Oral History of Gene Frantz

Interviewed by:
Rosemary Remacle

Recorded: May 8, 2009
Mountain View, California

CHM Reference number: X5314.2009

Rosemary Remacle: Gene, welcome to the Computer History Museum.

Gene Frantz: Well, I'm glad to be here.

Remacle: Let's get started with you giving who you are, where you are today at TI, and then the background of how you got there through growing up, college, all of that kind of thing.

Frantz: All right. My job title at Texas Instruments is Principal Fellow. We have a technical ladder along with a management ladder and the top rung of the technical ladder is Principal Fellow. I am the only one at TI now and I'm the fifth in the history of Texas Instruments, so it's one of those positions that's as close to a tenured job as you can have in a corporation. I tell people short of slugging the CEO in public I'm safe. He would have a different story, but that's mine. So what I get to do is whatever I want and I spend my life right now out looking for what will be the technology and the products as a result of that technology five to ten years from now.

Remacle: Who were the other Principal Fellows at TI?

Frantz: Well Willis Adcock was our first.

Remacle: Jack Kilby's boss?

Frantz: Yes. Believe it or not Jack Kilby never was on the technical ladder at TI, never made Fellow. I'm on the committee that works on the Fellows and gets them elected now. About five years ago, we, as a committee, talked about should we give Jack the title of TI Fellow?

Remacle: Posthumously?

Frantz: No, no he was still alive at the time, so whatever time that was. I can't remember what year he died but this was before. He was still alive. One of the guys on the committee said, "You know once you have the Nobel Prize, making TI Fellow is just not that important." And so we chose not to, in a way, insult him with giving him the title of TI Fellow. So I joined TI in 1974 and if I then step back from there I did something that most people don't do. I got all of my degrees and I have a Bachelor's degree from the University of Central Florida, a Master's degree from Southern Methodist and an MBA from Texas Tech. I did all of those degrees while working full time and so I was one of those rare people.

Remacle: That's a huge accomplishment.

Frantz: In fact, the senior year of my education at the University of Central Florida I worked third shift, went to school during the day and I was married.

Remacle: That's a big load.

Frantz: Yes and I lived through it. So that's kind of my background and that gives you a little bit of a feel of what kind of personality I am. I'm goal oriented. I drive. I work hard to get things done. And so that's kind of the background I had.

Remacle: You were raised in Florida?

Frantz: No, no. I was raised in Kansas, born in Oklahoma. My father was in the space race so we moved to Slidell, Louisiana and I went to high school in Slidell. And then he moved to Florida with Boeing and I came there after. I was in college already, met my wife, married her, moved her out and so that's kind of the thumbnail.

Remacle: So was your father's career --- there must have been dinner table talk and so forth---was that an influence on you going the direction you did?

Frantz: He was an electronic technician at Boeing and so I learned by hands-on, touchy-feely, of electronics and loved it. I was one of those kids who was more than willing to take something apart to see how it worked. Mostly I could put it back together which really reflects on my first job at Texas Instruments in the calculator division because one of my jobs was to tear our competitors' devices apart and see how they worked.

Remacle: You got an MBA. That's kind of unusual, particularly at that point in history. What made you want to get an MBA?

Frantz: I had just finished my Master's degree at Southern Methodist when I was moved to Lubbock from Dallas.

Remacle: And your Master's degree was in…?

Frantz: Double E. And I'd already been accepted for my doctorate degree at SMU but moved to Lubbock and decided I wasn't going to be able to either do my doctorate remotely or didn't know what I would do at Texas Tech which was a university in Lubbock. And so I chose to do the MBA. My supervisor at the time said, "Gene, are you planning on changing careers?" I said, "No, what I really want out of an MBA is to know the difference between gee whiz technology and valuable gee whiz technology." And so to me, the MBA pulled everything together so I could look at a technology and begin to ask the right questions and know how do you evaluate its value?

Remacle: What were the right questions that you arrived at?

Frantz: Oh, the right questions are things like now when somebody comes to me with a new idea, I play the "so what" game. And so if you came to me and said, "I have this brilliant new product I want to go create" and I'd say, "So what? Who cares?" And get you to answer that and no matter how you answer that I could say, "Well so what?" And I could get you down this path and the end of the path is one of two things. I run out of "so whats" and I say, "Oh, okay."

Remacle: Maybe there's something to this idea.

Frantz: Yes, or YOU run out of answers. I always like to tell the story and part of this learning, I had two daughters. One of them is now an engineer and the other one is a nurse, so I had one who could afford my old age and the other one who can take care of me in it.

Remacle: That's a pretty terrific scenario.

Frantz: Oh that's perfect. But my youngest daughter would come to me and say, "Daddy why," the old why question? And I learned that if I answered her "Why do you need to know," and get her on the answer side that at some point she'd run out of answers and toddle off to her mother which solved my problem.

