response time, echoing the text, answer judging, analytics in the sense of recording how people are using it. And is that when your wife began developing courses for it as well as other people. Is that PLATO I or later on?

Bitzer: I think that had to be at least PLATO II and maybe PLATO III, because we established a classroom over in the hospital and one at the community college for her. And I know before it was over, it was the PLATO with plasma panels and slides, because one of the courses she taught was the course in maternity nursing, and all the pictures that go with it. And we used-- the local TV station, during election time, always wanted to borrow a terminal from us, because they could put their TV on that and it didn't interfere. A good picture would come out. And they wanted to show election returns on it. So every time there was an election day, they'd come get a terminal. And one time they were over there, and the terminal they got from us had a problem. So they called right away, before they went on the air, and they said, "We need one quick." I said, "Well, come over to the house. We got one here." And it was one my wife used. And so they picked it up and went over, and I said to her that they were there, and they're on the air. And I said, "Maryann, did you remember to remove the slides?" She said, "No." I said, "Oh, I hope they don't select a slide." But they didn't. You could see an error, selecting the slide or doing something, but they didn't. They brought it-- they came back and we survived it. But she had slides then.

She had-- I think it was a hundred and-- it might have been 256 slide images. Or it might have been half of that, a microfiche slide. Just slipped right in the top of the terminal, a nice projector. It's clear as day, and you can superimpose those slides right over the top of your graphics. And they always align very well. So it was all you could do. And audio is the same way. We wanted to have a tenth of a second response time for the slides and the audio. And so in order to make that work, we used pneumatic pistons that we made that were binary in length so we could select the right positions in just one blast of air. So we used to have to carry compressed air with us in some form. And one of the good forms was when Freon-12 was always available in the hardware store, because that worked real well. You just hook it on, a little can, take you through a whole trip, and run the slide selectors and the speakers.

We wanted to give them a full range of things that they could do. We did not want them limitative. If somebody came up with something, and they did-- for example, when they were teaching young people arithmetic skills, first, second and third grade and so forth. They would-- the student, when he got the problem right, used to want a reward, the young kids. And so we built an M&M dispenser. And every time they got a problem right, it would dispense an M&M to them. And if it went on the floor, they picked it up before they went on with their math-- working on their math. But it worked out well. They loved it. And so we've hooked all kind of things on. Things that had to do with negotiations, because people from Northwestern wanted to find ways of having peaceful negotiations with people who were warring with each other, and they wanted to do the experiments there. So we'd hook-- we could make anything, because it had a general output. And you could just build anything and connect it as well.

Weber: And then for the authoring early on, though, was really true, full-blown programming, right? Create courses in the earliest version?

Bitzer: Oh yeah, there was something called TUTOR that was a language.

Weber: Well, that was much later. I mean, how easy was it for the average instructor to create courses in PLATO I?

Bitzer: Early on? Early on, the ability to create courses was pretty easy. I helped set that up. I set up a way that they could set up the logic separately if they followed the rules, and then they could branch off that logic to different programs they might want to have at that time. And the first one that the people used was kind of interesting, because they wanted to have help. They wanted to have continue. We had a key set that only had 12, 16 buttons on it that was used for another project. And so one of them was help, another one was return. But it was interesting, because if you needed help and you pushed the help button, it would take you over to a new sequence to help you with that question that you had. And then they had an Aha button to push when you caught on, and it took you back to where you left off. And those were used a lot in going through the material. And so with the logic that was set up, and the logic that was set up, and the logic control, there are a lot of programs that could be written that way, but not nearly as flexible as when you can have any kind of judger you want for algebra or chemistry or anything else.

Weber: Yeah. So you really invented a content-sensitive palette for the early system?

Bitzer: Yes. Yes. It went all the way-- students had a choice. They could take the regular course, or take many courses in chemistry and physics, all kinds of things of that type, on PLATO. Because there were enough courses to do that. And the students frequently chose the computer, which surprised me, but it doesn’t anymore. And I just wish we would have the system here when COVID set off, because they would have had 10,000 hours of lesson material all ready to go. And we just turned it off just before that, what we had here. So it was too bad that it was just a couple of years earlier than COVID that they decided that they could do this by other techniques. And they're still working on it.

Weber: Yeah, COVID did increase the amount of all sorts of use of online learning. I know that.

Bitzer: Yes. And there's a type of learning that we would love to encourage, and I still love to encourage. And I called it synthesis. Most of the time, people are doing an analysis. They take a course and they learn to solve problems, check them in the back of the book. They learn a subject-- differential equations or mathematics. But that's quite different than having a real problem which you have to figure out how to use all these tools in new ways to help you solve the problem. And that's called synthesis. It's much easier to answer fixed questions than it is to ask the right questions. And we try to train students to do that. I spent, in my class, until we got over 150 students in a class to teach as many as possible how to attack new problems. And we'd give them new problems. Sometimes they'd come up to my office and work them. But in addition to that, we always put one of those problems in their exams we gave them, usually unsolved problems, and see how far they got and if they liked it. And we'd give them-- it was an extra-credit problem. And every once in a while, a bright student would get pretty far into that. We'd hire

him and put him into the graduate program. That was a great way of selecting students, but it's really different. Some students didn't like that. A fraction of the students that are in class, they get through. They're not interested in being computer scientists. They're interested in something else, but this is a required course in discrete math that they can take. And so that would divert the effort of the class sometimes. So it was much harder when the class-- when the class was 40, we could handle them all in different ways. You can't do that with 150 in the class. That's a little too hard. So it was more teaching before the classes got that big. Now they're 300 to 1,000. It's amazing.

Weber: Yeah. It comes back to more rote. And with timesharing, you had tried-- you and the administration had tried to file a patent, but something went wrong?

Bitzer: No. Oh, well, yes. The patents that we filed went through. In fact, one of the patents is now-- what they selected in the patent office is the best 500 in the past years or whatever it is. But that was the plasma panel patent. The PLATO patent itself was the timesharing type patent. But we lost all those rights, because when we passed it through for signature, from the university into the president's office, they were more interested in-- they didn't do many patents. So it was put on the wall and hung up like a picture for about a year or two. And we finally found it, and it was too late for timesharing. But that's all right. I mean, you win some and lose some.

Weber: And talking about the structure there, the hierarchy, so Dan Albert, I'd say was hugely important. Could you talk about him and how you met him? He really recruited you to it, right?

Bitzer: Well, Dan Albert, yes. He was a fantastic person. He was a great manager. He was a good scientist. He was a high vacuum scientist. And so we had a lot of vacuum systems in the lab, which was good when we built the plasma panel. But he was also-- he was a sportsman, too. He loved to play squash. Didn't play handball, but he loved to play squash with me. And he became the dean. He was the head of the lab when I was there for several years, and a good one. I was on their board. He's the one that appointed me, I think, to being head of the computer-based laboratory when the first man had to leave. But he was very good. He was a good squash player. He's a competitor. I liked playing him, because in squash the rules are such that a man gets in your way, you can hit him. In handball, it's a hinder. And I, unfortunately, I think I split his head open twice in the court. And each time, I'd say to him, "Well, you got a choice. You want to forfeit or go to the doctor?" He said, "I'm not going to forfeit." But he did after blood started dripping down enough. But he was a good sport about it all. Always was. And he was very good. He could see new things. He supported new things, and he supported young people doing research. And that-- I've always thought of that. It's our young people coming up that are most important.

Weber: And you actually used high school students for some of the work? Can you talk about that?

Bitzer: Oh, in Illinois, I had two high schools that did a lot of the work. In fact, we built a computer at one. We had the Urbana High School, and we had the University High School. And there was a funny case there. I'd always told the students, if it affected their grades, I'd no longer employ them. Because they were spending so much time working on the research. Well, one time I was sitting in my office, and one of

them came through from Uni High School, and he left his last test on my desk. And I said, "Oh, I'll just take a look at it and see how he's doing." And I think out of a score of 100 he had, like, 55. And I looked at that, and I said, "That's it." And I called him in and I started talking to him. Very smart. I said, "You're not doing so well in school, are you?" He said, "Well, who told you that?" And I said, "Well, I just saw a test where you got a 55 on it. And that's out of 100." He said, "Yeah, that's all true." He said, "What are you worried about?" He said, "That was the highest score in the class." They just made the test that hard. I never looked again. But I checked on them. I had to hire them under the Farm Labor Act, they were so young. The Farm Labor Act required that I give them food twice a day and rest periods in between. I had to kill them to stop them. They didn't want to stop working for 15 minutes and take that rest. They wanted to sit and work all they could. At Uni High, people just had to run across the street, and they'd run back and forth.

So they were very good. And there were six of them that I hired all summer to work on things. And the faculty-- not the faculty, but the researchers at the laboratory complained-- Dan Albert was still in charge-- that we were spending money, good money, on these students. Of course, they had never worked with them. And it was very exciting because I had talked to the students. They were doing very new, novel work. You wouldn't believe the work they were doing. So I said, "We're going to have a seminar. All six of you are going to present your work to the rest of the laboratory." And they said, "Oh, they couldn't wait." And it was beautiful. And you couldn't believe. I mean, they have a person marching in, and they had her singing out of a synthetic voice-- her voice. It was marvelous. And when she stopped singing personally, it kept on. Then they played the instruments. They had-- everything they did was excellent. Well, after that, I never heard another complaint from the rest of the faculty. They had to worry about getting their own ready, because these students were really good.

And I've done the same here at NC State. NC State has a-- I had really three wonderful high school students who-- I think one of their best high schools in the area, who came to me quite by accident. They went to the university looking for someone to sponsor in what's known as the Siemens Program now. It was the Westinghouse Scholarship Program. And they were looking for someone to advise them. And they came to my office and they said, "Well, everybody we talked to said, 'Forget it. We don't have time for kids.'" So they said, "We came to you." And I said, "Well, why-- how'd you come to me?" They said, "Well, you gave a talk at IBM.." which was true, for the laboratory out of the universities, "... On PLATO and the plasma panel." And they were excited about that, because their father was there and heard the talk. And the last thing I showed them, showed on the slide, was the new work I was doing, which was in making messenger RNAs. And one of the fathers saw that right away, and he said, "Go talk to him." And he did. And they were as bright as I thought they'd be. They had taken college algebra at college. They knew how to do differential equations. I could talk to them at the blackboard as graduate students. And I said, "I'll take you on, but I can't say yes yet. I got to talk to your parents."

Because all of them were too young to have drivers' licenses. And I said, "You've got to attend the meetings. I'm going to treat you like a graduate student. You have to attend all the meetings. You have to take a piece of the project and present it. That's how we're going to run it. And they did that. The parents came in, the parents said, "We'll do all the traveling. Don't worry about it." So they did. They took up every meeting, they did everything. They took them around the country when the contests moves around the

country as it grows smaller. They were selected for the final six around the world. The finals were held up in New York, the Times Square area, their names flashing around. I was teaching a class. I turned the TV on, because it was on TV, and they went backwards in giving out the awards. They started with the sixth, fifth, went all the way down. And every time they announced one that wasn't their names, the kids knew about it. Everybody stood up and cheered. They finally got down to the last two. And they got second place in the world and the other group got first place. Which was fine, except they had been noticed now by the people, that they had done their own research work, not just reporting. And they now adapted the process that they got involved in as the way of doing-- of how messengers really work, how you build them, how you make them work and go through the process of making proteins. And so that became a new process that they had contributed. They got that nice award. They got 50,000 dollars, and the school got 10,000. So as I say, never underestimate the ability of a young mind. They're very good.

Weber: In fact, in PLATO two days, didn't you have a group that built a reed switch computer on their own?

Bitzer: Yes.

Weber: It was those students, right?

Bitzer: Those were students from Urbana High School, and they wanted to build a computer. Well, I wanted them to get involved in it, too, but they were working, doing other things. And I said, "We can make one. We don't even have to buy the chips or anything." I said, "In fact, I think the decoding would have been a lot faster during World War II if they, instead of building these mechanical, moving machines, if they'd just gone out and-- we had a lathe. We had thin copper wire, we had a plastic tube. You could wind the wires in the plastic tubes or two-- whatever you wanted for the logic. You could put what now are called millisecond switches in. You could cut the commanding wire, cut the metal off, it's a thin strip, put two of them into the tube and glue them. And they close in about a thousandth of a second. And you could build and/or logic, all kinds of things with them.

And so we built one up and we fixed it so that we could load it up and make it work. They got a-- I guess they won a big award for that. And I still have an abacus somewhere around. I can't remember which building I got it in, which house. It's about six feet long. That was given to me for helping them. And that was-- they worked at night. They would come over from the high school to my basement where I had the lathe and all this stuff set up. And they would work. Their parents would come over and sneak and look in the windows. They weren't really sure where they were at eleven or twelve o'clock at night, and they were getting worried. Well, they found out, and I was the one that should have worried, because at two o'clock in the morning they'd come upstairs, knock on my bedroom door. And Maryann, my wife, would say, "Don, they have a question again. You better answer the door." And I'd go to the door, answer the questions, they'd go back downstairs and work a little longer. They did this for a long time, day after day, building the computer. They learned all about computers. They all became-- one of them became the head of the computer science department at Indiana University, just retired from there. They all became leaders in some field that they were in. It's just amazing, how these kids do.

Weber: And there were-- obviously there were fewer girls and women in most of these pursuits, but could you talk a bit about gender in this?

Bitzer: Well, we had-- they were very good about it. They made sure that the young women in their high school, particularly the public high school, Urbana High School, were invited to participate. And they were really senior members of the whole thing. So no, they did a great job. And I hired many of them. Once, I got a portrait of the first original six. One day I went upstairs to-- I gave them an office on the fifth floor. The elevator went to the-- no, on the fourth floor, and the elevator went to the third. And there are stairs that went up. And I said, "That's a good place to put the young people, because they can run up the stairs." And so I did that. But I didn't know as much as what they were doing all day, but then we'd go up there. And I went up there one day, and on the wall, about eight feet long, was this big poster made on paper. Each painted a portrait of themselves as they saw it on there. And so one day when they were gone, I photographed it and sneaked it, and the next time I sent out cards to Christmas, I sent them a picture of all of them. But there were-- absolutely. There were a lot of females involved at the high school then. They were smart, too. They were-- I don't know if the men thought they were as smart as they were. I didn't ask them. But they were-- they made major contributions. They made a lot of major contributions, even the faculty, a lot of them were females. And a lot of that work..

Weber: Can you talk to-- oh, go on.

Bitzer: Go ahead. I'm sorry. What was your question?

Weber: Yeah. I mean, also within PLATO, talk-- Tebby Lyman , I guess.

Bitzer: Tebby Lyman was wonderful. She was the husband of a physicist. She herself, I think, had a degree in physics. And I placed her in charge of a lot of the management of the technical side of the laboratory. She could program. She knew what it was about. She knew what electronics was about. She could read my handwriting, which was important in those days. And she was just very good at things. And when I left for India, which I'm sure we can discuss later, she ran the laboratory for me and sent me postcards of every project that was going on, because that was the time when I finally finished thinking about how we were going to make the plasma panel when I was in India. But we can cover that later

Weber: I think that we're getting to about-- oh, before the plasma panel, so you had switched away from the ILLIAC in that period, right?

Bitzer: Yes.

Weber: It was turned to CDC.

Bitzer: CDC. Yeah, it was [a] 1604.

Weber: And you wrote an emulator to run the ILLIAC stuff?

Bitzer: For a while. We wrote a program, then we switched the program over. But the first came in, the easiest thing to do was run an emulator, yes. And they did that. It worked fine, except it wasn't-- that wasn't as fast as you could do if you went back to direct instructions and optimized things. So they eventually went back and did that. And we modified-- we got faster computers, too, as time went on, all supplied by CDC.

Weber: And how big was the project around that time?

Bitzer: The laboratory grew fast. And the first three people or four people I worked with, we had probably 120 people by the time they were writing lesson materials for grade schools and other places. It just-- it grew awfully fast. I was gone an awful lot traveling. And I didn't require anybody in my laboratory to go get money. I'd rather have them work on projects. So I tried to get all their money, and I did that for almost everybody except for the people who were writing special courseware that the government wanted to support for children in high school or children in grade school. And they could get-- they got money to do that separately. But outside of that, we did the whole thing. And Controlled Data furnished all the computers until we built our own at the end.

Weber: And Peter Brownfeld met the project somewhere in that area, right?

Bitzer: Oh, very on-- no, Peter Brownfeld was involved from day one. He was in the first meeting when we named PLATO. In fact, he made one correction. We called it Program Logic for Automated Teaching Operations. He said, "That's not the right word to use." He's a good linguist. He said, "Automatic is right, but not automated. It's not self-mated." I said, "You're right." And we changed it right on the spot. But yeah, no, he was involved right from the very beginning. He worked in the laboratory earlier on other projects. And he knew how to program ILLIAC very well. And he worked with someone-- Lloyd Fosdick, I think was his name, in the computer science department, who also did a lot of early work on PLATO, the courseware.

Weber: And he left right around the time you were getting and ramping up for the display, is that right? I mean, tell me why-- why did he leave or consider-- that's sort of when you became the main head of it, is that right?

Bitzer: Well, he still came over and did a lot of work. He was, as I said, he was a mathematician. He taught-- he was in the math department. The taught mathematics then. He started teaching more of it. And he got himself involved more in the things that he was doing. But he would come-- whenever I had a question or anything, he would come over and we would work it out, get it together. It was very, very valuable.