Remacle: Did she become the engineer?

Frantz: And she became the engineer.

Remacle: That's a good story. So anything else besides the "so what" question that came out of your MBA?

Frantz: Yes. What I found in a corporate structure is if you understand the financial system but the financial people don't know you understand the system you can get away with murder. And then when you're caught say, "Oh, gee I'm just a dumb old engineer. I didn't know you could do that."

Remacle: Can you give me an example of when that worked in your favor?

Frantz: Yes, oh yes. When we were starting up the DSP [digital signal processor] business in the early 1980s, TI had decided that nobody should have a PC, personal computer. We were going to a conference and we had a PC division, so it wasn't as if they weren't available, and I had my technician. I said, "We need three demo units to go to a conference. Can you call the PC division and see if they have one?" And he called them and they loaned us three and we took them to the conference. When we got them back my technician said, "I am ready to send them back." I said, "Don't send them back." He said, "Well what am I going to do?" I said, "When the guy calls you, send him to me." And so the guy in the PC division called me and said, "Why aren't you sending them?" "Well, can I just keep them?" He said, "Yes, you want more?" And so we began to work the deal. It was the best deal in the world because he just needed to zero out his cost center and so he'd say, "I'll send you the PCs. I'll hold the cost until I

need to zero out my cost center and then I'll zero that out so you won't get charges." So if you think about it what you're hearing is "use your credit card. Buy all you want and I won't actually charge your credit card until I need some money", a perfect deal.

And so everybody in the little DSP department had PCs but nobody else in the division had any. And so one of the other department managers came to me and said, "I have complained to our division manager that you have all these PCs and we don't." And I said, "Oh, wait a minute. Call this guy. He'll give you all the PCs you want and all you need is a good cost center." He said, "Really that's all?" I said, "Sure, call him." He said, "But I've already complained to the division manager. What do we do about that?" I said, "Well two things. One, go back and tell him that you and I have talked and we fixed the problem. Secondly, did you see a PC on his desk?" "Yes." "That's one of the ones I got." And so it was that idea that I knew as long as I was playing that game within the corporate structure I was making no mistakes, no errors. Financially it was ethical and legal. Later, I did some more things when they shut that one down and I actually went to the financial guys. I said, "Here's what I'm doing and I just want to make sure that I'm not violating any federal laws by doing this." And that was building PCs out of spare parts. And I began to see the financial guys get mad and I said, "Why are you getting mad?" They said, "Because you're not doing anything illegal and you're not violating any policy and we can't stop you." And so it was those kinds of things that allowed us to get the resources we needed because I knew how to play the financial, excuse me. Just in case my financial people see this video I knew how to properly handle the finances to get the job done.

Remacle: Did it ever blow up in your face?

Frantz: There are a lot of rules on what you can do with equipment that have my name on them, yes. Yeah, you get caught and then you'd find the next set. In fact, while we were building our own PCs for our department, one of our IT guys sent me a note and said, "If you build one— if we see that you build one more of those PCs, we will cease to support your whole department." And I sent back a note and said, "Really, can you put that in writing" because we were supporting better than they were at that time.

Remacle: To take a step back, how did you get to TI?

Frantz: I had known TI for years as a kid who wanted to play with TTL [transistor-transistor logic] and other logic things and so I knew TI existed. When I was in the Army, after my two years, I decided I would start interviewing, so I interviewed TI because I knew them and they were doing calculators. I got into the calculator division, so it was one of those cases I found a company I knew. I knew the reputation. They were doing something I wanted to do, and they were in Texas and that would seem to be a good place to go and that's how it happened.

Remacle: Can you recall when computing, computers or computing first entered your, maybe not day-to-day, but your life, your mind?

Frantz: I was talking to somebody yesterday. I went to visit him, one of the entrepreneurs here in San Jose and he showed me an analog computer. Well my first computer experience, one of my first computer experiences was an analog computer and I remember the digital computer we used in my

undergraduate. You had the cards and you had to type up each card. It was a real pain to be useful. So that was my first experience. It wasn't until I got to TI and began to work with the calculators that you begin to see what we would now consider a microcomputer in that sense and began to work with them and make them part of everybody's life.

Remacle: When you came to TI how did you get absorbed into the organization both technically and corporate culturally?

Frantz: When I joined TI, we were in a very big growth time in the calculator world and they just said, "There's a desk in the hall. That's yours." And so I started with a desk in the hall and it finally moved into a place where I could feel like I had a home.

Remacle: What was the culture?

Frantz: The culture that I loved at TI, we had color badges based on how many years you've been at TI, so we had red for five and under, blue for five to ten, yellow ten to 15, silver is 15 to 20, and then gold 20 and more. And I remember somebody telling me…they said, "No matter what problem you have, if you can't solve it, go in the hallway, grab a gold badger, somebody with 20 years or more, ask them." They either knew the answer or knew one of the leading experts in the world in the research lab that had the answer and they will more than be welcome to take care of you.