Weber: And then let's see-- and in your personal life, so your son was born in this period or a little before, right?

Bitzer: Before what? I'm sorry.

Weber: Maybe before. Because the plasma display you started thinking about seriously when? '64, '65? Something like that.

Bitzer: In '64, we finished the first small panel.

Weber: Right. And your son was born a couple of years before that.

Bitzer: Well, my son was born in '63. No, no. Yeah.

Man 1: No.

Bitzer: You were born in what?

Man 1: '61.

Bitzer: '61, right. He turned three when we were in India.

Weber: Right. And then you went to India right around then. That's sort of leading up to that time.

Bitzer: When he was about a month short of his third birthday, we all went to India for six months.

Weber: And I think you met important people for the plasma display there, right?

Bitzer: Later on. Yes, Brij Aurora was one of the main ones from India. And he was a student there as well. And my job was I helped get the computer and get it installed, and I wrote up programs and how to program the computer, put them on slides so that they could use them in class. And he was there, and he would come over all the time and was very friendly. And I said to him one day, I said, "Some time you ought to come to the United States, and I got room in the laboratory and I'll get you there." And it was about a month after I got back, somebody says, "There's somebody here to see you." And it was Brij Aurora. I said, "Okay, I'd better get started." I got him a position in the laboratory, and it was a good thing. He built a lot of the original one-dot and two-dot panels and studied them. We had lots of people visiting doing that. Almost all the Japanese companies sent people over to the States, some for years, studying how to make the panel.

Weber: And how did you get the idea that you and your colleagues could build this sort of panel? Where did the germ of the idea come here?

Bitzer: That came from sitting down one day and just trying to think, what could we use that would give us the memory and everything else? And those things were just used for output lights in those places. But it was easy to do some simple experiments before we left for India. And I had a graduate student that was on the patent with us. And he was-- I left him in charge.

Weber: Was that Robert Willis?

Bitzer: Robert Wilson. And he was a graduate student at the time. I said, "Here's what we want to do. We need to make some measurements." So he built the equipment that would allow me to do some electrical measurements on little neon tubes. We were interested to see how much charge we could store inside and what the voltage was at firing, and things of that type. And he went through that, and then he also helped build the first, I think, maybe four-by-four panel, and doing all the experiments with that kind of thing. But he did that for his PhD thesis, worked with that. And I got him out of the EE department. He was just a student. And I talked to the EE department afterwards, because most of the students who came out-- it kind of bothered me, because you'd draw a picture of a capacitor on the board or an inductor. And you ask them, "What is this?" They'd say, "That's a capacitor and an inductor." I'd say,

"Boy, if it's that, just copy them fast. We'll print them up and make money." So they didn't realize the difference between a diagram and the real thing at first. We didn't teach much of that. We always worked off diagrams. So I taught this person to work on-- not just worry about what was in the diagram, but worry about what was really there, because we had to worry about all those things. And he did, and we got it done. He worked on the data while I was in India. I got a report once a week. And by then, I figured out that it was going to work. And so when I got back, we decided to… Gene Slottow, who was the other inventor, came into my office. And we were waiting for our wives to pick us up at five o'clock. And they were late, both of them. So we sat down in my office and we said, "We might as well not waste our time." So I went to the blackboard and said, "Gene, what do you think about this? This is why I think it's going to work." And we drew it up and next day, we built it. And it worked.

Weber: But wasn't there some sort of breakthrough around putting the electrodes on the outside or changing..

Bitzer: Oh yes, yeah. Well, that was-- we never put the electrodes on the inside. There was a company-- I'm trying to remember the name of it. They probably wish I'd forget it-- who worked for 20 years trying to build this kind of panel. And the first thing you realize is you have to isolate the elements, so you can turn one on and the other off. They had drilled holes in the glass and put resistors in. And the glass would break after they put some in. They tried smaller resistors, it'd break again. And so I thought, "That's crazy. We know what we need is impedance, but capacitance is an impedance." But it's AC, and that's why the panels were called AC plasma panels, because we drove them with AC. About a megahertz of frequency on the outside driving them back and forth, which immediately made things work out right. And it looked like it was going to. Gene did some calculations, so that's the first one we built. And it worked. It had a 20-volt memory.

We were so excited. But it worked for the wrong reason. It had a leak in the vacuum system. And it was the nitrogen that leaked in that made it work. You couldn't run neon with it. So we figured that out, and the problem is that-- these are the days we use mostly vacuum tubes. And to drive a couple hundred volts and a megahertz in a vacuum tube was not the easiest thing to do. So we were very careful to make sure it was a sine wave that we were using, because it was easier to use sine waves. The problem with it is that with these plasma panels, there are two important features. One is you want to cause a fast

discharge, but then you want to keep the voltage on for a long time, because you want to transfer electrons and ions to the opposite side of the glass. So sine wave doesn't look that way. The higher the frequency, the shorter everything goes on you. But it was good enough that it would work with nitrogen, a mixture of gas. It wasn't good enough to work at all with neon. So the first thing we did is we settled why it was. We fixed the leak, put in-- filled it up with the neon we wanted. It didn't work at all. Then we decided we needed a different driver, and that's when we got these drivers that were more like square waves or pulse waves, plus and minus. It worked like a charm again, and we then knew how to really balance any gas usage. We wanted ultraviolet, eventually, against the voltages. And they had good memory that worked for several dots. No one except us believed the one-dot matrix. We could tell, because we were making the measurements, how it focused the charge right in the center, even though it wasn't sealed off there. If you look at it, it's those dots, self-focusing.

There's a principle involved there that has to do with getting dynamic stability. And I still work with those principles. I can't tell you about some of them, but my latest idea is that we ought to be able to make small fusion machines with dynamic stability. If I get around to it, if I still live long enough, I'll get that started. But you learn a lot from each of these projects. And so we made it, we put the right charge out and put the right gas in. We immediately were able to move the ultraviolet and phosphorous inside. That worked fine. But we were not in the business until later on of building big ones ourselves. The biggest panel we built was a 16-by-16, which was early on. Which was good enough we could carry it around, write things on it, the characters and letters, and show people how it erases. We put it in a little suitcase. And then we started working with companies. And Owens-Illinois Glass Company was the first one. And the reason they were the first ones was because their officers were graduates from the University of Illinois in business. And they always come over for the meetings. They said they heard about this. They liked to take a look at it. And so they decided, said, "This is a glass product. We ought to be doing it." And the way they decided to do it was to the management was they took in what they had to do to make plasma panels and showed them. And they showed them what this thing they called this iconoscope tube that they were then making, the <inaudible 01:48:19> cathode ray tube that introduced the shadow mass tubes. And they told them what that took. And when they got done, the management said, "Don't touch those." They said, "They're too hard. Go work on the other one." That's how they got permission to do this. And they did, and they did a good job. They had some nice changes in things that made things better. And they produced panels up to 512-by-512.

Weber: And you had already patented it by this time…

Bitzer: We had patented that, … everything was patented, and the patent was applied for in '64, issued by '68. We had gotten all the changes and everything they wanted. That was still too early. They only last 19 years, 20 years. So by the time television was done in the US, the patent had run out. But we had, in the patent, all the kind of new things they put in the middle, but they were out too because they were all in the original patent. So we didn't get that, but the government didn't pay a royalty either, because they supported the research. And they were going to-- they built lots of panels. Big ones and small.

Weber: The government wanted big displays for military stuff. Yeah.

Bitzer: Oh, they wanted it for-- I can't tell you without violating secrets, they wanted at least three different reasons. One is they wanted them for the big displays in caves so they could watch the skies everywhere. The second reason was they needed them for communications, because the plasma panel, you can't track. You can take a CRT, and you can scan it. As it scans, you can be outside a building with an antenna and read it. So they didn't want that, and so they were interested in that. They were also interested in dropping them from airplanes as panels for communication in the fields, and they needed something rugged. And so these were rugged, and they needed them for space shuttles and submarines became a big use. So the government made a lot of them.

Weber: And the fact that the memory function was important for all those, too.

Bitzer: Yes.

Weber: Because they saved on having to have video… external video RAM of some sort?

Bitzer: Yes. Well at the Western launch site, they always wanted to track the land under the missile as it flew off the California coast. That was important to them. And this was so nice and easy for them because they could track the missile and data on the panel, and project from behind the image of what was underneath it as it flew. And they did that. And so I went out there and they did a nice job. A lot of places contributed ideas of how to use these things, how to use the panels. And IBM had clever ideas. IBM's biggest use was key set entry stations. Because you could see through the panel, they'd tape off the top half on one side and the bottom half on the other. And you could run two people, each saw their half at the same time. And that was a lot better and cheaper and easier than one. So they manufactured those point of sales terminals and key set entry terminals by the droves. They did a real good job on that.

Weber: And you could change the color of the pixels, so theoretically you could have had the basis for color display.

Bitzer: Well, we actually-- yeah. As far as color came along, one of the first things we did when, I think, we built a three or four-dot panel with different colors in each one, [using] phosphorous and a UV gas. And it looked just like what the Japanese had done. And the Japanese were, of course, doing that earlier. The Japanese really produced a lot of earlier terminals. Not just for TV, but for their busses, for their filling stations, regular sales points, because they have Kanji alphabets. And it's hard to use segmented displays and do a good job with Kanji. And so they loved it, and they jumped right on. And they worked much harder than the US industry on getting up there. But they were ready for TV when they came along, and they could make good color TVs.

Weber: And you did use some of the early plasma panels for PLATO III?

Bitzer: Yes.

Weber: The smaller one?

Bitzer: No, 512-by-512.

Weber: So those were already 512, okay.

Bitzer: Oh yes. Well, it grew fast after-- the size grew fast after they knew how they worked … and what they had to do to make them, and the spacing and protecting the surface of the glass. Those were all nice contributions by Owens-Illinois Glass.

Weber: And it took them several years, right? To go from your concept and prototype to something that you could manufacture.

Bitzer: See, I think it took that long for them to get everything done, including where you could make them for bowling alley displays and things. But they worked on it pretty hard. And it might have taken two years of time. There's a lot to do to be sure you can manufacture them and guarantee them for a long life. And they did that. First of all, testing had to be advanced testing, because you wanted these panels to last for ten, fifteen, twenty years. And you couldn't test them in real time. You had to do aggressive testing of some kind. And they did that, so they did a lot of work that we would have had to do. We didn't build our own in the laboratory, larger panels, until later on. And that was done by Weber. Larry Weber, who was a graduate student, started on that. He built the big ones, right from scratch. He built the equipment to build them and spinners and tubs, and he had a big room on the first floor of the building. And he liked doing that, so he's the one that started the Plasmaco. And then he actually built color displays. They were bought out by Panasonic. And Panasonic went into the big business, and he joined them. I think Panasonic, the story is that Panasonic sold 25 million TV panels a year. And I can believe it. It represented a good fraction of our foreign trade to Europe at one time.

Weber: But that was all after the patent was run out, or some of it was.

Bitzer: Oh, yeah, all that. Yeah. The patent, IBM paid on the patent because there were other aspects to it that they wanted that we had done. And so they paid pretty well. IBM was a good patent user.

Weber: And so some of that came to the university and some came to you and the other inventors?

Bitzer: All of it came to the university. And that got divided up to the lawyers. And then it got divided at the university into various groups-- some for the lab, some for each of the inventors. And the one I objected to the most was for people supporting people whose research didn't get funded. So they helped support with all that money. And I tried to explain to them, that's the wrong type, to be supporting people whose research did not get funded, because there's probably a reason. And I said, "If I were you, I'd investigate every year. You either reduce it or increase it based on performance." But that's the way the universities worked. Universities never really had patents before. They had no idea what the…

Weber: Yeah. I mean, technology transfer was still not as routinized as it is today.

Bitzer: Oh no, there was no technology transfer. They had a couple patents. One was for Krabiozen, which was a fake [drug] done at the university medical school in Chicago. And I can remember when I was an undergraduate student, marching with the crowd of students to the president's office, screaming about the Krabiozen, which was a fake.

Weber: A fake what?

Bitzer: Cancer drug. A fake..

Weber: Yeah. Oh, that's a cruel thing.

Bitzer: It was cruel. It was by people who came over here, foreign professors, brought it with them, worked on it in Chicago at the medical school. I think everybody knew that it wasn't right. But the university finally did do the right thing and get rid of it. But they really had no experience in patenting. They didn't have a patent office. It was kind of a-- they did when I left, not before I started doing it.

Weber: Is that part maybe because … obviously the university developed all sorts of technology, but mostly for government clients, where patents were not an issue. Was that why they were doing less transfer to industry?

Bitzer: The general view of universities that were fairly good universities was that patents are not what universities should be doing. They should be publishing. And they lived up to that. I mean, they did everything but punish you if you had a patent until they found out it made money, then the changed their attitude. But no, they didn't-- I think in the long run, my publications were not as important as the things that we produced. But no, publications were the big thing. And some of that's true today. People are evaluated at universities for promotion based on three things. One is for the amount of money they bring in. Number two is the number of papers they write. And the number three is the public service. And those are the … because of that, there are people with 200 publications and probably zero ideas.

Weber: Do you think the fact that you came from a business family made you more open to the commercialization?

Bitzer: Oh, the day it's-- particularly at NC State, I don't know personally about Illinois, but when I left it was getting a lot better. But when I came here, they had set up properly. And they had a transfer. It was done very well at NC State, and that surprised me, how well it was done, because I couldn't rely on transfer at the University of Illinois for much of anything but to send in the patent. But then once you got patent people involved, then there were people from IBM who argued with me at first. They told me they were going to put me out of business. They had a better panel. And I said, "I'm waiting for them. Why didn't you tell me? I don't want to make money on them, I need panels." And it turns out that was just a … they were trying to get in. They were barred from getting in because we gave an exclusive license to Illinois glass. So the lawyers, we went-- we were called to Armonk to argue it out. And the lawyer was very good, their lawyer and our lawyers. And they worked it out, and they figured out how to make it go so they could get one. They were happy. It cost them a lot of money just to get the letter written, but the

lawyer was very good. He had done a tire business in Chicago, so he was very good at it. But I came here, they have a-- really it's easy here. They make it as easy as they can for you. They even teach courses on how to go out and do this, which is-- it's almost switched the other way. And I constantly argue with the administration on when we pick people for a promotion, we want to start asking them what ideas they've contributed to make the field different.

Weber: That was the intention even back in PLATO III days, that you saw things in a more-- more as an inventor in a way than as a…

Bitzer: That's correct. It was interesting, and when I came here, as I said, it was well-defined. It didn't-- Illinois, it wasn't sure you were going to get the patent money, because they may have needed it for something else. They didn't get away with that, but they would try. I mean, this was … not run professionally. But when I left-- and now it's professional. And the one here was professional from the very beginning at NC State. And I enjoy it. They appreciate getting things. Illinois did not. Illinois thought it was time wasted. Here, I'm more worried about the faculty learning to do new things that are creative, and new ideas. Because they're all-- everyone's interested in getting it in the national academies. And that's the first question on the first page, on the top of the page, don't go any further if you can't answer this question about the person. So it's different. And I told them that in there, and one time I almost caused a fight, because the person had only six papers, and they weren't going to promote him. But they were good, and they were new ideas. And so I laid it out. I said, "How many of you here who have been-- who are now professors, have had one idea contributed as being brand new and good?" No one raised their hand. I said, "You see, I said, you ought to read those papers, these eight papers, and read them before you criticize him." And they said, "Well, if we do that, that'd take a lot of time." I said, you ought to take a lot of time. There are people here whose lives depend on taking the amount of time. So the university has changed since then. Now, the chancellor and vice chancellor are very interested. They've changed instructions to people on how to pick professors. And it's really, I must say, gotten a lot better here at-- and Illinois was always a great school with faculty and all. They seem to be able to do all kinds of things. NC State has really grown the past 30 years, too. Really different, bigger, and more important university. And so I hope they keep doing that. It's a little harder job, but if you really want to evaluate someone, you've got to read what they're doing, not just guess. Not count.

Weber: Yeah, and clearly you and Dan Albert have a more commercial or research approach than some of the people at Illinois.

Bitzer: Yes, yes. Dan Albert was-- he became the dean. He had good ideas on how to change things, and he went with them really as long as he could until I think he finally got into a fight with someone in the administration, and then asked if he could join in with my group. And I welcomed him in, put him in charge of all the lesson material. And he always did a good job at whatever we did. But no, Dan Albert made a big difference at the university, at the laboratory, and certainly in what I do.

Weber: And both you and he were open to commercializing research in a way that was not that common at the time.

Bitzer: That's correct, mostly because he came from Westinghouse, where he knew what it was like. He knew what we could do and how much industry could help. And now, it's a regular thing at universities.

Weber: Sure, no, the world really did change that way.

Bitzer: It wasn't easy.

Weber: It's now a standard. Universities see it as a way to get income now in a way they didn't back then. But back in the time of the plasma panel, so PLATO III, you had it going. It was being-- starting to be produced. That's also-- Alan Kay came and saw an early version back then, '68, something like that.