Remacle: Did you do that?

Frantz: Many times. I got assigned to create TI's first LCD calculator and it was "give us a price, give us a cost of what LCD calculators would cost." And I said, "I don't know how to do this." And I grabbed a guy in the hall that was a gold badger and he said, "Oh, you need to go to this guy over in the research lab. He knows all about it." And that's how I got to be able to do that first cost estimate for an LCD calculator._____.

Remacle: Does TI still have that system in place today?

Frantz: No. It went through an era where gold badgers lost their reputation of the guys driving, or the people driving, the technology to [becoming perceived as] the pre-retirement group and there was a time where I began to tell people, "Whatever you do, don't let a gold badger get on your project because they're on retirement." When I turned gold, my boss Made me get a gold badge and wear it. [Then] there was an era when we were getting rid of the colored badges but my boss would not let me go to the non-colored badge. He said, "You're going to wear a gold badge."

Remacle: Because he perceived that you could add value to the junior people coming in?

Frantz: I'd been bad-mouthing gold badgers so long it was his idea that maybe I should be one and I still have my gold badge. I'm one of the few people in TI that still has a colored badge.

Remacle: Going back to the corporate culture at TI, can you describe it in a little more detail?

Frantz: Sure. The thing that's fun about Texas Instruments is virtually all of our innovation has come from the underground, so we have this active, and still do, this active underground where we churn up the ideas. When I describe Texas Instruments, we're now 1930 to now, we're almost 80 years old, is that right? Did I add that up correctly? But over those 80 years we have reinvented ourselves every decade.

Remacle: What drives that reinvention?

Frantz: Well I mean just so in 1930 we were an oil exploration company. In 1940, we were an instrument company because the war needed instruments. In 1950, we were a transistor company, the 1950s. The 1960s we were an IC [integrated circuit] company or a TTL company. The 1970s we were a calculator company. In the 1980s we were a DSP company. In the 1990s we were a wireless company. And now we've kind of reinvented ourselves to be an analog company. And you look at that and you say, "How did that happen?" Well, seldomly was it ever a management decision. "We will now be this." It was these new things coming up, boiling up and all of a sudden they begin to be too big to ignore and that's what we became.

Remacle: When you got to TI you said you arrived in 1974?

Frantz: In 1974, yeah.

Remacle: So was the excitement over the IC and Kilby kind of behind the company or was that still a badge of honor?

Frantz: It wasn't necessarily a badge of honor in the sense of, "Wow, we invented the IC," which we've always had that feeling at Texas Instruments, but if you remember the calculator is one of Kilby's pushes to prove that the IC was valuable and so we were in this business unit that was proving the value of the integrated circuit and so that was the excitement I was a part of, of, "Gee this is really great." We had our political battles as you would expect over whether the world should be PMOS and NMOS, CMOS or bipolar. And so we were going through that battle.

Remacle: Was Kilby involved with your group's work directly or indirectly?

Frantz: Never with what I did, no. He was off doing some other things at the time and so actually my first connection with Jack Kilby was many years later when we were doing things in the DSP world and we would invite Jack in to celebrate things and that's when I first met him. I never had the chance to work with him and so I was always stuck off in another area. I was not an IC guy. I was a systems designer so I kind of got stuck over here in the corner.

Remacle: Well, let's talk a little bit about the calculator because that certainly was a huge accomplishment on TI's part and we had a big influence going into the computing era riding on that. When you got there, did you have any say so over where they put you?

Frantz: No, they just shoved (me) in what was known as business calculators, the ugly, boring, nobody wants in this organization and so we had the big desktops, the printer calculators. No fun there. And then I got stuck on the production line keeping the production line running, but that was a lot of fun to be able to go to the production line and see what the problems were, fix them, go to the end of the line and watch them roll off the end of the line.

Remacle: What were the key challenges in the development of the calculators?

Frantz: I think the key challenges were all of the associated things with this brand new concept of a micro controller, microprocessor. It was fun Wednesday night [May 6, 2009 CHM lecture, *From "Tinkertoys" to "Solid Circuits": Microcircuitry in the Late 1950s*] to listen to the different people, but we had things like exposed gate oxide, that was in the early days of trying to create integrated circuits, a huge problem. We had silver migration. We had electrostatic discharge. We had devices that had an ESD protection of 15 volts which just is non-existent. And we had all these problems, the yield issues. I remember we had devices or systems had had four or five chips that you had to cherry pick which ones work together. And so all of this that we now look at and say, "Wow, did you really have those problems?" Yeah, we lived through all those problems and still made a product and shipped it.

Remacle: This is probably a good place to ask the question about how much did you share with colleagues in other companies? How much competitive pressure were you feeling? How did that influence how you and your team approached the project?

Frantz: Sure. Look, so when I was in the calculator division we were isolated from semiconductors and we had our (own) competitors. We had HP. We had, oh, let's see Sharp and a few others, Bomar I think. So we had these competitors and we were in our own little world. And so from a semiconductor point of view, TI's semiconductor [division] was my vendor, to some extent, my hated vendor because I had no choice. I had to use TI. I couldn't go look for the best part in the industry. I had to use TI. We were TI's hated customer.

Remacle: The TI semiconductor group's worst customer?

Frantz: Yes, yes, TI's semiconductors worst customer was us because we could go to the computer and find out their exact cost and so we expected a lot out of them. They made no profit. We didn't like them because they were our only choice. It was one of those cases where you found out that because we're in the same corporation, we were in the worst of all worlds. We couldn't sue each other and so you had none of the benefits of going to an outside vendor or selling to an outside customer. And I found that interesting as I got away from the production line and got into designing systems and having all the integrated circuits designed by our calculator division designers and then manufactured in the semiconductor group and all the politics that go with it, just phenomenal politics, but we lived through that

and did that quite well. And so I didn't really have that issue until I moved to the semiconductor group into the DSP division or the DSP department at that time in 1984.

Remacle: How did you incorporate, kind of following on my earlier question, how did you incorporate customer feedback or was there any customer feedback into product development for the calculator in particular?

Frantz: There wasn't really that much feedback because a calculator is a calculator is a calculator. Two times two is always four I think.

Remacle: But things like ergonomics and so forth?

Frantz: On what?

Remacle: Things like ergonomics?

Frantz: Yeah, I know, but we were early enough that it just didn't matter.

Remacle: All we cared about is the functionality?

Frantz: Yes, it works. I remember on the production line of one of our desktop calculators, our quality control shut the line down because on the keyboard---which was about that big (10 by 30cm)---one of the gray keys was a different color from another gray key and they (quality control) said, "We're shutting down." And so I grabbed one of the products that had the problem and I went out in the hallway and I just stopped people and I said, "If there's something wrong with this calculator, tell me." Couldn't find it. I said, "Okay, something about the keyboard is wrong," Couldn't find it. "Okay, it's between these two keys." Still couldn't find it. I said, "This key is a different gray than that one." Then they said, "Oh, yeah that's a bad problem." And that's when I began to find that some of the feedback was such that it wasn't a problem until it was obviously noticed and then it became a big problem. And it was things like keys. It was things like our keyboards double entered at times. It took us a while to figure out how to resolve that with software and so those kinds of things were the problems we were having. I talked about silver migration and exposed gate oxide. Both of those showed up in the customer as "I've used them a long time and they quit working." Silver migration between the pins would short them out. Exposed gate oxide at the time, we didn't know how to cover the whole gate and so you could build up a charge onto the gate and all of a sudden it would just turn on.

Remacle: Hello.

Frantz: Yeah and so the product quit working and (the customer would) ship it in for repair. By the time it made it through the mail to us, the charge had dissipated and so we'd look at it as "no problem."

Remacle: It's working?

Frantz: It's working and we shipped it back and said, "What's wrong with you, it's working?" And it took a long time to finally figure out what the problem was.

Remacle: And when you say a long time, how long is it?

Frantz: Oh, three, four months of customers being irritated over this. And, not all of them, depending on how you aligned the masks, [only] some of them were exposed. Some of them weren't.

Remacle: How big were the teams, incorporating design and manufacturing, that it took to get a calculator to market in those days?

Frantz: Let's see. We usually designed a new device every time we had a new calculator and the new device design teams were usually ten to 15 people. The system design team is usually two or three people. That was about it.

Remacle: I think I understood you to say that you ultimately brought the device design, the semiconductor design, IC design into the calculator group?

Frantz: Yes.

Remacle: And why was that?

Frantz: Well just because we wanted to control our own destiny. There was just a little bit of politics here of how we needed things designed. Later on when I took on the Speak & Spell program was after we had decided to go into educational products that I, and this other fellow by the name of Larry Brantingham, were the two new kids on the block who every time something new and creative came up, they'd give it to us because we were interested in going off and driving and make them happen. And so he and I were kind of assigned to this Speak & Spell thing. We found that getting the IC designed and done and once we got into the politics of who was first priority in the wafer fab and how did you get material through the fab, what I would do is send the engineering design manager (K. Bala), who was in Houston, the design was being done in Houston, a case of calculators and he'd go to the people on the production line and hand them a calculator and say "Could you get this through fast?" And so we were not first priority in the corporation but we had the fastest turnaround times in the wafer fab because we were handing out calculators. And about once a month he'd send me another note and say, "I need another case of calculators" and I'd ship him another case and we would continue that abnormal method of getting priority.