Bitzer: Alan Kay was a good friend. He was involved in the same ideas of trying to apply technology to teaching things. He worked, as I remember, for Xerox at one time. But Alan Kay was-- he would come out and visit, and we probably met once a week at meetings. We both seemed to hit every meeting in the country, and both of us would be there, and we'd both give our talks and go home. But Alan Kay, and there were a few others at the same time, but not a whole lot. Most people did not view computers and education as being very important. They had programs, scrambled books, all kinds of things. But if you kept your eye on the computers, you knew that eventually that was going to be the winner. And it did.

Weber: And Seymour Papert came to visit as well, right?

Bitzer: It did work out for what? For who?

Weber: Seymour Papert. Am I saying his last name right?

Bitzer: Seymour Papert from MIT.

Weber: Yeah, but he came out to visit as well?

Bitzer: Yes, he did. He stayed. He came over and stayed there. Seymour Papert, and he had a friend. I forgot his name, a senior to him at MIT. And they were interested in artificial intelligence a lot. And I attended a lot of industry meetings with both of them, with NSF, where we make presentations. And they were pushing how fast artificial intelligence was coming along. And this must've been 30 years ago. And it was just two years away. And they really liked that idea, and I remember the thing that kind of scared me a little is someone said, "Well, if it really works out this way, we'll be replaced." And I think it was not Seymour, but his friend from MIT that said..

Weber: Minsky? No?

Bitzer: Who?

Weber: It wasn't Marvin Minsky, then?

Bitzer: Yeah, I think it was. Marvin Minsky. Turned around and said, "What's wrong with that?" He said, "If we're not as good, we ought to be replaced." I said, "What?" Thank goodness they were wrong. But Seymour had a lot of things for teaching, teaching students to program and run little things around, robots. And they were both good at language, introducing language and translations and things of that type. So yeah, we all meet, I would say, a dozen times a year or more. We'd always be at some meeting together, same meeting. I used to fly in, hear the talks and fly out.

Weber: So it was a small community where you all knew each other?

Bitzer: It was a small community. Gradually, it was introduced with the plasma panel. People with the various types of input devices would show up and tell why and demonstrate them. And the new technology would show up at the meetings, too, in the talks as well. And that was some time ago. So a lot of this stuff's been around for a long time.

Weber: Speaking of input devices, it's for PLATO III you started with the idea of a touch panel, is that right?

Bitzer: We started the touch panel out. And that was nice. PLATO III. We molded those in my wife's-- in our oven at home. I went to the store. We were right on the main gas pipeline that went through Illinois, and so they located a plastic company there, because plastic products and bags and things are made by extracting products that go through natural gas. They take it off and send it on. So then they located this-- that was ten miles away, fifteen miles away. So I needed plastic to mold these. I wasn't sure just what kind, so I called him up and I went out to see him. I said, "I need some plastic. I'm going to make these touch panels, and here are the characteristics I need. I'm going to use infrared and we're going to mold them and so forth." And the guy said, "Oh." He said, "No problem," and he told me exactly what I needed. But he said, "But I'm not sure we can get you started on that." He said, "We can't deliver over maybe a railroad car of material a week." I said, "A week? All I want's one bag for five years." So they told me all about it, gave me a bag, I went home. I still have a little of that left. And we built the molds and we molded those panels, put them on, they worked right off. It was very nice.

Weber: And that's basically electric eyes or a..

Bitzer: It had the panel for the purposes of sensing the touch, had intersections both vertically and horizontally, diode lights and diode detectors in the material that we molded around the edge. And self-focusing, we made the material such that it would focus into the detector with the panel. But since we molded them, we could mold anything we wanted in as the shape around the edges of the holes. So we did that, and that was-- as I said, we had, really, a lot of interesting things we could do in that lab, because we had a really first-rate machine shop for technical work. But they had a student machine shop that we could all go to and try to do it, and if it didn’t, we'd just give it to them. But we'd try to do it, so we actually made all the molds on the machines, the lathes and all of it. So we got it done in a couple weeks and put it right on, and we had an input for it right away. The whole terminal was set up so you could add things and take things off digitally.

Weber: We're going to talk about the multimedia aspects on PLATO III, which led into PLATO IV. And the number of users on PLATO III. Don, tell me if this is right. I'm seeing the later PLATO III, you're kind of doing a dress rehearsal for PLATO IV. You're testing out different features you're going to put into place. Is that right?

Bitzer: Yes. The PLATO III terminals were very much like the PLATO IV terminals, except in between we had done a lot of development on communication devices. We liked to put, if possible, 16 terminals on a dial-up phone line, and things like that. So we had a lot of different communication devices for PLATO IV.

Weber: And how did you get that many on the phone line?

Bitzer: Well, we had developed-- we were able to put a lot of people on a phone line, even an acoustically-coupled one. In the early days, you weren't allowed to make electrical couplings. You had to make acoustic couplings. And we developed a broad-spectrum modem, which Gandalf Limited in Canada came and got the patent for and made them, because they were in the short-haul business and they wanted them, too. And it was just one of the inventions that we turned in with one of the grad students that I'd worked with. And they worked well. They did just what we wanted and they got produced by the thousands. And we used those. You could connect almost anything to those. You use a very low baud rate, but a very high bit rate. And you get the bits by the number of bits per baud. And the baud rate's what you have to protect yourself against on changes. So it worked out well. It was just another idea we had, and it turned out to have a lot of use outside of our function. And it was picked up by Gandalf Limited in Canada.

Weber: And so PLATO III, you had 20 users, maximum.

Bitzer: Mm-hmm.

Weber: Is that right? And then it was partly through going away from the acoustic coupling that you could go to the… how many were in PLATO IV?

Bitzer: The number of terminals in PLATO IV eventually got to...

Weber: And then you could theoretically do four thousand…?

Bitzer: ... Seven thousand. We used to advertise four, but I think that actually the last model that they had commercially, they had-- I used to look and it had seven thousand simultaneous users at one time. That's a whole university in operation.

Weber: And you were-- yeah. Anyway, it was a big step-function jump. And along-- so you have the touch panel, the flat screen, the plasma display. You already have well-established the slide, microfilm… the slide reader. The audio disk was already there in three? PLATO III, yes?

Bitzer: Was what there? I'm sorry, say again.

Weber: Sorry, the audio disk. The audio, for playing audio on the terminal.

Bitzer: Audio on the terminal? Yeah, we had audio on the terminal. We had an audio selector. We could play music or audio or teach foreign languages. You could record your own voice on it as well, and then play it back. So when we taught foreign languages, you could..

Weber: And that was all happening on PLATO III?

Bitzer: Yes. The later models of PLATO III had all that in it.

Weber: Okay. And so you were really thinking in multimedia terms, you could do…

Bitzer: Right from the beginning, we had decided that the important thing to do was to get multimedia to the student from the teacher, and make it easy for the teacher to use that multimedia or put it in without any real difficulty on their part. And four became a big expansion way of-- once we knew it worked-- how to expand the system so we could handle thousands at the same time. And the communication has changed. We were able to put several thousand terminals on one TV channel. And then we-- and sometimes we'd use that-- we would broadcast that channel locally with an antenna on the roof, so the cities around could just put a little antenna receiver and distribute it in the community to whoever wanted them. So there were a lot of communication devices that we started working on. That's how we really got into the communication business, is trying to distribute this effectively and inexpensively.

Weber: Now, distributing it on TV to people without a terminal would still be useful, then?

Bitzer: No. We were using TV channels for the data. And even the terminals that use the cathode ray tube had different devices for receiving the data and then going in and driving the program inside the computer driving the TV set. So even if it was a TV set or a plasma panel, we used everything we could over communications with about the same bit rate. We knew what the data rate was from the terminal back to the computer, and from the computer back to the individual, because we had all that data for a lot of terminals for years. And so it turns out that people had a lot more to receive than to say. So that..

Weber: Yeah, in an asynchronous way, like most internet connections are today.

Bitzer: Yes.

Weber: They need more coming down than going back up.

Bitzer: That was one of our patents is the communication boxes that you have for cable coming into the homes. We were-- we discovered that one time. It didn’t take long. I got a call from CDC, who was trying to put, I think, 500 terminals on some cable and they said, "All we get are collisions and noise. We can't get them through there. All the data is colliding. And that's because it's coming from separate sources. So they asked me to think about it, and I went on a run and thought about it with some of my friends. We came back. We had the answer. And the answer was, if you're having trouble, send more. But you want

to send the right stuff, because you'll cause more collisions if you send more. But if that collision data is the same repeated data from others, then the probability of getting through error-free goes way up, because that goes up exponentially, while the collision rate only goes up linearly. We called them up, they tried it out, and that was CDC. They called back and said, "It all works." And so then we had patented that with the back offer, if you have a collision and so forth. Most people don't know about that, but that was another part of our communication problem that we wanted to sell, and it worked well.

Weber: And roughly what year was that?

Bitzer: Oh my. Let's see, I was out running, then. I can't-- it had to be-- CDC was selling terminals. That had to be in the '70s, best I can remember. There was a lot of things happening simultaneously, a lot of different communication devices. And we wanted to make sure they all worked, and we tried and we got them out. And we had a lot of people wanting them. CDC was selling systems to the government, the airlines. I guess airline training for the new path guides and routes that you program before you leave had just come in, and they were trying to train all their pilots how to use those, thank goodness. So it all worked. And the Army was doing a lot of training on a lot of things. Helicopters, they did a lot of training on people who represented their person in line to help people in the field if they got a hit, things of that type. So there was a lot of government use of the system that came along. And that was all about the same time. It all happened-- it all came to head between the '70s and-- early '70s and the early '90s is where a lot of things came to head. And we had a satellite uplink, so we could broadcast it by satellite to remote cities. And that worked, and we had just all kinds of things going on at one time. And they all took time and they all took effort. They were all fun.

Weber: And we'll get to the '70s and beyond in a second. But for multimedia, you also-- did you experiment with switching images quickly to sort of do a very primitive animation? Something like that for molecule visualization?

Bitzer: You mean for the display? Not for the display, but you mean for the lesson?

Weber: Yeah, where you could sort of switch the images quickly enough to do almost like a quick look and see something?

Bitzer: Oh yes. Yes.

Weber: Let the molecule rotate?

Bitzer: Yes. Well, we put-- we made the experiments pretty darn real. Even the chemical experiments were real. Not real chemicals, but the chemical colors, the mixtures, the timing, you have to fill them. You have to explain what's going to happen. So that went very well. Stan Smith wrote a lot of chemical type-- chemistry type programs, including organic chemistry, which became very popular, because organic chemistry was a painful thing for most students. And they were always glad to get it on the computer,

where they could spend more time watching what happens. And yes, you could rotate molecules. You could run orbits. They had people who studied how to do orbits. Had simulators. We had a landing simulator control that you could hook to the terminal and practice your landing on the moon. That was pretty good. All kinds of things, that I wanted to do more than that with them, but I just didn't have time. And so whatever the people wanted to do, the users, since they could do their own programs, they did. And they're very interested in these strange games, which I never caught onto, but they played them all the time. Even had tournaments on weekends.

Weber: And it's right before PLATO IV that CERL [Computer-based Education. Research Laboratory, became its own institution? Or that's still in the PLATO three era, right?

Bitzer: We were our own institution back in the-- oh, before the late '60s. We were there..

Weber: So PLATO II. Okay.

Bitzer: Yes. And when PLATO III came along, it was early '70s, as I remember.

Weber: So that's PLATO IV.

Bitzer: That was IV, too. But III and IV were a bunch alike in the sense that we were looking at the new terminals. So it all depends. We named them differently depending on how many terminals could be connected, the quality, things of that type. But III was a fine system. PLATO II was still [using] those expensive tubes. We had gotten a lot-- we had maybe 20 terminals at the beginning for IV that were cathode ray tubes, and 20 storage tubes, maybe. But right then, we knew that we had to go get the plasma panels then. And we did.

Weber: And partly because of the cost, by storing the data in the screen, it became affordable to have a graphical display? Could you talk a little bit about why that was important at the time?

Bitzer: Well, it was important to have the storage in the tube for several reasons. One is we didn't want to retransmit anything that was [redundant] … if we wanted to change the picture, we only wanted to transfer the changes. If somebody touches their finger on a color, we then want it to change color, or if they wanted it to say a given word and they touch that word. So we tied all that together and said, "Only [send] changes to the terminal." And boy, that cut the bandwidth way down, too, doing that. So we were interested in low bandwidth, but high performance at the terminal end. And plasma panel made that possible.

Weber: And it's around this time that Socrates came in as a rival system?

Bitzer: Oh, the education school, Socrates. Yes.

Weber: Yeah, could you talk a bit about that?

Bitzer: He was the dean of the College of Education, and a friend. But he sort of felt that he had been bypassed because this was doing education, and that was the job of his department, the College of Education, or his college. But they had no really good ideas of what to do, because they didn't understand technology at all. They had their chance, and they were part of the group that said, "We can't do anything." So after we were successful, they first wanted to get part of our funding to transfer over to them so that they could do it, do their thing. And they started out by doing these various 35-millimeter frame movers on film, tapes, and the whole program was going to the right number of film when you pushed the button. And they had enough problems-- had trouble keeping it working anyway, but it wasn't very-- you couldn't do much with it educationally. And they had hired a couple of good people to help them, so when they realized that that wasn't going to work, the people who worked for them, they came over and they asked them if they could join our laboratory. And I took them in and they were good. And they didn't do much after that. It wasn't that they couldn't have, they just had no idea of how technology works, or how to do new technology. A lot of people don't, maybe even in the country.

Weber: Mostly. And it's around that time that Dan Albert was promoted to what? Heading a graduate school and..

Bitzer: He was dean of the graduate school.

Weber: ... Stopped being the direct manager, right?

Bitzer: For the laboratory, yes.

Weber: But then he transferred back. Tell a little bit about how that whole transition, how it affected the project.

Bitzer: Well, he became the graduate dean and went over to the graduate school. And Dan Albert, for his appointment, he then appointed a person who was in our administration, fairly far up, it was an accountant and a business-type person in the school who came over and he said he would take care of it. I didn't want to do that, because I was working on the plasma panel. The last thing I wanted to do is spend any more time on other things. So he said he would do it, but after about a year, he said that he couldn't do it. That there wasn't-- he didn't know enough how to do it. And he hated to hand it back to me, but he did. A little debt with it, but anyway, we took over. It didn't take long, and we got it back up again, running the way we wanted. And then Dan Albert decided that he didn't want to be the graduate dean after a while, so they moved him back to my laboratory, where he now headed up the people working on educational projects. And he was good at that. Dan was a very good administrator, and I don't think most of the people realized how good he was. He didn't put up with any nonsense. He wasn't guided by any fixed rules that he thought might not work. He didn't feel compelled to do things that the university administration told him to do. But it was fun to work for him, because when he was there-- and I've worked for him for a number of years before I took the laboratory over. And just-- I learned a lot. He hired some very good people while he was there, so he stayed on for doing some of the vacuum tube research and other things we did. And then the other wonderful projects. You can't imagine, and I can't tell you, the

projects that were done that really were important and paid off for the country. And we may be alive today because of some of them.

Weber: And he was offered a directorship of Xerox PARC at one point.

Bitzer: Yes. Yes.

Weber: Could you talk about that?

Bitzer: I don't know a whole lot about that. I know, I mean, he did that. The things I know more about were his record in Washington. He was on the president's science advisory board, and other boards, too. And that made convenient access to Washington when we went for NSF to get millions of dollars. He arranged for a demonstration to not only NSF, but the congress itself, and the advisors, live from Illinois. We gave them all a demonstration, in order to free up the budget, because we needed money that they had to-- new money that they had to go get. And we got it. We had to split a little bit with-- I forgot-- it was another program that said, "If you get the money, we got to have some of it." We got it and had some shipped to them. So that's when we got some significant money to really expand PLATO around the world. And it was worthwhile.

Weber: Do you remember talking to Dan Albert about whether he should go to PARC, or what that would mean for PLATO if he had done that?

Bitzer: I don’t remember the talk itself. But I can remember he would come in and talk to me about things like that. And I was glad that he decided to do things the way he did in the end, because I think it was better for him and for science. He was very good at that stuff, better than most. He knew-- he did high vacuums. And high vacuums, you had to worry about x-rays affecting your readings. And he knew all of that stuff. He was a first-rate scientist, which helped. He replaced a man who was head of the physics department, who headed the laboratory before him, Loomis, a physicist. Loomis was good, too, but he retired one year after I was in the laboratory and Dan Albert came in. But Dan was the associate dean, an associate head for a while with Wheeler being the head while he learned the place. But then he took off on his own, and he grew-- at the university, he had-- he was good. And as I said, I was very fortunate. Everybody I worked with was really terrific and smart. And that made it so much easier for me that I'd just sit there and laugh. Because I thought the ideas were crazy maybe, too, but I knew better than to laugh too loudly, because we always made them work. They were thought to be impossible, even today.

Weber: And so tell me a bit about TUTOR as well.

Bitzer: Paul Tenczar.

Weber: ... When-- yeah. And how that changed the way people used-- also wasn't that around the time that disk drives came in.

Bitzer: No, no. We had a different way of programming it, which allowed people to program. But they wanted to have a complete language to program in. And Paul Tutor-- not-- the TUTOR program itself was written..

Weber: Paul.