Remacle: That sounds pretty clever.

Frantz: Yeah but when we got through the Speak & Spell program, I called a patent lawyer that had taken care of all the patents for us and I said, “Andy, I have this confession I have to make. We’ve been getting first priority in the wafer fabs on the Speak & Spell by using calculators as bribes. Is there an issue? Might there be a legal issue with that?” He said, “There might be but send me a Speak & Spell and I won’t say anything.”

Remacle: What were the technical lessons that you learned as a new kid out of school when you got to TI?

Frantz: I think one of the most important lessons I learned was just because you can build one doesn’t mean you can build ten. Just because you can build ten doesn’t mean you can build 100. Just because you can build 100 doesn’t mean you can build 1,000. And so every decade of manufacturing you find a new set of issues and you can’t just say, “Well I built a prototype now. Take it to production. All is done.” I had the Speak & Spell program. Again that was my big lesson on that. It fell out of production at a half a million units.

Remacle: And what was the reason for that?

Frantz: It ended up being a design issue with the IC, one of the ICs, and, not even a design issue. It ended up being a process issue in the wafer fabs.

Remacle: There’s a question I’d like to ask and I have to take a couple seconds to think about it. Life in a semiconductor company that goes into systems production and manufacturing is difficult. Can you talk about some of the difficulties that are associated with that….you’ve mentioned you were their worst customer and so forth?

Frantz: Yes.

Remacle: Talk about any other difficulties that are set up inherently by having the semiconductor division being separate or group being totally separate from the system producing and designing group.

Frantz: Boy, that’s a fun question because what I learned very quickly was to step across that boundary and be the IC guy’s best friend. And so I spent a lot of time with that and so once again we were using PMOS in all of our designs which was a 10-volt process. I remember specifically on the Speak & Spell product where I had four devices in that that we had all designed from scratch, so all four of the ICs that were in the Speak & Spell, we designed. That was the design part of the project. I called the manufacturing engineer who was in the semiconductor group and I said, “Tell me something. Is there a better voltage at which all of these devices will have a better yield? I’ve chosen 10 plus or minus 5 (0.5) because that’s our spec. Is there a better place to set the voltage that would give you the best yield for all the devices?” And he looked a bit and he said, “Yeah, nine and a half volts rather than ten.” For me that was a change of a ziener diode. I said, “Okay, let’s change the spec to nine and a half plus or minus 0.5.” He got better yields. I got lower power dissipation and we were all happy.

The same product engineer I had worked on the SR-52 (actually said 59 in the interview but was, in fact, the SR-52), which was the first calculator that had a card so you could program it and the device that had the analog section to read the card, the op amps, he sent me a note and said, "We've shut down the production line because the gain is out of spec on the op amps." And I said, "Well I haven't noticed a problem. Can you send me 100 devices so I can check it out?" And I said, "But let's keep going." And I never actually received the 100 devices because I think they were shipped. It never was a problem. It was just a spec problem but rather than being the internal customer who said, "Well that's just too bad. We're going to shut you down until you fix it," I was more than willing to say, "Well that doesn't look like a problem. How long have you been shipping them like that? Let's just keep going." And that worked out, but I found myself one of the few calculator product managers or program managers or system designers who was willing to go to the IC guys and say, "What can we do to make it work?" And so those are the politics I've seen across the boundaries.

Remacle: What about at the kind of resource allocation level? How did TI senior management balance the semiconductor group against the systems groups?

Frantz: That was well above my head. I planned my career to avoid those high level management issues. In fact now my daughter, who is actually an engineer at Texas Instruments ,came to me about six months ago and said, "Dad, you have a reputation of falling asleep in the meetings." I said, "Yeah they're boring." And I call a lot of our meetings now 'study hall' because everybody brings their PC, opens it up and they're reading their email while somebody's talking. I said, "Why don't we just sit at our desks and do our email?" And so I've never been one to want to play that game so a lot of those questions of the high level politics, I just don't care about.

Remacle: If you could summarize, you've kind of hopscotched around in your calculator part of your career. Could you just do a linear, "I was here, here, and here" for us?

Frantz: Sure. Sure, I entered the calculator division in 1974 doing what was called sustaining engineering on the business products line, which were the desktop fairly sizeable calculators. The sustaining was to make sure that while it was in production it didn't have any technical problems. From that I began to build a reputation of knowing how to handle the system and keep it in production and so they began to give me some scientific calculators. I was responsible for awhile for the 50, the 51, the 52, all those calculators. And, by the way, the story I told you earlier on the 59 was actually the 52 which was the first calculator, but nobody really cares. But I took those into production and from that, I got a new boss and we were beginning this thing called learning aids and he needed me to help take the Little Professor into production. And so he and I went to our production line at the time, which was in Lubbock ,and we went to Lubbock and started up the production line for the Little Professor, which was a learning aid to teach children how to do math.

Remacle: Would you consider that a predecessor to Speak & Spell?

Frantz: Yes, because from that my boss and his name was Paul Breedlove. The reason I say that is the beginning of the Speak & Spell has an interesting point and I'll come back to that in a minute after I finish. Then I went from that to the Speak & Spell, took it into production. By that time, production had moved to Midland. I moved to Lubbock. The production line moved to Midland. Then I got a group of scientists or

researchers to do all the speech products for the calculator division including the home computer and when the home computer finally met its tragic end in late 1983, my team was told to go away.

Remacle: Go away from TI?

Frantz: Just go away, whatever you want to do, go away. And so I grabbed up a couple of my best engineers and tried to sell us around to other parts of the company and it ended up that the division that now is the DSP division was willing to take on all three of us. They kept saying, "No, we just want you." And I said, "No, if you just want me you don't understand. You really want all three of us."

Remacle: When you said, "You don't understand," you don't understand what?

Frantz: Don't understand how little I actually do. I am more of a cheerleader and an instigator than I am a doer and if you think about that, I'm the person who can go in and get everybody excited about a new opportunity, get them to take it on, and then walk away because I've done my thing. They're off and running. I want them to get the credit because they're actually doing it. And then I go onto the next one.

Remacle: Let's go back to the Speak & Spell, so how did you officially get from working on the calculators to the learning aids?

Frantz: So my boss, Paul Breedlove had this idea of what we could do for math with the Little Professor we could do with spelling by having the product speak the words and the child then spell on demand. Well, this idea of speaking the words was an impossible task. Nobody had ever done it. He had spent a couple of years in our speech research lab and he said, "We have research guys that really know what they're doing. I think we might be able to pull this off." And so he had this brilliant idea and it started out kind of as a brainstorming session on how and what can we do with a bubble memory. So we had bubble memories. You remember that fun era.

Remacle: Absolutely.

Frantz: But we didn't know what to do with them and so there were some brainstorming sessions of which Paul became a part on how do we do and what do we do with the bubble memory. And he said, "Well, we could do a speech product because speech takes a lot of data and it needs to be stored and played back." And then he realized we didn't need bubble memory. We just needed ROM for that. And so he came back with this idea, wrote it up, brilliantly wrote it up. And at the time we had this program called Idea Programs which was an ability to get $25,000 to go do something new. Well he went around. None of the idea reps would give him $25,000 because it sounded too risky. There was this thing called wild hair money, which the corporation would give out if the probability of success was less than ten percent. They didn't give us money because it was too wild of an idea. But he finally found an idea rep to give us $25,000 to go demonstrate it. And so I was his employee and so he said, "Gene, take this on." Larry Braningham, the other guy that he and I were doing a lot of the new businesses, pulled him over to do the IC architecture. There was a brand new kid in the research lab by the name of Richard Wiggins who had just hired in, didn't have a job yet. And so I was between projects. Larry wasn't doing anything.

Richard was brand new. And so we went off to try to demonstrate we could do it. And we weren't smart enough to know it couldn't be done, so we did it. The fun of that first thing was watching Paul push and push and push until he found one person willing to waste $25,000.

Remacle: And what were the ultimate revenues from Speak & Spell?

Frantz: I have no clue but we were in the millions a year of units that we were selling to the market. Once again, once it got to people making money, I wanted to go away from it. But we ended up only spending about $10,000 to demonstrate the capability and the partial reason they got the cost center wrong on the project and we actually charged some other poor cost center manager who had no idea where that money came from, so we didn't bother to clarify that. It didn't seem reasonable to do that. We almost lost the program when we had our early first demonstration because we brought in our senior VP. Ron Ritchie I think was the VP at the time and Richard Wiggins had done it on our 980 computer in the research lab and set it up so you went to a terminal and you could type in and he had it on Level A and it said "Spell Cat" and so we noticed that the VP was looking for C-A-T and hit enter; very good. Now try---"dog"---and we did a couple of those. Then Richard made the mistake of saying, "Let's go to Level 4" and the first word came out something like "Now spell onamanapia. Not many people know how to spell that word and if you're—

Remacle: I may be a VP but I can't spell that word?