Bitzer: Yeah, Tenczar. To do that, it solved it. He was a biologist. Or he was putting material on it, and so he started doing all of the various ways of putting a language together which would make things go fast and easy. But the mathematical side of it, the things for judging equations or calculations and all, was done mostly by-- he was a physicist at the time, too. And he was very good at it. He did a great job. He was there for years, then he went to another university, left the-- that's the problem with good people. They sometimes leave. But he was good, and he did the programming part, he and another person, who did most all of the programming for mathematical stuff. That was all that. And it worked well. And so together, it represented a complete program. I used those programs for modeling how RNA works and produces protein before they knew how. And I put it on the computer. It was nice, because I could model it quickly. And I had graphics to go with it, I could show the things moving through and what they did. And so it was good enough to do anything like that. I wrote many programs on it. But you could do general programming and modeling. And I think it's turned into another language that they did when they used it at another university. It's now a very famous programming language <inaudible 02:39:50> their latest one. So these things all spread and people improve on them and they do a good job. I never use them. I keep promising myself I'll use the advanced version, but I'm so addicted to using these simple instructions, doing my own B-registers, doing everything so I know what's there, that I never found it really-- have to use those other fancy things to do it. I was better off watching what I was doing using just the general instructions, and I still do that today.

Weber: TUTOR really changed the way people could create courseware.

Bitzer: … courseware that was complicated, and where you wanted complicated graphics, complicated calculations, and you didn’t know much how to do that. You could just do it. And it was well-laid-out. There were TUTOR manuals that they would hand out that you could read. We had a whole group of TUTOR instructors and helpers in the laboratory. And you could come over for help if you wanted. It became the language-- it replaced the other language very quickly, and it was the only one we really ever used at the laboratory was TUTOR. And it was good.

Weber: And I read in Brian Dear's book that there was some interim tension over that, between I guess what Ted Ivina [ph?] and Paul Tenczar.

Bitzer: Tenczar? I think he was wrong. I don’t know who he talked to about that. I never saw any tension there. Paul was a different kind of person. He liked-- first of all, he started a company to sell TUTOR, which took time from him. But he also didn’t have a lot of tolerance for other people's ideas. He was somewhat upset when the math stuff was done by another person, but not a whole lot. Paul was a reasonable person. He was a good biologist. And he kept improving things. Finally, TUTOR was the only good thing that was done with the modifications made for the math stuff. And it worked just-- you could do

anything. You could do the graphics real easily, in color, and fast. And you could write a program. Some programs I could write in an hour that ran right away. And diagnostics were great, it was easy to see in your individual terminal. So it really paid off. And Paul was good. As I said, he was a biologist, very interested in biology and animals. I gave him all my flying squirrels from the attic, because he loved them, and he built a little cage with a tree in it for them. But he was just a natural, liked doing that, and got interested because he wanted a program that would help him in teaching biology. And he did that, but he did a lot of others, too.

Weber: And the TUTOR was for teachers, basically, to create courses, not for students to learn? I mean, obviously some must have, but I'm saying it was not a way-- it was not intended for students to use to create their own stuff. It was more an easy way for the instructor to create the courseware.

Bitzer: The successful stuff was mostly done by teachers and professors. However the games, which were all the games that you can imagine, were done by the children. Not children, but now college-age and sometimes even younger. And those were harder programs, because they all had to interact-- every terminal had to have interaction with each other. And oh, they jumped on that right away. They loved it. They spent a lot of time doing that. And they used a lot of computer time for their games. We wouldn't let them play games during the day while we were teaching large numbers, but on weekends they would bring bus-loads in and have contests with these games. And they were many of the games you hear about today.

So the games were another big thing, and there were a number of game-players, really good ones, who wrote those programs. They could write [a] program just fast, too, and speed it up. Because they used the same kind of instructions, except they had to add in the communication instructions that we had. I always felt it was a little dangerous. I felt when computer terminals start talking to each other, which we wanted us to do because one of the main features was that the teacher could ask a student to show their screen. They may be in Chicago. He was in Champaign. Show me what's on your screen, we'll work it together. But with permission, they could lock screens and do that right-- early on. Very important feature, which they can now do. So that-- but that I like, but I was a little worried about all these games eating up so much time. But I let them do it. I'm glad I did.

The games became very popular, and you read-- you're probably thinking of The [Friendly] Orange Glow, there—the book. There was a lot of that. And a lot of people, teachers wanted me to turn it off. And I said, "No, we'll control them, but we're not going to turn them off, because there's a lot of good, creative work going on, and that's part of learning." And they all became good programmers. Some went to CDC. They'd go to different places. They all knew what-- they were all very good at it. And they learned to do things that were new. They wrote programs that did information retrieval quickly. I remember those. I kept wanting to work on that, because I wanted to see how we could do the searches like they do now. And you needed another kind of memory to really do it fast. And they could make that memory sort of appear in their lessons and do it right. So they learned a lot. They were all-- as I said, they were bright kids. All of them today are out there either-- most of them are now retired, interesting enough. I will be the last one to retire, probably.

Weber: One of the questions I had for you was about search and retrieval. So there was somebody… there were people working on that?

Bitzer: Yes. Both.

Weber: On search and indexing? There was indexing in the search?

Bitzer: There was reverse indexing. What you did is you-- I don't exactly remember how to do it, but they had a method of storing where to get the content in a way that you could scan it quickly into memory. And they didn't put the indexing in a special kind of memory that you could read differently. And I'm trying to remember what that was, but they did a good job. And I tried to stay out of their way. The best thing I found with these young people is get out of their way. Make things available and get out of their way. They really go fast.

Weber: And so you could search across various courses for something like that?

Bitzer: Oh yes, yes. You could get online, find out who was there, who wrote it, how long it was, and call it in and use it, fast. Those were slow things. I think if you wanted to search like they searched today, search around the world in two tenths of a second for everybody-- everything that's mentioned, such and such a word, no. But they were able to do that by word-searching words and memory separately than by the whole content. And they do that-- I'm sure they do that today. That's the only fast way they can do it. So they did it, and the kids helped do it. The children. Small-- young adults, actually, did it all. And they did a good job. Now, some of them went and worked for CDC and helped design the new supercomputers. Very smart, the people, and they're now consultants out in California, near you. And they work very well. Their parents-- one of their parents worked for me as well. And she was very good. She worked as a teacher, programmer, did a lot of nice programming. So we had-- there was lots and lots of help around for anybody who wanted to know anything. And the students used to do that.

Weber: Okay, sorry. And with the search, there was some categorization? Were things classified at all? Categories, subcategories, or was it more keyword search, both?

Bitzer: The thing I remember most, there were things like that that people wrote that wanted it that way. But almost all of the available material and lessons was done that way. So you could [search] into a category, you could then sub-search it and so forth, and find out more about it and how big it is. If you want to write something about it, you can put things in and underneath it. So yeah, they had almost everything you can think of worked out. And yeah, it was very unusual. That made it nice for me. I come back with problems, and they'd come back with solutions on the software. They were very good. And the hardware group was just as good. We made everything from scratch. And nothing-- we were not limited by what was on the market that was available. And that was very nice. And it helped us a lot when we started to do communications, particularly.

Weber: And you did not add hyperlinks, which I don't know…

Bitzer: Hypertext?

Weber: I mean, they were pretty obscure, back then. Were you… did you consider that? Were you aware of them? I mean, Engelbart was demoing them and Neslon was writing them, but…

Bitzer: Yeah, we had hypertext. We had-- every time somebody'd do something like that somewhere, the kids would pick it up and say, "Hey, we need that." And the next thing you know, it's on. So yeah, I can't-- go ahead.

Weber: I think you had some sort of jump command to go from one lesson to another that you could use kind of as a link. Does that sound familiar?

Bitzer: Used that, too. Used that, too. We had a variety of commands which were usable by the user, but not available for modifying or getting to the central software. And they could use those, and we added plenty of those so that we could do it. And if it wasn't there, they could do it themselves. If they wanted someone else to do it, they'd come in and tell us and we'd get someone that'll do it.

Weber: And then, so the CDC, the Cyber computer came in the PLATO IV era, right?

Bitzer: Yes.

Weber: And that's when you got more and more kind of involved with CDC, over that period.

Bitzer: Actually, we got involved with CDC before the big Cyber series. We got the first 1604, because they came by and visited and said, "Well, let's make a deal. We'll give you a computer free-- except for maintenance charges, and we'll have to have someone down here-- if you will let us be involved in the process of getting into NovaNET and PLATO, as it was called. PLATO mostly, then. So we said yes. The university, they were anxious to-- they needed a Cyber. It wasn't really a Cyber. It was a 1604 at the beginning. But that was a good machine. Solved a lot of problems on that Cyber machine, including underground nuclear explosion collapse, was solved on the Cyber machine, and probably the one that they gave us.

Weber: The Cyber was a genuine supercomputer that could be used for scientific modeling and things like the <overlapping conversation>.

Bitzer: Oh, the CDC 6400 was a decent machine. It was bigger than the ILLIAC by-- a large size bigger. But yes, you're right. When then got into the 6000 series computers, that worked very well. And we got one of those right away from them. And it was a good thing for them, too, because one of our best people went and worked for them and helped them design the next 6000-series machine. And so it worked both ways. We sent help up, they sent help down. And once a week, we would transfer software changes, because they had systems and we had systems, and we wanted the software to be the same. And so we'd just transfer them once a week to each other, the changes, and then make sure they run-- stand by to put in the old one if they fail. And it was an interesting experiment, because we had, at that time,

several thousand terminals on. And so when we ran the software that they changed up there, it lasted about 30 minutes-- maybe 30 minutes. Ten minutes to thirty minutes before they had to change it because the errors that were found. When we did it, it would be weeks. Sometimes we'd never find one, because we had so many students using it that it'd catch it right away. And they didn't have that many students. When they got that many students, then it eased up more, and the changes that took place were more reliable each time. But we kept everything up-to-date with both of them in software.

Weber: Were you surprised by some of the… you talked about the gains, but the other uses of PLATO IV, like the communications, Talkomatic. I guess the termtalk was built in, but obviously Lotus Notes, I mean, all these sort of community-building… tell me, how did that strike you at the time?

Bitzer: Well, I thought all that was very important, and would promote it. Our biggest problem was keeping people out of the laboratory after hours or during the day. They'd crawl through windows, they'd do everything. They wanted to get there and do things. And most of them were very competent. So we let it go. I let it go. I don't think that the police were very happy about it, but I thought that getting these young people who were so anxious to do new things with computers was important for the computer industry. And it turned out to be, they all became very-- their lessons or the beginnings of their lessons are still used today, things that they did. It's amazing how much stuff is out there when you see it, that is used today, yeah, in principle. Using things that the young people developed for them.

Weber: Back when you started in 1960, you were trying to revolutionize education. Were you thinking at all of these sort of more community functions? Or was that a kind of emergent property?

Bitzer: At the time, I wasn't thinking about the commercial part, or the things that would come in later.

Weber: Communications part, not commercial.

Bitzer: Oh, the communications..

Weber: <overlapping conversation> communications.

Bitzer: That came up right away.

Weber: Was that part of it?

Bitzer: That was very important. And as I said, I got graduate students where we worked on it, the communications. All kinds, from satellite, where we built new coding and correction techniques. Still do have patents on them. And that's by… Mladen Vouk worked with me here at NC State and we got three or four, maybe five patents on how to do that kind of stuff. But we had things that we did back there as well. I started it back there, we finished it here. But we did all kinds of things you can imagine. We were interested in lowering the cost of communications, because we did not have any government money for communications. And users could hardly afford anything. So we bore that expense ourselves, and it worked out fine. I'm glad we did it.

Weber: Had you seen online communities or communication as being something that might happen back in the earlier days? Because I'm just saying, you started it off to create an educational system. It ended up turning, also, into an online community. Was that a surprise? Something you had hoped for?

Bitzer: Oh, right from the beginning, it was clear by the time we had three or four users, that communications were important to them. That they wanted to talk to each other or leave messages. So they helped push very quickly to get us into the communication business. Some days, I feel sorry that we did that, because the unintended consequences of all that are starting to come up now. But we did that very early, and were very aware of the problems. I used to get calls all the time, as I said, for all kinds of things, including from people who didn't like the material that somebody was putting on and what could I do about it and so forth. It was a big job to monitor communication.

Once it got into communications with other people talking to each other, it became a bigger job of monitoring what was going on without interfering with the rights of people. And the real question was, when does, how do you decide someone has a right to put something on that disturbs someone else? And I remember sitting there thinking about that, and I said, "You know, the first thing I check on and see if the person that's using that space for putting on things is paying for it separately." If they were, then I was easier on it and tried to get them off of it. If they weren't paying for it, they were gone, because you can't just let it run wild that way. We know what happens now when it runs wild. But first, it was very nice. It was very effective. We saved a lot of lives by getting the communication out there and in. We got a lot of things done that couldn't be done before then, and so communications were very important. And then I wasn't the only one that saw that. The young people who were there earlier saw that. You couldn't turn them off of getting any of that on. They wrote these things on their own, many of them. The most interesting ones, and there were some that came out that were very close to-- but ours was in a lab-- and the person who wrote those. And one went to IBM for industrial communications and other communications.

People, it was just… there was no stopping it. As long as it stayed within the limits, as long as no one got into the main system by doing something that we didn't foresee, I let it go. Now, I had CBS come in, Midwest, they wanted to do a taped show. They just raided the computers… government computers in New York and found all kinds of information. And CBS wanted to do a show on how material-- how you can get in and steal material. And so they called me up and said, "We'd like to come out and film all that." And so I said, "No problem." And they came out and they said, "By the way, we got something to tell you. We've got a person who's going to be on with you who says he's broken in." And so I said, "That's all right." And so he came in. I knew him. His mother lived in Chicago and was the person who actually ran our system in Chicago and had passwords. And I guess, evidently, might have shared some with him. But it didn't matter, because our computer tracked everything and had already printed out to me his whole action that year and what he had done. And so the first question was to me. They said, "Tell us about this and how you do this." I said, "You see this man sitting next to me? Here's a record of where he tried to break it." And he turned over and says, "If I had known you were doing that, I wouldn't have done it." <laughs> So, and that worked out very well and so everybody knew that if you tried to break in, in some way, because you had the keys to the kingdom, you weren't going to last long. And, so we never got broken into after the very first time. There was a sign off on PLATO, which was a shift stop, and the

reason we had that was that was put in by the high school kids in Springfield, Illinois because they had broken in, I hired them all, and they said, “We’ll tell you how to stop that now,” and they did and for twenty years, they sat there working with me, stopping them, and they were all-- as I said, these people all contributed.

Weber: You formed an actual security committee at some point?

Bitzer: Oh, sure. I had a committee that was more than just security. You could call it all security, but you’ll get people who, well, who had actually gone off their rockers, and they would,write, message us. Now, I didn’t usually pick them up because I didn’t have time to read a lot of that stuff, but other people would and they’d be online. We had a group, a person whose friends called in because they were reading his notes online, and they said, “He’s having problemsbecause he said, “PLATO is God and I want to be a disciple.”

. So, and I can tell you the end of the story is I got all kinds of calls from people Sometimes it was really good. We had a very talented programmer who was a quadriplegic, and he was good. He heard me give a talk on The Donahue Show and he came and he wrote me and he said, “If you really believe all that stuff you said about computers helping the handicapped, you’ll hire me.” So, he drove out. I interviewed him. He was absolutely fantastic. I said, “Well, if I hire you, you’ve got to be on union. You’ve got to get contracts like everybody else, or if we get them, you’ve got to have your own work.” He said, “Oh,” he said, “I plan on doing that.” He came out, he did all that. One of your-- I’m trying to think of the person right now who is a member of your museum.

Weber: Ray Ozzie?

Bitzer: Ray Ozzie.

Weber: His encounter, it was very important for Ray. Go on.

Bitzer: Oh yes, I was going to say, well Ray, he and Ray were communicating and Ray didn’t understand why this guy was so slow until one day he met him and he was typing with a pencil in his mouth on the screen and he said, “I made a big mistake,” and he was doing proposals and everything that way. He did a great job and he was not sympathetic to himself. He came down and he said to me one day, he rolled in my office. I wrote a letter for him. He said, “Will you write me a letter for my proposal to cover my proposal?” I said, “Sure.” I wrote the letter. I said, “This will work out really well because he knows the problem. He’s been suffering from this problem for years so he’s good at writing programs and doing things to correct them.”

All of the sudden, this wheelchair comes rolling around the corner by four of my secretary, into my door. He put that letter on my desk and he said, “I do not suffer.” I said, “Nope, you sure don’t.” I grabbed the letter back, scratched that out, and rewrote it for him and put it back in. He went down and got the contract, but very independent person. He went out, he learned to drive. You can imagine what that was like. But, he worked out really well and he was probably the most handicapped person I had and

everybody in the laboratory would help him. They helped fix up the automobile that he had to drive with all this stuff. One time, he got soap in his eyes and he had to call in and they rushed over and took care of him, took him to the eye doctor right away. So, everybody was in there-- everybody was very good for everybody else. It was a team that really worked and that allowed me to do so many other things that if I had to sit there and manage one hundred and twenty-eight people, I would have still-- I would have been locked in there forever. But, with the people that I had, I didn't have to do that and it was just, it was a marvelous experience and I'm glad that most of the stuff that was written in The Friendly Orange Glow is accurate, most of it. There's a few that I think are just off a little, but they're not off that much, not worth correcting. That book took a long time.

Weber: Yeah, about thirty years or something.

Bitzer: Seemed like it. I don't think so. I think it was more like ten or twelve, but he [Brian Dear] wanted to interview everybody and he was not from Illinois. I think he was from out on the East coast as I remember, but he was good. The book he wrote, he spent a lot of time on it and that book has been read by a lot of people who didn't know anything about this stuff. The last time I inquired about it was the gentleman who started Pixar came out to see me and we talked about some things and then he wrote me a letter asking if I could identify the person who had done the proper kind of shading algorithm, because he wanted to talk to him about it. They had a lot of influence at other places and other things that were done that will never be reported as work that was done by them at the laboratory, but they had plenty that they did at the lab.

Weber: You talked a little bit about the limits of what you would put on the system. Tell me about the political organizing stuff around the Nixon White House, forum, and discuss-- I've also interviewed Jacques Vallée who did some of those, Institute for the Future.

Bitzer: Well, there was a problem. Excuse me, we bought that. We had all kinds of people programming the system for class, including young political science people. The big one was during the Nixon problem and I was out giving talks yet and I got a call as I left my room with equipment. I was giving a graduation talk at one of the Pennsylvania institutions and as I walked out the door and the phone rang, I answered it and it was NSF and they said that, "We're upset because somebody put on the PLATO system a note to leave what they used to call the other terminals, the other network, the network for the government. Run to your PLATO terminals where we're going to hold a meeting on-- a discussion on Nixon."

Weber: Impeachment, right?

Bitzer: Well, I don't know if they used the word impeachment on the discussion of Nixon and that was one that-- the one I was reading about was the one that was going to be a political class discussing the issue. So, I had my terminal with me. I said, "Look, I'm turning on my terminal in a few minutes, I'll look at it. If there's going to be a political meeting, I'll cut it off. If it's a legitimate political science discussion on the issues, then it's part of the class. You don't want to interfere with that." They said, "You better-- the President said he's going to cut us off and we'll have to cut you off if we do that." I said, "Well, that's the way it is." I hung up. I started out the door. The phone rings again. It was ARPA, our other sponsor. Same

message, they had gotten the call from the White House. Well, I told them the same thing, but their response was different. They said, “You’re doing the right thing,” they said, “and don’t you worry, we’re going to take care of the rest here.”

So, it was a whole different response from those two branches of the Executive there, one from ARPA and one from NSF, and I always thought that ARPA is less political as a result. And, by the way, I did look and they did go on and it was not political. It was a political science type session and it worked out well. I don’t know if I could have stopped them very well from where I-- I guess I could have, but I didn’t see anything wrong with teaching political science with the system either if it was proper and not nonsense. Now, we’re used to all nonsense anyway, so it wouldn’t make any difference now. No one would bother to call you.

Weber: And, speaking of ARPA, I mean, obviously at ARPA, they have very different users purpose, but you were friends with Frank Kuo, you were funded partly by ARPA. Did you think about trying to do more connections with them or with their community, or maybe there’s more than I know about?

Bitzer: Well, the interesting thing about ARPA was my first contract from ARPA came while I was in India and the university signed it for me without telling me and told me when I got back, and I was a little upset, mostly because it was not from the technical branches of ARPA. It was from the behavioral science branch of ARPA and they wanted me to list for them the ten most important aspects or things to look at for computer based instruction, which was zero of my interest at that time. I was trying to get the systems up. So, they said-- so I started-- I said, “Okay, you’ve done it, I’m not going to turn you in, get the money, but I’ll tell you what the number one priority is. The number one priority is a good display for education and that’s where I’m going to spend the money.” And, the university said, “Okay,” but when they heard about it over at ARPA behavioral science, they were upset because they said that that was not what they had in mind. I’m spending their money. It was kind of threatening, except I wasn’t worried, and immediately, they passed that Mansfield Amendment and the Mansfield Amendment was one that said you have to show how you work things into the society that you’re supporting.

They had nothing in the behavioral science branch at all. So, the regular branch took it away from them immediately and we put it in and I switched branches for that kind of support, and then they gave a lot more support to it. But, ARPA, the technical side was really good at doing things. They were better than, in many ways, better than NSF. NSF sponsored a lot of the coursework type stuff and classroom stuff, but ARPA gave a lot of technical support to a lot of different projects. It’s still my favorite place to get support, and I don’t think things have changed much, I hate to say. I can remember when we started to do the messenger RNA work where we discovered things that were wrong and how to do it right and we applied first, I think it was, to NSF because they had issued a request for a proposal that was high risk but high payoff and Mladin Vouk a person who works with me at NC State, we both decided to write a proposal. This we thought would fit well. It came back denied because it was too risky.

So, what we did was the state of North Carolina is very generous to me. I’m sponsored by the legislators and so I had money for anything I really wanted and so we just took some of that money and did it, and I’m glad we did because we came to new ways of doing this that made it possible to do things quickly and

efficiently and inexpensively, and that's thanks to the fact that we had gotten-- we had to do that one ourselves. So, getting support is a thing all in its own. Most support is going to help continue to support for people that they've been supporting for several years. That's the easiest way out, most. They have some new projects but not many, and that's always bothered me because I like to see more things going into new things that have risk and a high payoff for the country and all, and those are not necessarily sponsoring that comes out with the government. So, I hope someday though they'll figure out how to do both without one harming the other.

Weber: And, a lot of your work was so amazing. Talk a bit about any memorable demos or meetings or turning points in that.

Bitzer: Oh, I probably gave demonstrations to five thousand people a month. Sometimes, there were two thousand in a group. Sometimes, there was one. The Governor might come in, and he did, and we got more money as a result. But, I had all kind of visitors. I was supposed to register and send to the government all the people, all foreign people that visited me, and I didn't want to keep track of all that. So, I had my secretary make everybody who came to the laboratory, which were thousands, register and I'd give them the book and they can sort out what they wanted. That worked out better as far as I was concerned. So, I spent a lot of time doing projects like that and with lots of people. I think we probably had twenty thousand visitors a year. We were on the bus tour from Japan, tour bus. I was late getting in one time because I was playing handball and I didn't know about it. They forgot to tell me, I guess. The bus driver and the tour planner was really angry with me for being fifteen minutes late for their tour and I didn't even know about them. The bus was sitting outside, so I gave them a talk a little late, but we got it done.

We had thousands and thousands of visitors who came in and it was a fun time but it was a hard time because it's not easy to give talks two or three times a day, particularly if they're not in town. We used to have a private airplane, a twin engine Aztec that the university had and they would fly us and we could land the plane. They'd meet us at the airport. You could drive up to the plane with their car. They would then unload the stuff into-- from the plane into their car and then talk to me. That was the greatest fun of all because I never wore my good clothes, speaking clothes, when I was on the plane. I tried to change when I got there afterwards, after I set things up, and so when we get out, if they didn't have a picture of me, my pilot and copilot were dressed to the tees and boy, they'd get out and they could shake their hands and start talking to them. They'd even turn around and say to me, "Can you bring the rest of the equipment to the car?" and we'd get in the car and we'd be driving and they'd say-- ask a question and they'd say, "Dr. Bitzer, what do you think about this?" and I'd answer and they'd say, "No, no, we asked Dr. Bitzer." That's the first time they realized that I was there and the other people were the technicians that were there, but they were good. We had a lot of fun. We'd fly up and down maybe three stops a day at different places, different universities, including here and Clemson, other places, Florida, Florida State. It was a lot of work, but we went out and gave a lot of demonstrations. Every business operation at a decent size company in this country wanted to have a talk on the new stuff coming and so I visited about every one and did that, gave talks to their employees and all that worked in the administrative offices with computers, and so I got to see a lot of the world and a lot of the people, but it was a job. I was tired by the time the day was over.

Weber: So, when you gave a typical demo talk, what would you take them through? What would you show them?

Bitzer: The whole thing. I had the whole terminal with all the apparatus on it for speaking and projecting slides and had a phone line. Sometimes I got connected to a dial up operator, but typically I had them install a phone line earlier, a direct phone line, absolutely. I'd give them a complete hour talk on it and I did that to all of them. You name a place across the country. I used to fly out to California in the morning. They would meet me. They usually had the equipment there first. They'd arrange for the meetings to be at the hotel. They would pick me up. They'd take me over to the equipment, where they were having lunch. I would wait until lunch was over for them and I'd give a talk. They'd then decide if I was done answering questions, they'd put me back in the car. They'd take care of the equipment. They'd drive me back across the airport to the other side back to the airplane that left at three o'clock for Chicago and if I was lucky, I'd get that plane and then I'd get another plane in Chicago that led-- took me back home down to Champaign before night. So, I moved around a lot in those days, giving talks, and it was a real experience but everything always worked. I can't ever remember a failure that came up and if it would have come up, I had a tape recorder with a program on it that would drive the terminal remotely from the tape recorder. I thought for a minute I was going to have to use that in Italy out of Pugnochiuso because the phone lines on the coast, that coast at that time, were not real good. You had to book them hours in advance and book them all the way through, but we made it through one time just about one second to go. I had a switch and they said, "Hey, we think we're online." I'd throw the switch and pop up on there, "Welcome to PLATO," and I'd give the show. They thought it was so unusual that their lines worked so well that they arranged to have their ministers come out the next day for a show. The next day, I thought I was saved because it rained hard, the mountainside slid down, you couldn't get by, you couldn't pass. I put on my swimming suit with my wife. We went out and we said, "The day is off, we can swim, nobody's coming." All the sudden, we look up and there's helicopters coming in with the ministers. Phone lines still worked on the ground. We got through. So, they still think that they work perfectly.

Weber: And would you take them through the same lessons? Would you just show them games?

Bitzer: Showed them everything.

Weber: What would you show them?

Bitzer: I'd show them, first of all, at every talk, I started the talk by trying to show the fundamentals of the terminal. So, I'd start off with the graphics and I would say, "Look at this, you can change one part without changing the other," and then I would say, "We can add pictures from behind," and I'd add a picture and then I'd say, "You can hear voice and music," and I'd play something and then I'd say, "We can record too." I'd go through each of the things first and show them to them. I found that that got their attention because they hadn't seen any of those things in a terminal at that time, and so after I finished that, I would go show them some lesson material that they might be interested in, different kinds of things that were there that you talked about, different kinds of lessons, different kinds of games, whatever they would like to see. I let them choose if they had to and then after it was over, I would normally pack up and make the next site. I did a lot of that.

Weber: Did you let them play with the terminal?

Bitzer: I did that one time. I made a deal with the French telecommunications [company]. The French wanted to keep the terminal for a month and go around and show their people everything and they said, "If you agree to that, we'll get the terminal back to you and we'll give you every phone line you want free back to the USA because we've got lots of them," they said. So, they did and I got-- all the rest of them worked well from Switzerland and France and Germany and everyplace and when I left it, they did just what they said. They took it around and showed it places and then they returned it, so it worked out well. Everybody was interested in helping spread the news and following things.

Weber: So, speaking of France telecom, did you see Minitel and did you have any thoughts on that?

Bitzer: No, not to my knowledge. The only time I got involved in telecommunications in France is we had a meeting called Institute de la vie, which is more de la vie than institute, but that and then there was a national meeting on the communication problems in prices and I was on the board to help. I guess I made enemies. They were after AT&T to lower their prices down to the same prices that they were going-- not AT&T but others were going to have with the cell phones and the trouble was that they'd just convinced AT&T to put in millions and millions of dollars in upgrading and didn't want them to charge-- the plan charge for it. So, I objected to it and I think that it happened the way I thought it should happen, but I had to make somebody unhappy in the room, and so I did. But, the only time I've been there and done that. I've been a lot of places in France and gave them a lot of talks, different places.

Weber: It's right around the time of, I guess before PLATO IV. You formed a, what was it, education information systems, a company to sell…?

Bitzer: No, I think that was… that might have been right after IV. It was right in that period of time that occurred… not that I was interested in doing that but the patent people, the lawyers in New York wanted to do that and they were former IBM people and they thought that it ought to be done. I wanted to stay out of all that stuff the best I could, but they wanted to do it. They formed the company. It was called the Educational Testing Service I think, ETS. That wasn't the Educational Testing Service. That was another one. This was--

Weber: EIS?

Bitzer: That's right, Education Information Systems, right. So, they did it because they wanted to and we ran it. It ran fine. They then sold it to a company up in Iowa as I remember who ran it for about fifty years afterwards, systems, and that was a big thing. Because they didn't want a conflict either, they gave us at NC State all the free terminals we wanted, not terminals but free access to the terminals. They didn't want a conflict either, so that was good and so we taught a lot of courses with PLATO at NC State, and still do. Some of those are online. We discovered what we call fault tolerant teaching. It was also part of the program.

Fault tolerant teaching was able to put all the terminals people were on, if they're on the same program, and by processing the data of all of them, we could make up a form with a response that when a person puts an answer in right or wrong, we could tell what the concept was. It would move them over to the right concept. So, we could put programs, lessons and next questions even, based on what they didn't know but not waste time on what they knew and we could just go on and they'd work their way through it. We call that fault tolerant teaching. That paper just got an award because they used it at ETS for trying to evaluate things, but they had it wrong. The first time, they had errors in how to do it. I had a graduate student I started with. I said, "Hey, wouldn't you-- how are you and would you be interested in looking at this?" They said, "Sure." So, we got the data from them. We ran it. It didn't matter which way you ran the data versus the problems, you got the same answer. It was obviously wrong, so we told them, and then we went back and fixed the program so it really did right and it's still going today. In fact, the paper I think was awarded the surprise was just this year and it was done by…(Tiffany Barnes)

Weber: So, that's a more recent one.

Bitzer: That was one of my graduate students who finished it off. She's now a distinguished professor. She was my student, undergraduate and graduate, but she was smart. I'm very fortunate, I keep saying, I ran into the smartest people in my life. I was very lucky.

Weber: Tell me about some of the… I know that in the seventies and beyond, PLATO was used in a number of different settings, but in prisons seems notable, the CIA and NSA, as well as the music program later on. Just paint a picture of some of the various places it was used in-house.

Bitzer: I think it was, it was either NSA or the CIA is the only terminal we ever lost on their boarding dock they said, <laughs> after we left it for them, gave it to them. They needed to do some things and they wanted to use the terminal to prove it out, so they did. I went out there to talk with them about things and pick it up and low and behold they said, "Oh, that got stolen off our dock," the only terminal that we've ever shipped out that got sto alen off the dock, but that was expected I guess. It was interesting, it was fun. Everybody was interested in doing something at the time with it. As I said, it was the only secure terminal they could get because all terminals that use CRTs transmitted the pattern through the air and they knew that. They were using it too for picking up things. They were very anxious to test it.

Weber: You think they were-- I mean, they may have used it for teaching but also they were using it for security?

Bitzer: I talked to them about a lot of things and they'd come out and talk about. That was one topic we never talked about. One time, we were having lunch up in their elegant third floor, the directors and myself and a few others. They kept telling me how much they knew about me. They knew everything. They could get anything, anything I needed. They could do anything and I said, "You don't know as much about me as you think," and they said, "What do you mean?" I said, "I'll demonstrate to you." We were sitting at a table that was, like, eight feet long and four feet wide. They put me at the corner as if this were the corner and the side back here. I'm left-handed. I said, "If you had known what you were doing, you would put me on the other corner because my hand is going to interrupt with the person to my left

because I'm left-handed," and they were sharp as a tack. One of the heads turned around and he said, <laughs> "We knew that," he said, "we just didn't want you to know we knew it." I thought that was pretty quick. <laughs> He was good. I knew him pretty well because he was following all my talks. Every time I gave a talk somewhere, and I gave a lot of them, he'd be in the audience. So, they were watching carefully and they watched me carefully. I don't know why. I had nothing to say that-- well, I guess maybe I might have, but I told them one time and they kept questioning me about how someone can make me talk. I told them there's no way I would talk except if they started pulling my fingernails off, I'd squeal like a pig and that ended the conversation, and they approved that particular trip that I had to take, which I didn't really want to go on. I'd rather have stayed home, but I had to go. But, they were really--

Weber: To go where?

Bitzer: Oh, that was to San Diego, the naval base there. But, we have lots of bases, we have lots of schools, lots of good people. They do good research work. For a long time, I had one of the jobs. I was on a committee from the National Academy, which placed postdocs and graduate students in our government laboratories and we'd place about seven hundred a year and my first job was I read-- the first year, I read twenty-five or thirty of them for them and gave them the results. Then, they said, "Hey, you know what, everybody gets three readings but if there's a tie, what we like to do is have you read those," and make my vote break the tie. So, I did that. Now, there were only about twenty a year to read ever for me. Well, the rest of them are reading lots of them because there weren't that many ties in the program, but they did a good job. We had a lot of graduate students who graduated with good programs at laboratories run by the government and it gave me a lot of confidence in our government laboratories that you normally wouldn't think of.

Weber: If you could tell me a bit how you modified the PLATO terminals for the use for the prison system..?

Bitzer: Oh, for the prison system, we didn't do really any modification for them, didn't have to. They had their own… we named their own site. They actually had their people-- they had some people there who could maintain it if we had to. When they got out, they wanted to use it as a job, maintaining terminals, our terminals. But, they were very-- it all worked out very well with them. We didn't have to do anything special. That program was run by, I'm trying to think of the person who wrote the software, but it was done well. It was taught all kinds of fundamentals. They loved it, the prisoners there, and every once in a while, they'd ask me to come down and visit. That was always different and exciting because <laughs> they had-- it turns out that they had a sense of humor. I was visiting what used to be death row but it had been shut down and the electric chair was still there with all the stuff and meters and switches behind it, but of course it wasn't being used. So, these guys decided, I probably didn't know that, they said, "Hey, why don't you try it out, sit in one for a while." So, I sat down and they put the stuff on and then they acted like they were throwing the switch to see if I'd jump, but I knew better. I knew that wasn't going to happen, but they were fun. Go ahead.