Frantz: Well but if you realize it's a senior VP who didn't know how to use a typewriter, didn't know how to spell this word, and was kind of in a position he's going to show himself as not very bright and he tried it, "wrong, wrong, wrong", and then it said, "Now try vovoviporous," another wonderful word that everybody should know how to spell and about the third word in, and I don't remember what, he was on the verge of killing the program because we had embarrassed him. And so, we fortunately made it through that, but that's how that business started. And then we went and got a little bit of funding to begin the design. We had to figure out how to do the speech synthesis which was at that time an impossible thing and we were using PMOS, very slow, not NMOS, and most of the scientists at the time even with NMOS said, "You just can't do the speech synthesizer on a chip" but we did. The real fun of that program is the technical conference of the IEEE that covers that whole world of signal processing that's called ICASSP, International Conference on Acoustic Speech and Signal Processing, and we had chosen to introduce the Speak & Spell, not at a technical conference, but at a marketing conference at CES in June. Well the ICASSP I think, was in April or May that year, and we made our research staff swear that they would not disclose the product. And so you had this phenomenal signal processing breakthrough of the state of the art of which they went to a conference and could not talk about.

Remacle: That must have killed them.

Frantz: Oh, it was terrible. They just stood in the corner and smiled and it wasn't until the CES, the Consumer Electronics Show, in June in Chicago that we actually showed it and demonstrated its capability.

Remacle: I know you've said a couple times that once the product got out of the lab, you were less interested or less involved perhaps, but what was the reaction at CES to Speak & Spell and the reaction to TI producing a truly consumer kind of product? Calculators were more technical or academic?

Frantz: Yeah. Well, it was one of those cases where we were at that time trying to do three things, the home computer, the CB radio, and the Speak & Spell.

Remacle: When you say "we" you mean your group?

Frantz: The consumer group. I was the poor schmuck on the Speak & Spell. And just as an aside before that all three of those would show up in corporate committee meetings because they were all very important to the corporation and I always felt really bad because the person in charge of the CB radio was a fellow by the name of Jim Clardy and he would explain how they were behind schedule. They had spent all their money and they needed more money and they were in trouble. Rob Wilmot [Now Sir Robert Wilmot] was in charge of the home computer and he would get up and explain how they were behind schedule and they needed more money. And then I'd get up and I would feel real stupid because I'd say, "We really didn't spend all the money you gave us and we're a little bit ahead of schedule and I don't really know how to handle this, but we could use some more money." It was one of those strange "Why don't I lie and say we're behind schedule and spent all the money" so I could feel like I fit in?

Remacle: What was the reason behind that? Was it anything to do with the design of the products or was it the work ethic of the groups or the moon, sun, and the stars?

Frantz: I have this philosophy. There comes a time when you get a team and they gel, whatever that means, and all of a sudden two people look like five. Five people look like 50 and ten people look like 100. It just multiplies and you really can't explain it. It all gels and it comes together. Then at some point it falls apart and you can't explain why it fell apart. Well we gelled. We started out with the four of us. We ended up I think at max had 25 or 30, maybe 35 people on the program throughout TI. If you remember we used calculators and other things to bribe but there's not much better incentive than you have the opportunity to break through the state of the art. You have the ability to really do something that's never been done before.

Remacle: Let's go back to the question about how was it received at CES?

Frantz: So we didn't know how well it was going to be received. So let me step just before CES because we finally decided we needed to show the product to the target audience, children, and we were in Lubbock at the time doing the design. And we got into this battle with our legal staff that before we brought the kids in we needed to put them under NDA and then they realized that you can't put an 8-year-old under NDA and so we put the parents under NDA. I kept arguing, "Look, we're in Lubbock. It can be on the front page of the Avalanche Journal and nobody would know. What's our problem?" And that was when we first saw the kids come in and it was on the simulator...t wasn't even on the real product…and just fall in love with it, just play, play, play, play. We said, "Oh, we must have something here." That was our first indication. When I took it to CES I chose not to run it on an AC adaptor. I ran it only on batteries which meant about every three or four hours I had to change the batteries. And the reason I did that is I

wanted to make sure nobody could accuse us of having it on a desk and underneath was this huge computer making it all happen. It was what it was. And I also wanted to make sure they either had to conclude that we had actually solved the CB radio thing and were radioing the stuff in or that it was actually working. And they let me go, not because I was a marketing person. They let me go with soldering iron in hand to fix the Speak & Spell to keep it in production or keep it moving at the CES. But it was a huge hit at the CES.

Remacle: Did you have to use the soldering iron?

Frantz: Nah. I figure if they wanted me to look like a technician I could very well do that.

Remacle: What made it a hit? I mean it was a hit in what respect? It was just cool? The speech worked?

Frantz: There were a couple things we did that ended up being very surprising. One, we went to an educator, one of the leading educators in the United States and said, "Okay, we need a set of words for preschool through third grade" and he said, "There is no such thing, because in first grade you learn to read. Second grade you learn to write. You need both of those skills before you learn to spell." Well we were creating a product that needed neither of those. And he said, "Secondly, you're going to teach spelling by rote memory and that's not the way they do it in school. I suggest you not do the product." And he had a third reason. We had all capital letters and he said, "Children do not learn to spell in all capitals. This is a bad product. Do not use it." And then he said, "But there is a set of words that don't follow rules that you have to learn by rote memory. If you had those words in the Speak & Spell you could actually increase the IQ of the student." Well, that's what we were looking for and so he gave us the word list and we put it in, and our marketing guy was all excited about "We're going to put that right on the box." I said, "No, you're not. The last thing you want to do is put it on a box that a kid can read 'This will make you smarter.'" So that was one side. It had a good set of words to learn.