Weber: I'm sorry. It just made me think of when you said that your early test where you told the people they're going to flip the high voltage on now and their heartrate…

Bitzer: Oh yes, one heartbeat. That's what was amazing, their heartbeat doubled.

Weber: I mean, if they had been measuring you...

Bitzer: I don't think any of those people were the ones that were in prison or the switch might have been connected up, but no. <laughs> I don't think the people that we tested by doing that--

Weber: Oh no, no, I'm just saying your heart rate probably doubled when you were in the electric chair.

Bitzer: Oh, it about doubled just before but I looked very carefully at that, making sure that certain wires didn't go all the way past behind the walls and so forth. But, it was a lot of fun and the person who wrote the materials wanted me to go see what was going on. At one time, it did help me, having that project because I was on a federal jury and the federal judges are not very nice. They think they own you, and they probably do, and they were really irritated at me. I don't know how I got selected but anyway, I was on for six months and they would-- every Monday, we would meet with the whole group and then they'd select who was going to be on the various juries that week. After they looked at my crew cut and found out I was a professor, they decided-- and these were all drug cases in the federal court system. They decided that they didn't want me. Now, they were down getting pretty slim because the first question the judge would ask when we were there was, "Do any of you think that drugs are good for you?" and half of the group would stand up and they were asked they had to leave. I thought, "Why don't I just stand up so I can go too and come back next week?" I couldn't make myself do it, but I always got deselected. I got selected by the prosecution and thrown off by the defense in every one of them, so I'd just go back home, but he [the judge] was getting pretty upset with me because somedays, I didn't even have to come in because he was so tough on people. One poor guy was going to trial himself the next day. He wouldn't let him go and he says, "With me here, you're a juror, you don't go to trial, you can figure out what to do later." Oh yeah, he was tough. Well, I was doing work for the government, which I did have-- the only group that had control over the judge and they would call him and write a letter and say, "This man is not to be there," and I'd be out. That did not make the judge very happy and so it went on that way for a long time. His, not secretary but what do they call him, the person who made the arrangement.

Weber: Clerk.

Bitzer: Yeah, she was good. She knew I went on vacation at Christmastime. She'd let me sign up first so I got my vacation when I wanted. Everything ran fine until they finally decided that they were going to get me on a jury. The way they were going to get me on was this was a case where the prisoner said that, it was a she, [they] had been approached or maybe attacked by one of the guards and I got selected to go on that thing. I didn't want to go and then they phrased the question of, "Does anybody know anybody involved in this case?" and guess what, the head of that prison had just signed a contract with me for putting in PLATO and I said, "I sold him that." He told me, what was it, he said, "Get out of here and don't ever come back," and I said, "Thank you," and I got up and left. But, no, it was an interesting experience but the federal judges are tough and they own you. But, that was the closest I've come and I didn't ever go back and I hope I don't have to ever go back. I don't think you can take me anymore. I think I'm too old to be on jury duty.

Weber: You traveled with your family all over the world. Didn't you go to the Soviet Union several times?

Bitzer: Sure did. I went twice. My wife went with me once. When we stayed in Moscow, she went with me. She loved it. She didn't get in any trouble. Sometimes we'd get in trouble when we went somewhere because she was one of these explorers. When we were in Germany, after the tour, she went back by herself on the train to see more and the train didn't stop at her stop. It went to the east and she had to get off and get in the next train back and get their permission. But, we made it and I was at a NATO meeting. They said, "Oh, they won't keep her but just overnight and send her back," but she got back one minute before five o'clock.

But, she liked to do that kind of stuff so I always worried a little bit about that, but she liked to explore. We went over to the Soviet Union. They were very good to her. They were very good to me. We had, as our audience, their astronauts, their ministers, all kinds of people and I wanted to run. I loved to run fifteen to thirty miles a day and it was cold out. I looked out the window, it was twenty below zero and I saw a Russian runner go by and I told Maryann, I said, "If he can run in the cold, we can run in the cold, I can run out there." So, I went out. I was dressed pretty warmly. I was used to that from Illinois. I went up and ran down to Moscow River and the wind was to my back and it didn't bother me at all, and about the ten mile mark, I turned around and started running back and the wind was into my face. I thought my whole body was going to freeze solid. When I got back, my wife said, "I was worried about that so I filled the tub up with hot water for you," she said, "but I got it all filled." What she had done, she was afraid it wouldn't be there when I got in, so she drew the hot water first and couldn't tell me fast enough. I ran and jumped in it. So, I went from freezing to boiling and jumped out of that. <laughs> But, she went with me and they were very good to us. The ministers were all very good too. They were cagey. I said, "Will I get in trouble if I run here?" and they said, "No, you can run here, don't make any problems, just don't make any trouble." I said, "Well, how will I know if I'm making trouble?" They said, "You'll know if you make it." <laughs>

Weber: But, did they end up installing PLATO there as well?

Bitzer: That's one of the things they wanted to do. CDC was there. They had just sold them a computer, a big one, and so they had to dump that every day to make sure that they were not using it for weapon developments and all. But yeah, they were very interested in getting the PLATO because they had never seen that before. So, what they did is we had an agreement. I went back without them, without Maryann, for the government and I got-- and I went to Novosibirsk in Siberia, as well as all the other places. I went to Ukraine and other places and it was a nice trip, a good trip. When we got done with-- there were three others with me from the State Department. When we got done, we went out to dinner at three o'clock and I'm not a drinker, but everybody else in the room was, and they all-- we all had our own waiter behind us with a bottle of vodka. So, I turned to him, I said, "Do you have anything that looks like vodka but is water?" "Oh yeah, we've got mineral water." "Put one of those behind me." So, that's what he did. I was the only sober person besides the waiters in the room when the meeting was over and I was-- I took--

Weber: They were toast

Bitzer: I took the passports from the other Americans, called for the car, got ourselves down there and in, helped them into the hotel, which was a special hotel for government visitors, and they had a person in there to help me get them in the tub. We were supposed to write a report that night and turn in the next morning at ten o'clock. Now, they weren't going to write anything either. They were out cold and the waiters asked if I would help them with their people and I said, "I can't, I've got my own here I've got to take care of." So, they had to get their waiters out, and so they investigated to find out how come I was the only one sober and they found out that I didn't drink.

And, so they came back with a return visit with their ministers, the highest ranking government officials from the Soviet Union to our house for a party and a meeting for a week, and my wife loved it because that's just the kind of person she was. She couldn't wait to get them in and meet all of them. They couldn't wait to meet her because they said that, "A good husband has to learn to drink and we're going to teach you tonight," and they had brought this special black wine of some kind from an area down in the south with them and said, "We're going to serve this and host your wife for helping us and give a cheers for her and we expect you to drink with it." I said, "I'm going to drink water." "No, you're not, you've got to drink this, we're going to watch you." I said, "Watch me? It's okay." <laughs> So, they pass out this expensive wine. We had about fifty people there by now. Everybody wanted to come, all the university people. So, there we are and I said to her, I said, "Maryann," she liked wine so she drank it and I kept my glass of water, I said, "Watch." They never asked me again about that. They were all friendly people though. They were ministers, high up. We had used their cars for getting around when we were over there. I was particularly grateful when we got to Novosibirsk and Akademgorodok, which is the outskirts where they have twenty-eight institutes, which I was cleared to go through and look at anything. Then they returned the same visit, they looked through all my stuff and they were there and it all worked out fine. We had agreements signed. The government was happy and as far as I could tell for years, it all worked. It worked out fine and it was worth going, but she didn't go with me on that one. That was probably a good thing because I can remember riding the airplane out to Siberia and I used to worry about luggage that people would put over my head when there's a plane here. This lady going to Siberia gets on board and has a big hatchet, no an axe, a big axe. She sticks that above my head. I said, "What the heck?" but it stayed there, thank goodness. It didn't come off, but it was--

Weber: Sort of a family place.

Bitzer: Oh, yes. They knew I was coming and I was supposed to be able to do anything. Sometimes they forgot to tell the guards and many times, the machine gun was down and they had to run in between and stop them. But, it was worthwhile and when they came, I made sure they got the appropriate attention too. So, that was all part of the Soviet trips. Actually yeah, they were still the Soviet Union at that time.

Weber: Sure, and this would have been what, seventies and early eighties?

Bitzer: Yes, because when I was there that time, I don't know what they call them. They spoke very good English. They were supposed to be people who helped guide you around and all, but they were really agents.

Weber: Did you meet any of the, I'm thinking, like, Glushkov was still around … any Soviet computer scientists?

Bitzer: I can't tell you for sure because we stayed in the room and they came over to us, all of them. It was cold outside.

Weber: So, you were telling me, I wanted to kind of talk more about it, the CDC relationship, unless there's any-- I don't want to cut you off if there's any particular...

Bitzer: No, it's all right.

Weber: Ted Nelson wrote about visiting CERL and was very impressed. Do you remember his visit?

Bitzer: Who was it?

Weber: Ted Nelson, the Hypertext pioneer.

Bitzer: Okay. I don't specifically remember that, but I can tell you that--

Weber: No worries. No, he wrote very nice things about it. Your vision, as you got closer with CDC and appliance development, weren't you talking about vastly expanding the PLATO terminals and multiple other...

Bitzer: Correct.

Weber: ...hundreds of mainframes or supercomputers. What was your vision or their vision for how this would be used? This went far beyond education, correct?

Bitzer: Yes, well at least education in a loose sense. They were interested in training, education, and other things as well. But they had a fixation on using their own equipment. They saw this as an opportunity to get new terminals that they were building out and that was probably a mistake on their part. They should have first started with terminals that people liked and wanted instead of trying to worry about getting the new ones, but that was their choice. That was Bill Norris's choice and he wanted to do that, and they did. They put a lot of terminal systems and as I said, the military, airports, airplane manufacturers, all kinds of places, and they were interested in the general broad use of communications like this, probably very much like we have today with the networks that we have.

I don't think Bill Norris nor I saw all the unintended consequences that happened when things got to be so useful in the homes where everybody had anything they wanted and could. It just, I don't think it-- I think he was mostly interested [in] education. He was very impressed when he visited a school where we had the terminals and they were using this. He'd talk to the kids and the kids would, "Oh yeah, this is great, it doesn't know who I am or where I'm from, I can really like this." He really liked doing the educational part as well. But, it's a business and he was a businessman.

Weber: Wasn't there, I'm thinking in The Friendly Orange Glow, he talks about Bob Morris, who had a different vision and worked for Norris and that there was a vision of a more PC type terminal and the business uses beyond education, is that right?

Bitzer: Well, you're right. Bob Morris was, he was very good. He was a friend. He was very smart. He came out a lot of times to help, but he had the idea that maybe we could fund communications if we had standalone terminals and we called them the micro tuner, which would essentially run the same kind of programs if you had the disc and put it on, on a local terminal, which they built and supported, and it was put together first by a man by the name of Jack Stifle who was one of my engineers and he was good. So, we had that. That was called microTUTOR .

Weber: And, that was almost a PC, or was a PC.

Bitzer: Yes. It was something I remember. The Japanese went for that, TDK. TDK was the most profitable company in Japan and they bought systems and put them out to a lot of places, but they were almost all these classroom terminals with individual operations at the terminals, and it didn't surprise me. I mean, they were in the tape and disc business and it was probably easy for them to produce as many of those as they needed for the terminals, but they were good. They also did the big ones sometimes but not so much. We did a lot of that and you're right, Paul Tenczar had a lot to do with that and a few others, doing the micro-computer stuff. The university actually thought that the micro-computer would be much better than a central source. If they're not tied together, you don't have a whole lot, it turns out, but it was easier for them to think about that starting up, not tying them together, no communication problems and the like.. We could support, deliver, and get courseware for standalones.

Weber: When you say standalone, I mean, it could function standalone if they could work in connected mode.

Bitzer: You could connect groups of them together to make a classroom, like thirty, onto a smaller computer or they could stand alone or you could do all kinds of things with them. Everything imaginable was done and tried at that time. Most of them worked out and it was hard keeping up.

Weber: So, I mean, they could act as a conventional PLATO terminal? It could be a pure terminal, right?

Bitzer: Yeah, it was a physical terminal manufactured by Control Data Corporation, which they would use as terminals and other projects, and they made a lot of them and they were anxious to use those things proper-- what they thought was the right way of doing it in the educational side of things. They also wanted to make plasma panels. That was the interesting part and you mentioned Morris. They had sponsored a program up there to make them using tubes rather than plates, a bunch of tubes, and they did a lot of experiments with that and some of them worked out decently, but it was clearly not the right direction to go. So, they never got into manufacturing plasma panels of any kind in really any size or any amount…

Weber: What was the advantage of using a tube?

Bitzer: Oh, they used the vertical tubes as isolation to fill the gas and pipe them out and then they put electrodes, they could put electrodes on the tubes on one side and then they could put cross electrodes on the other side and it would work. They'd hope it would work the same way except be glued together tubes and I think maybe some panels are made that way now, particularly the curved ones. So, you never throw an idea out because it's somebody else's. It might be better than yours. I thought it was a cute idea but it never developed much.

Weber: So, your primary interest remained with really timesharing with the central computer. You were not particularly involved with the appliance server kind of models.

Bitzer: Only in funding it and I had hired a number of people to do the software and hardware to make it work that way and microTUTOR, which was a programming language that went with it. So, I made sure that it got funded because there were people, that's what they wanted, and I was solving my problem. They had a different problem. Help them solve it. It doesn't hurt any, at least it didn't. I don't know, there's some probably still around somewhere. You've got a lot of the old PLATO IV terminals. Are they still connected to anything?

Weber: No, not right now. You were simultaneously working on a PLATO V terminal, is that right?

Bitzer: Yes, that was…

Weber: Tell me about that.

Bitzer: Well, PLATO V was really just a larger version of PLATO IV, so you could run more terminals, you could program better, its software. It was just really an upgradable model. PLATO V was a hope of a replacement for PLATO IV because for a while, those panels were expensive and required maintenance. If we could do something else, I was quite willing to invest in finding out how to do it and memory had changed completely. Memory is so cheap now, it doesn't cost a thing really to put [things] in memory, and that changed the ballgame. That's what made the color television so easy, because besides storing the image on the panel and just changing what you had to change, you can store an image in memory and you can put out-- when they make the colors, they put out five, I think it's five passes for each color and intensity…

And, so the color is really great, anything you get. So, there were a lot of changes we were looking at, but I wasn't there long for PLATO V except some of the communication stuff and the software. I left in 1989 I think for North Carolina State. I had been in Illinois there for thirty-nine years. They'd let me spend more, but I could work at both places. In the summer, I worked at Illinois and otherwise down here. Yeah, they always worked things out. So, I was very fortunate. As I said, their projects are still going on-- that were still going on then back there. Most of those, I got the information out that I needed and we finished them up here and the patents are from up here. I haven't counted the difference. I think maybe there are half a dozen or nine from here and the rest of them, like another nine or so or more from Illinois. The last thing I have time for is to sift through and read patents after the lawyers have spent four days with you reading them.

Weber: I mean, CDC basically started losing steam after the PC got going and I mean, with Apple giving away computers with--there was an emulator for PLATO, on the Apple II, is that right?

Bitzer: Yes.

Weber: Once again, to capitalize [on] the educational market.

Bitzer: You could do a lot of interesting things with that terminal. They had a decent language. The chemistry professor could essentially put his programs on the Apple or vice versa, change them back and forth. What was lost in the Apple was the ability to record all of students' work for all students and analyze it. We had programs that analyzed it, displayed it for you, displayed it on the screen. You'd get all your statistics and everything you want just by pushing the button. So, that, I don't know if it ever came about in the Apple machine and then it went too because it didn't have enough power to do what they wanted. But, no, my hope was to have a computer tie everybody together around the world. It didn't come to that, although maybe I'm glad it didn't now that I see what gets on when you do things like that. That's not necessarily good news anymore. I always envisioned the people voting from their terminal. Boy, I'm glad that didn't happen. I'd be in court all the time, but it did its job and I had other interests then. I was doing a lot of different work and messenger RNA coding theory.

Weber: And, we'll get to that definitely, but what would the business model be for the common global system? Would people pay for connectivity? Or advertising?

Bitzer: What was the business model for PLATO?

Weber: Suppose your larger vision of this… of a million terminals. What would the business model have been at that scale?

Bitzer: Well, I didn't look for a business model at that time because I was looking at the technical problems first. My guess was that the closest thing to a business model was the young people thought of putting all this different kind of communication on, and that turns out to have been a pretty good business model. I don't think we ever put advertisements on the system anywhere and I don't think we ever planned to. Of course, when you start getting into paying for it more and bigger, you start looking at things like that, but my objective was never to make money doing it. The objective was how many people can we educate and teach how to solve problems because remember, that was a time when we just came out of the Sputnik era, maybe ten years, and so we still had a lot to catch up to do and we still do today. So, I'm not sure what's going to happen with the rest of that. I don't think much about it. We do other things. We did forensics, voice forensics, lip syncing. We got all that done. That was done and modeled on the computer and it worked out well. So, we got into a lot of different fields and as I say, the new ones are… about four new ones I want to at least get them started.

Weber: And, you were doing some of that before you left Illinois. I mean, you were moving beyond PLATO while you were there instead of after you left.

Bitzer: Yes, but most of the things I was thinking about beyond PLATO, I thought about mostly on paper. I was hoping that that would be taken over by industry. Industry has its place and a good place if you want things done. So, I was always concerned about getting industry involved at all the levels if we could and it could have gone that way, but in a sense, it did. Everybody got their own programs that they wanted to run and I'm not sure how their models work. Most of it's free. So, I guess unless you're a university giving lectures over it or something, it's not easy to make money in that business.

Weber: Toward the end of your time in Champaign, I mean NCSA had started up with Larry Smarr. Did you talk to those people? Did you know them?

Bitzer: Oh, I know them, yes. I ran with-- some of them are runners. One was the husband of one of my good employee's wife there. I forgot who he sold his to, but he sold his. There were several of them that he sold. That came from the big computer lab there in Illinois. Oh yes, no we'd talk about it every day on the runs, what was going on and so forth. But, their idea was they made the money by selling stock. It worked out well for some of them. Actually, the university is the only one that made a mistake. The university wanted to take cash up front instead of stock. They'd be much better off taking the stock but universities aren't organized for business and it's probably a good thing. They have enough problems with education and what's going on. They're learning and I defend education. This is my, what is it, thirty-nine plus thirty-five, thirty-four, thirty-five, so I'm up in almost eighty-one or eighty-two years being in teaching and research.

Weber: Seventy.

Bitzer: Seventy-two?

Weber: No, 70, right?

Bitzer: Oh, I started when I was in a sophomore in undergraduate and it was the research lab that they asked me if I would-- I took two courses and they asked me if I wanted to join the research ranks, and I said, "Sure, why not?" and I did. I worked with them all the way until I left the university. That was one of the three and then, I, of course, had this laboratory, which was the main responsibility and that went on for, my goodness, since I was, well very young. I'm trying to think of it. And, I retired.

Weber: I know what you're talking about.

Bitzer: I retired thirty-nine years. I retired because one of the graduate students of mine was interested-- he came back and he asked me if I would be the advisor to his granddaughter as a graduate student and I said, "What? You've got a granddaughter coming up?" I said, "I better take a look at this, it's been a long time." Go ahead.

Weber: I wanted to ask what-- oh, sorry. Speaking of, so did your own son, I assume, learned with PLATO to some extent?

Bitzer: Yes, and the neighbors would come over too, but David, my son, yes, he would come over and use PLATO for things that particularly he may not like, but… the courses. He'd use them for physics too and mathematics, but if he'd come over and there was a real problem, I would give lectures on the blackboard to him, and that paid off too because one time, he came in and he said he had this problem, this charge distribution problem and he couldn't solve it. So, I worked it about thirty minutes on the board and showed him how to approach it and we solved it. Went back the next day and the two professors teaching the class came up-- I was waiting in my hallway of my building. They came up and said-- I said, "What are you doing?" They said, "We're getting ready to go to class." They said, "Well, we've got a problem we can't solve," and I said, "Here, let me look at it." They said, "No," they said, "we don't have time for that." So, I said, "Okay, but maybe I can help you," and they showed me the problem and that was the problem and I sat there, "Well, that one's easy," told them the solution. They all ran off to class and taught it and David came home. He said, "You know what?" He said, "The professors solved that problem just like you." <laughs> I said, "Of course they did. I told them how to solve it." But, there was a lot of that kind of stuff. There was a lot of good fun that went on doing these things. The young people were really terrific. As I said, I'll never forget the young people. I still think of them as very young, but they're all retired. That's amazing.

Weber: And so what led you then to leave Illinois?

Bitzer: I'm sorry, what?

Weber: What led you to leave for North Carolina?

Bitzer: Oh, that was an interesting event. I used to get letters about once a week. Most of them were to be a dean and I threw them away in the waste paper basket because I was happy what I was doing and everything and then I get this one from NC State, which I threw in the waste paper basket, and my wife comes to visit me in my office and she looks in the basket and pulls that thing out. She says, "You did call them, didn't you?" I said, "What do you mean?" She said, "You've got to answer this. This is big and important." Well, I didn't pay any attention to it. I said, "Okay, I'll call for you." So, I picked up the phone and called and the head of the department had just left. He had originally worked at the national laboratory in Tennessee before he became head. So, he was heading back there to finish up some things that day. The secretary said, "He's gone but he'd been waiting here for you for two days to call." I said, "Well, I'll call him." She said, "Well, he stops and calls in halfway there, when he calls in, I'll tell him you called and I'll take your phone number and he can call you back."

So, he did and I looked at the paper a little more carefully. I was still a little surprised about it because the things they sent me were one was the running tracks and the second were pictures of the handball courts and nothing picture about the university really at all. What the heck? It turns out they had studied my past pretty carefully, what I really liked. So, that was their way of trying to attract me. So, I talked to him on the phone and I said, "Is this-- are these numbers real?" because typically when you make an offer to someone when they're new, you offer them more the first year so they can buy equipment and things, but that disappears. So, I was interested in asking that question, "Is this just for the first year?" and I meant it that way and he said, "Oh," he said, "Yeah, that was for the year," he said, "but if you would like, we'll

make it just for nine months." So, I said, "That sounds better." I caught myself right away. So, it took a year to get out there and visit him and another year and a half to make the move because I had a laboratory that I was responsible for, and they waited and I just found out a few years ago how I got selected for that job.

It turned out that the state legislators in North Carolina had approved an endowment for me for life that they would give to the university that I had to spend only by university rules but my accounts, and I didn't know that. So, that's why they told me not to worry about having to get money or anything because they were making money. They were paying for other people, my students, faculty, all kind of things, off of the grant, which was fine, but I didn't know that until he died and his wife brought over a plaque, and I don't know if it's in there or not, where he said-- where he's got the ticket to the World's Fair in Tennessee, a ticket to the building and the coin, the PLATO coin that they gave there. CDC had built a building with all my inventions and he went through it and he said, "That's the man we want." So, he went back and they pursued me until he got me and I've not been sorry.

It's been very good and I've been there thirty-three years now, something like that, since '89, and they've all been good. They never went back on their word. I went and spent, I think it was six months, sometimes people tell me it was twelve but I think it was more like six, a sabbatical just to make sure that it was real, the building was there and everything. But no, ever since day one, it's been a great place. They've done everything they can to make things happen and I end up just-- I asked them what I had to do and they said, "All you've got to do is show up now and then, talk to our faculty and staff," and I said, "I can do that, that's easy," because I like to talk. So, I got there right away and loved going in and talking with them. They were all very smart and the staff cooperated very well, from all the departments. I was what they call a university professor. I could get students to do work from anybody, which was nice. So, they just made it very comfortable to get work done, and I did, and they liked it, I liked it, and so it worked out really fine.

It was a good decision I made to go because I'd done most of the work I could do in that area, in Illinois, before I left and I took with me those things that were in transition and worked with those with different people and languages and different things that they needed to use the computer to do the analysis and programs to recognize who's speaking. We did a lot of that. I never went to court but my partner always had to go to court and testify, but we never convicted anybody on those results, because it's not like a fingerprint, not as reliable. But they could limit who to follow and check who was doing things, and we got a couple good ones that they were checking the wrong people on. It all worked out fine and the lip synching was great. That was a company they started too. That was one where if you spoke, the computer could track, by listening to the voice, track your shape of your face and that's called lip synching. I had a graduate student do it who started over at Duke and came over to finish up at NC State. He did a nice job and he asked when he was going to be done. He was at a party at our house and I said, "Well, I'll tell you when you're done, when it works right. Let's go into the bedroom here where it's quiet." We had a party going on. I turned on CNN and there was a female announcer reporter. I said, "Record that, put it through the system, we'll play it back and move the lips of the other person we've got there," and I said, "Let's see if that works," and the darned thing worked perfectly. I said, "Okay, you're done,

write it up and you're out of here." He now teaches at one of the schools there in town, so that's the way that came out. Go ahead, I'm sorry.

Weber: But sorry, I'm not sure if I understand exactly. So, it can read your lips?

Bitzer: No, you just speak in the microphone. It tracks--

Weber: And, it predicts your face?

Bitzer: One of the patents I have is it tracks what's happening with the sounds and can tell what's happening with the lips and the vocal cords and all. It's amazing and there were three of us that worked on that, a mathematician, a linguist, and myself. As I said, that worked fine and when they formed a company, what they did is they sold… they wanted to sell these to big places like Disney and all when they make these comics and they want to move the mouth, make it easy, and I think they sold them to two or three of the big ones. But, I said, "That's the wrong market." Nowadays, kids can put cartoons on their terminal. I said, "I think they would love to have something they could speak in and make the cartoon speak and mouth move and everything." I said, "Fifty dollars from a million people is better than two million dollars from two people, why don't you do that?" Well, I don't know what they did. They're still doing whatever they're doing, but I think that the bigger companies still have some of that. But, that was another thing. We worked in all different fields. Every day was different. Every day, I'd meet with a different group and we'd work on problems. I hope to do that again for another year maybe, two years, and then I'll think of-- I think it's time I get out and retire and then still work on the problems but not worrying about who else I'm working with.

Weber: You told me when we talked on the phone a while back, what was it, fusion and genetic coding are some of the problems you're interested in.

Bitzer: Yes, there's some very interesting ones that ought to be solved. One is we know how to make messenger RNA from one species to another. It's all coded beautifully by nature. We cracked the code and what we can do is take some protein from another plant or another gene and run it in another plant that would normally reject it completely and it will work because we know how to change the code to make it run in the new stuff. And, this is when nature protects itself from random things moving over. That's why you get the flu only after the birds get it and take it to China, live with the hogs and the hogs get it. Now they're close enough to give it to humans. But, we had a way of just doing it in the program.

Well, some of these things are longer now and I want to make sure everything folds right because that's what makes proteins active and there's a protein that stops blood vessel growth, which is very important for tumors, and so we want to develop that, get it so they can make it cheaply. They've tested it from the original stuff, which is, like, a million dollars a gram, but it works. It stops blood growth to the tumors and kills them. They die, if there are tumors inside. And, I think that's important enough that the first thing I'll do when I get back is get that project finished up and running and that's in conjunction with the biomedical and the biology departments. So, I'll meet with them. I'll tell them the plan and ideas and they'll get it all solved and working and test it out and take it to the laboratory. There's a lot to do with everything like that

and they'll do it because they're all good at doing those things, and that's the number one thing I'm going to start with.

The number two thing I want to do is small fusion machines. I think I know how to do those, how to keep fusion going in a small machine by special kind of stability that we use in the plasma panel, too, for the dots. It's simple in the plasma panel but makes it more complicated. We know how to do those things. We've done most of them with the plasma panel. We have electronic switches in there that switch in fractions of a microsecond and are either on or off. They don't spend any time in between. So, the energy lost in switching is small. So, you move energy from a capacitor to an inductor and back and forth, without losing much. And we wanted to do that with a plasma panels, because you're charging and discharging a capacitor that's a huge screen which is a lot of capacitance. So, when you do it that way you save 95 percent of the energy. But and that's used in all the plasma panels. The other one is that I told you I'm concerned about these high-speed supersonic missiles that fly low and you've probably heard about them. Russia sent some-- or uses--

Weber: Hypersonic.

Bitzer: Hypersonic, yes. And I've got some ideas on that. I worked on some of those ideas years ago when-- I'm trying to think which President it was that did Star Wars, that was-- yeah.

Weber: Reagan.

Bitzer: Reagan did Star Wars. And I worked on a number of things with him. Some which worked and some which didn't work. But it's a Star Wars type thing but I think I know how to do it. I think I know how to-- nah, I'm not going to say anything more. I think we can make it work and I think we can make it work at the speed of light and it's cheap. It uses things that we already have in mass production, so I want to just get it far enough… well, I want to model it in the computer enough that we know it's going to work. And the same thing's true of the fusion. I want to model them to make sure they're going to work and then they can spend a lot of time putting them together. But I think they'll both work, but it takes time, it takes groups of people. Takes people who are willing to work on problems which aren't answers that you can look up and you have to apply everything you can. And I've been working on one of those even as I came over <laughs>, with mathematics. A 250-year-old problem. And I think we've got it solved. And the student thinks so, and we're-- I'm going to have him write it up because that's what I do. I love the students to write up-- put their name first, because students need publications, but they don't have many. I don't need any, so why not give the honor to the students in a more… and the same thing's true with the patent. I'll put their name first on it, because it's better for them and better all the way around. And there a lot of good students.

Weber: Could you say the name of that problem?

Bitzer: Which one?

Weber: The one you just said, the 250-year-old problem.

Bitzer: Oh! That's called Goldbach's Conjecture. Goldbach-- you know, Goldbach's Conjecture?

Weber: No, I don't, but I think you mentioned it the last time.

Bitzer: Yeah, Goldbach's Conjecture is that if you-- at any even integer above four can be represented by the sum of 2 primes. And they've never-- it's called a conjecture because they never found an exception to it, but they can't prove it. And I think we've got it proven properly. And it deals a lot with coding. How to handle primes, how to crack codes, things of that type. Rely on things in there. And so I decided to get that done during the pandemic. Because it's a long problem. I didn't want to waste 200 years, so thought I'd just take the time of the pandemic and get it solved, and it worked out nicely. So, you never know. Then I got one more to work in that area. But there's so many interesting things that need to be done, and every day and I don't understand why a student would ever think everything's done. Oh, my gosh, there's so much more to do.

Weber: Then if you think this is the right moment, I wanted to ask a couple of those things and then move to the looking back kind of section, which will be questions about future advice for young people, that kind of thing. But on the track of your career, is there anything more you want to say about North Carolina?

Bitzer: Not much more I can say. So, it's fine and I like it and I intend on solving all the problems that come up, or at least attacking them and letting someone else to finish the solving them.

Weber: Great. And then I did want to ask about the end of the CDC PLATO, there was that HomeLink. The PLATO HomeLink.

Bitzer: PLATO what?

Weber: PLATO HomeLink.

Bitzer: Oh, the HomeLink!

Weber: And if you could just talk a little bit about that and, if that did not succeed, what was the thinking there? What happened?

Bitzer: I have no idea what happened there.

Weber: You don't?

Bitzer: No, not in the HomeLink. We had our own HomeLink operations but I have no idea what CDC intended on doing in some of their projects. It was their business model and their operation and I seldom wanted to intervene in anything that they wanted to do. Except if they called up with a problem. When they couldn't put all those terminals on because they were interfering, I went out and solved the problem

for them and took about two hours and then they were off and running. I would do that, but I wasn't interested in another business model or another operation in general.

Weber: Oh, and speaking of, did I ask you with the interference? I mean, did you talk at all with Frank Kuo and other ALOHAnet people? Because obviously collision are a big part of that protocol.

Bitzer: Of course, I talked to Frank Kuo about it.

Weber: Sure.

Bitzer: Most everything. And it was always interesting. Frank was very bright; he had some very good ideas. He worked hard at them and he was a good friend all the time. And so, I don't remember-- he was with-- was it ARPA he was with when he was flying around? Or I think it might have been…

Weber: Yeah, for a long time after, I mean, he was University of Hawaii with ALOHAnet. But then back and forth to Washington for a while. And then I think he went and ended up in Washington.

Bitzer: He did.

Weber: Before coming back to the Bay Area.

Bitzer: Yes, and back at the Bay Area…

Weber: Well, he's in the Bay Area now.

Bitzer: Yeah, I know, but back there, he was also interested in a different type of computer that they were building. I think they put one in Hawaii and he took responsibility for making it work. Or that might have been another one of his friends that did that. But yeah, he was always…

Weber: Oh, no, I was just wondering if there was any cross-fertilization.

Bitzer: Oh, yes!

Weber: Protocols around collisions…?

Bitzer: Oh, oh, no, Frank and I worked lots of strange ideas together. For Engineering Open House, we once had taken a trip to Chicago with the department and we went through [vacuum] tube factories in all. At one tube factory they gave us some tubes and some of them were tubes that detected light and various things. And we went back and we built a robot that tracked light for the home-- for Engineering Open House. They put that in the paper, you could-- just wherever the light was we called it The Duck because it wobbled going over to pick it up.

And we worked on a lot of projects because I had a lot of equipment at home and he enjoyed doing those things. He was very useful with helping me. I remember a lot about Frank. I seen him-- not real recently, but I've seen him in the past, seems like probably long time now, but it seems like just yesterday when we flew back once we stopped at Hawaii to see him. Yeah. So, no, Frank is a friend. I have a lot of friends that are probably, you know, there that we saw each other all the time, worked together, had the same classes, same programs, sometimes worked on the same project together. We had our own set of projects, not just what the university projects were and learned a lot from that. And that's my advice to any young person. You know, what you ought to do right now is if your thermostat fails or your garbage disposal or something, don't just throw it away and get another one, take it apart, figure out what happened and see if you can fix it and put it back. You'll learn a lot!

And nowadays that's not the way it's done. It's replacement's cheaper than fixing, but that cuts out the learning for these young people. I love the young people and every time they ask me for advice, I tell them, "Go to school, go till they throw you out and enjoy what you're doing. Stick with it. You got to be stubborn. For these problems, you've got to stick with them, because you're not going to solve them instantly. You got to really go through a lot of pain solving them. You got to learn to stick with them. Eventually, you'll get it all together and you have to live with the problem for a while before you can really operate on it." So, I still tell them that when I reach them, and I still write that back to them when they write. And so, I'm hoping they're listening, because we're going to need a lot of good people soon and I don't know what the pandemic has done to our youth who we're hoping for really creative approaches from. I hope it's good. I hope they catch up. We'll see.

Weber: And that's great. I think we'll, after a short break, I want to do a final few questions, which I'll get some input from John for them as well. I just want to ask you, though, about how diversity, gender. So, and most of the time in Illinois, I mean, women were certainly part of a lot of projects and classmates but it sounds like it was tougher then to become full faculty or they had more limited opportunities.

Bitzer: Well, it depended on what field they were competing in. There were fields where they actually were the majority and rightfully so. In the engineering fields, they're now much more-- many more of them, it's much easier now, than ten, fifteen, twenty, thirty years ago. It used to be very tough for women. First of all, a lot of the people thought, "How can these be real women if they're working math all day and working on these projects?" <laughs> And they didn't appreciate that and I didn't either. But it got to be where that women turned out to appear and were smart and could really give help. Over half my laboratory were women. Only a few actually built equipment, but most of them were headed up software projects and other things like that. But they were a key element in the project. And the growth of the project. I had a saying that anybody who wanted to go to school that worked for me and get more education for anything, in anything, I would arrange for them to do it free of charge and not deduct any time and they could get in school. And a number of them took me up on that. A lot of them who were technicians wanted to become engineers. One person who headed a lot of things up wanted to become a lawyer and she did. And now university lawyer. Psychologists, psychiatrists. When I got chased that one time, my secretary had just finished her training in psychology and working with patients and I went immediately to her office and said, "Here's the problem. You take care of it. I'm going upstairs." <laughs> And she did!

But they all wanted advancement, almost all of them. And they all did it and it didn't cost them anything, in fact, helped them. So, it's just the people. It's who you work with. I keep telling you, but it's who you work with that counts. People talk about that but it's really true. And I was so fortunate in every move I made that I ended up with people who were just outstanding at helping and new ideas and stay up... Mladen Vouk from here, when we worked here at first doing the coding stuff, he'd come over to the house, well, I didn't get home from handball until eight maybe, but he'd come over to the house then and we would work on coding stuff and patents and whatever we had until two o'clock in the morning, and my wife would cook up donuts and things for us and put them out. So, we were working. But he was dedicated to what he was doing and he did a good job. He's now the Vice Chancellor for Research at the University. And very good. He's a computer man and when he was trained and done good work. And it's just having people around you that really know how to talk and make the talk make sense and don't want to argue or things like that. Just never… I just never run into people who were mean like that. They were all really nice. I used to be a magician. I guess I still am, but I used to love when I was there I would like to go visit everybody's office in my lab to say, "Hello, see how things were going, anything you need?" And I used to always go in and the first thing they wanted to see is, "Do you have any new magic tricks?" And I'd pull out a trick and show them, get their attention. They loved it, then I'd move on after discussing things with them. So, even when I was back I was… I was only having fun more than working. And so, I can truthfully say that I've probably never worked a day in my life. <laughs> Just had fun.

Weber: Excellent. Management by magic is great.

Bitzer: Yeah, oh, well, I used to make them. I used to be a member of the union. I'll never forget that. I was home and the phone would ring on weekends. And IBM was one of my clients. Patent clients. And they'd say, "We're from IBM and we'd like to take you out for dinner." It was a Friday night. And I said, "No, I'm not interested in going to dinner." And next week they'd call again. "Well, we're back in town. We'd like to take you to dinner." And finally, the third time I said to them, "Look, I don't care if you are International Business Machines, and my client, I don't want to go to dinner!" and they said, "Oh, we're not International Business Machines. We're International Brotherhood of Magicians!" I said, "I'll be right over!" <laughter> And became a member. And I used to make up new tricks. Tricks that they thought they knew, the magicians. But I did them, I could do them a different way with a different procedure and they couldn't believe it. Now you can't do that. They're just as susceptible as… the magicians [are] just as susceptible as the other humans are. But I enjoyed doing that, and I still if I get a chance enjoy doing it, but I'm running out of time, so only for the kids do I do things like that now.

Weber: I was like, okay, maybe for the Fellow's sake.

Bitzer: <laughs>

Weber: But that's up to you.

Bitzer: Well, I had one super trick they wanted me to make and it was super. I should have maybe made it. So, I call it the Black Hole trick. You know, the black holes were discovered, I don't know what, 20 years ago, sometime like that.

Weber: Forty or fifty.

Bitzer: But it was a very popular thing. You know, they discovered black holes and don't want to get sucked up in one and all this so. So, I decided to make a magic trick called The Black Hole. I took a peanut butter jar and painted it black so you couldn't see through it. Put a lid on it, a slot in the top. And I'd go around and I'd go over to a person and I'd say, "Do you have a coin that-- a special coin of any kind or you want to mark up a quarter or something. Drop it in the slot." And they'd drop it in the slot, and I would go over to somebody across the room and I'd say, "Here, hold this package for me." And they had this little package all tied up and wrapped, then I'd go back to the person and said, "Now, we're going to make your coin disappear and go over to that other person." And I'd say, "Shake it!" And they'd shake it to hear it rattle. Gradually it got quiet, pretty soon you'd hear no noise, they'd open it up and it's gone! And the person on the other side opened up that sealed package, and guess what? That was their marked coin or whatever it was in there. And I never wanted to tell people about that, how it worked. They wanted me to make it and sell it. "No. I'll teach how do you do this stuff, but I'm not going to get involved with manufacturing." But it was fun. And every meeting was a fun meeting. Because they spent time doing-- we had one business meeting every two weeks and the other meeting was somebody who was a professional would practice what they were going to do before the group and we'd give-- criticize it or give them feedback information on it. So, you always had fun no matter what. Good group of people. And I never did go eat that dinner with IBM. They were my licensee for years. They were happy at the end. I don't know why they kept wanting to-- it wasn't IBM. It was the International Brotherhood of Magicians. But I couldn't imagine why IBM wanted me to go to lunch with them. So, you got to watch your initials.

Weber: Oh, that's great. And to finish up on diversity, was Frank Kuo, I mean, he was unusual as an Asian in that department and how diverse were things then? And do you think that people faced barriers or what kind of barriers?

Bitzer: Oh, no, no, no. The College of Engineering in particular, and at the whole university in general, was as diverse as one could get. We had more Asians and South Americans, you name it, from around the world who were professors and students. So, I mean, one time I went to a meeting with a graduate meeting to see how well the students had done on the graduate record exam to… you know, get into graduate school. And I was sitting next to like a person who was very famous for lasers from there, and he turned-- I turned to him and I said, I said, "What are they saying up there in front?" He said, "Don't try. They'll mark some figures up there later." He said, "I can't understand them either." <laughs> I understood nothing through the whole meeting because they were all speaking in foreign language as far as I'm concerned. And when it came to English it wasn't very good. But they were all professors. They were good professors. They were smart, and they taught difficult courses, but it was very diverse. And so, Frank was just one of many. I mean, you could walk down the street and run into ten/twelve Chinese just on the first block. It was amazing! And but Frank--

Weber: African American?

Bitzer: Pardon, any from where?

Weber: Any African-- many African--

Bitzer: Oh, yes! Oh, yes. Oh, yes. All kinds. It was-- they had different fields. There weren't a whole lot in the engineering field at the time. There weren't very many women either in the engineering at that time. But there were all kinds of-- and it's still true today. And in my class, a good fraction of the students are Asian or otherwise, some foreign nationality. Which is supposed to guess worry me about what I say in class. But they had-- they were all good. Most of them stay, interesting enough. They don't want to go back when they're done. And I understand. The Chinese tried to recruit me and my last Chinese student.

Bitzer: Yeah, we had the Indians. Of course, they knew about me because I went over there and finished up their IITs. And so, they were good. And they were good students. Most of my coding projects they did that. But there [were] two or three women that did coding that were very good in that project. So, I couldn't really see a difference in abilities of them except that there were so many of them that were better than many of the students that we turned out of our schools here. Because you had to be-- there were good ones from our schools, but the percentage was much smaller than you could get from foreign schools. And I imagine that's the same today. I hope-- we'll have to change some of that around.

Weber: Yeah, I mean, the IIT as I know it is super selective and… how do you think-- what if any, what has changed as you say, you've been teaching as what 70 years almost…?

Bitzer: Yes.

Weber: Or something like that. I mean, when have you seen change over that time and diversity and inclusion? You talked a little about.

Bitzer: India has changed a great deal.

Weber: Of diversity or gender.

Bitzer: India is now a… if you went back, you'd hardly recognize it. We lived in the jungles in Kharagpur. And because that's where they built that IIT. Because it used to be an air force base for during World War II, that's where they flew planes over in Burma, out of that area. And so, they had a lot of leftover equipment there, so they build an IIT there. But it was considered a hardship area to work in and most of the Indian population had never gone down there into West Bengal into the jungles. So, we kind of felt good about the fact we were able to survive down there without any problem. And the school was good. They'd all learned to teach in the U.S. before they went back there. They had one problem is they had trouble keeping equipment up at the school, like oscilloscopes and all, in electrical engineering. And the reason was that it was below the status of the professors to fix things like that. And the people who would fix it were not educated in how to do it. So, I said, "We're going into the room together, all of you, and we're going to fix every one," and we did.

And they called me Lucky Pierre. I said, "It's not a matter of luck. <laughs> It's a matter of doing it." And studying it. And so, they… I was pretty frank with them, and they got that straightened out now. I think a

lot of things are straightened out that were marginal before. And I think that we… I'm really glad we went. I think we made a big difference in India over there. And that was all paid for by P.L. 480 Agriculture. That's Public Law 480 that when we… well, you couldn't give the goods to the food to the people, but we could sell it to them and keep the money in their country to spend there. And that's where the money came for the IITs. Couldn't generate it… interest on it generated faster than we could spend it, there was so much involved. And I was not used to that type. I think it was Galbraith who was the Ambassador at the time, called about four of us to come in. He wanted to discuss new projects.

So, finally, I talked them into flying airplanes with the instructions on how to do things over the area with the 65 or whatever it is, different languages on it so they can-- and broadcasting all of them so the city could turn on the video or village and then turn to the dialect that they spoke, and the village could then learn from that. And they went and did a lot of that. And that was not very expensive either. But it's hard to spend money when it was gathering like it was there. I couldn't think of anything big enough except building more IITs, which they did. They now have probably twice as many as they had when I left. But I loved it. I loved India. They were all good to me. I loved the jungles. I even liked the cobras that lived with us. It was a different life. No entertainment except what you made. And I used to like the contests between the spiders and the geckos. Spiders know that the geckos' got Doppler vision and can't see if you [don’t]move. But the geckos know the spiders can't sit forever. And I would put them in different corners of the room and see who got who. The gecko always won. We'd chase them in the house because that's how they kept the insects down. They were really-- it was different. But everything worked well. I got to tell you there are times when the electricity was more reliable in the jungle than it's been here when there's been storms. Less time to repair them and so forth. But it was-- that was a lot of fun. They wanted me to stay on for another year or so and I said, "I can't do that. I just got to get back. I got the plasma panel burning in the back of my head here, I got to get it done." And it's a good thing I came back at the time I did. It all worked out, though, and IITs were great. The students from IITs are good. I tried to get them here. And if they come and they say they're from an IIT, I make sure that they get into the University quickly, because they are very, very good. So, that's what I've done my whole life.

Weber: So, let's take a short break and then come back for just the sign-off, kind of looking back. So, tell me about what does this award mean to you, to join other pioneers as a CHM Fellow?

Bitzer: I'm sorry.

Weber: So, this is immediately thinking of the award, the coming CHM award.

Bitzer: Okay, yes, thank you.

Weber: So, what does it mean to you to join other pioneers of the CHM Fellows? Preface it by saying, "This award means to me-- or the Fellow's awards means," kind of okay.

Bitzer: Oh, let me tell you, the award means an awful lot to me. It's a different kind of award than some that I got, but it's in many ways more important. And the fact is that you have like 35 or so members of that award and it's an honor to be recorded that way in history. I never thought of it. I never tried to be in

anything but it was a very nice surprise when I got the word that you were interested in that. And I can't be more pleased than to say that I think it's… I think that the… I hope I bring honor to that organization as well with what you got.

Weber: Great. And then talking about your role with CHM, to face the pressing current needs of today's digital citizens, what role do you see for CHM as the leading Museum to help inspire and inform technology citizens today to shape a better future?

Bitzer: Well, in order to have a better future, we've got to keep innovation going. And the Computer Museum will be a great encouragement for people who are interested in doing things which will move the computer field forward in their lifetime. And that will be important. They see that there's a mission and an end and other people that think it's important and we need that to move forward.

Weber: Great, and then, John, I'd like to do that introducing himself, if that makes sense to you? Well, this would be to, Don, to kind of say in a short statement kind of how you see yourself. So, like, you know, I know you as an inventor, a mentor, a teacher, an engineer, entrepreneur. But how would you describe yourself very briefly?

Bitzer: Oh, I would describe myself as a person who likes to tinker and discover new things. I'm the happiest person when I'm working on a problem that they tell me can't be solved. <laughs> I like the challenge and I like to do things like that, and I've had a number of those. I was told a number of times that what I was doing couldn't be done. And they were wrong and that's fun to do. Now there are problems that you can't and you got to prove that you can't if you can't do them. But if you can do them, you want to get them done. And I've been that way since I've been a child. I probably worked hours on trying to trisect an angle, any angle without a ruler or a compass. You can't do it. I can prove that you can't do it. But see that seemed to me like it was possible. But there are things that you can't do and you ought to separate those. But there are things that if they aren't proven impossible, if they're important, we ought to get them done, and it certainly helps in the long-run to make sure that what we do is get students who know how to think, know how to apply their tools that we've taught them in new ways to solve the problems as they're going to continue to come up every day. And it doesn't make a whole lot of difference for us trying to estimate whether we should be wearing masks or not or any other object, to ply your tools the best you can to get it done and see it-- do it right is important. And I hope we have a large number of students coming along now who will recover from not being in school the first couple of years and be able to do those things in the future. Our future depends on that.

Weber: Great, and then last question is drawing on your wealth of life experience, what one word, single word of advice would you give to a young innovator, research, entrepreneur?

Man 3: Try to stay up for the answer.

Weber: What is the word? And can you tell us?

Bitzer: The one word that would tell what I would tell young people?

Weber: Yeah, one word that kind of summarizes your advice and maybe something about you and your ethos.

Bitzer: Yes.

Weber: And if you can just tell, just say why you've chosen it. And you can think for a moment.

Bitzer: Well, it might be two words like, "Keep--"

Weber: And can you start out by saying, "My words of advice are--"

Bitzer: Okay, my words of advice to new people is, "Keep going. Work hard and don't give up, because everything may be tough, but it's all worthwhile in the long run." Now those are my words, not just one word. But it's, "Don't be afraid to do new things. Don't be afraid to think differently." Be yourself, see how much you can get done. And I've written this to a number of children-- not children, kids in grade school and high school. "Just keep going. Work on it. Study hard. It's all worthwhile in the long-run."

Weber: And this is obviously putting words in your mouth, but it makes me think of words like perseverance.

Bitzer: Perseverance is a good one. If you don't persevere, you just won't get anything really done worthwhile. Everything you try is hard, and you got to persevere through it.

Weber: So, Chuck, do you want to-- I mean I-- your call as to--

Chuck: I mean, if you're comfortable with perseverance, it might be nice just to give that. And we can also have the other stuff, too, just say, "My one word of advice is perseverance. And this is why." That would be-- fit into the rest of our one-word category."

Weber: So, start with the question, "If I was-- my one word of advice for people growing up today is perseverance."

Bitzer: Okay.

Weber: And say, "Because--"

Bitzer: Okay, yeah, if I had to limit it to one word of my advice to young people today, would be to, "Be able to persevere and solve problems and do everything you can. But persevere is the key word of what you need to do to get through with doing new things that are difficult and that would be my advice to any young person coming along."

Weber: Okay. Great and were there any things that you wanted to quickly show us on camera, I mean, that's totally optional. I was a little unclear whether you would-- you had dug up things or not.

Bitzer: Oh, I got this stuff off the wall of my office and reduced it. The wall space is running out, but the-- I can't think of anything that you would need to see that you don't have probably the object itself or one similar to it. I got a four-inch-by-four-inch panel that we built and plays game with you. It was in a little suitcase I carried around. And but you got real terminals. You don't have worry about things like that. I've got plaques from companies that manufactured this stuff that we had that were interesting and made a difference with them and to us that we were able to do some of those things. There are a lot of things that we got from the foreign-- from different countries when I was there that are interesting, but they're not essential to the topic that we're discussing now. There's a large number of things that I've already put on a lot of-- used up a lot of your recording materials. <laughs> And there's no need to expand on any of that right now.

Weber: Okay. Perfect. Great, well, thank you so much. It was a wonderful interview.

Bitzer: Well, thank you.

END OF THE INTERVIEW