Secondly we added play value by other games, so the child could play other games. There was this, you type in a message and you can hit a button and it would put a secret code on it. It was a simple secret code method so that what you typed in would go and then come back to the same thing. It was really straightforward. One of the things on that is at one point after we had it in production, just started production, one of our marketing guys said, "What happens if little Johnny types in his name and it comes back a dirty word?" We hadn't thought of that. So several of us went to the cafeteria with our Speak & Spells in hand and decided the right way to do it, since it was straightforward one path to the other that we'd just type in the dirty words and see did it come out close to somebody's name. And we began to see people gathering around us and we forgot that as we were typing in the dirty words it was speaking the words to the whole cafeteria, and so we had quite an audience, but it didn't so that worked out well. But the kids loved it. We were surprised that the educators loved it because it was a friendly product. We used a male voice for just a totally wrong reason.

Remacle: I would have thought intuitively you would have picked a female voice.

Frantz: The synthesis was not mature enough to do female voices and I could go through that and just make people mad, but we found a male voice that was a very kind male voice, similar to mine.

Remacle: Mr. Rogers?

Frantz: No, no. It was a radio personality in Dallas. I can't remember his name now but he spoke very nicely and so what the product would do if you couldn't spell the word it never got mad at you. It would very calmly say, "Wrong, try again." And teachers wanted us to put a little file in there so you could keep track of the students' scores. No, the Speak & Spell never ratted on you, never told on you. It was a very kind male voice that said, "Now try" and go to the next word.

Remacle: How long was it in the market?

Frantz: The first year in the market was 1978 and it probably was in the market— well in some version still is in the market. We sold that business off to Tiger Toys I think ten or 15 years later but it became a staple in the market.

Remacle: What were the key evolutions of the product as it aged in the market and got more and more customer feedback?

Frantz: Yeah, it took on its path. The product I created had little round keys, the stick up keys, but there was a mechanical problem. By the way, the person who actually did the mechanical design for the case and all the plastics is now the CEO of SMIC, one of our largest IC manufacturers in China, Richard Chang was one of my engineers. His first design was the Speak & Spell and so there were a few things that were a problem. The keyboard was a problem, and then it went to a flat keyboard that I don't like because it didn't give you the tactile feedback and what you're really wanting. So it evolved on its own but the more important evolution or the direction it caused was to the DSP community, the research community who saw that the first real useful product of DSP was a toy that we sold for $50.

Remacle: That's an insult?

Frantz: Not so much an insult as, wow, if it can be used in a toy what else could we use it for?

Remacle: Ah, okay.

Frantz: So it became an enabler. Now if you go back and remember what TI did for the transistor was to created the first transistor radio with Regency and so there is this kind of inside philosophy of the best way to demonstrate a new technology is with a consumer product. The calculator, big success on proving the integrated circuit or the micro controller being valuable. Speak & Spell, proving the DSP was valuable. Several years later, the cell phone, showing that you could combine everything to do wireless. In all these cases that ended up being a consumer product that was kind of the poster child for the technology.

Remacle: Did you have any competitors for Speak & Spell?

Frantz: No, not at all. It was one of those things. It just caught everybody off guard.

Remacle: And did you have the 'me too' products that came into the market afterwards?

Frantz: Several years, it took several years because we kind of held onto that technology.

Remacle: Was it the speech?

Frantz: The speech synthesizer was the key on that.

Remacle: Was the key technology?

Frantz: But there was a second breakthrough and at the time our memory devices were 128K ROMs and that was in 1978 and if you go back to 1978, the largest memories at that time were 16K.

Remacle: So again it was an example of the interaction between the semiconductor side of the house and the product side of the house?

Frantz: Yes. When I talk to people now about innovation I say, "There are two ways to innovate. There's 'innovate in the research lab and push it to the market' and the other one is 'I innovate in the market and pull the technology through'." And the Speak & Spell was really innovation in the market. If we could teach children to spell using speech and that pulled through the technology and that's a much easier way in my view to get innovations out because you've done what I learned in my MBA, the difference between gee whiz technology and valuable gee whiz technology.

Remacle: Did TI over the years move more toward the market side or have they remained in the more balanced approach? Some products are driven by the technology and some are driven by the market or the interaction of the two?

Frantz: It's a little bit of interaction of the two and you have different areas. We still believe in "build a better mousetrap and the world will find their way to your door". So that's a little bit of the ego I think of the semiconductor business of "Gee, if everybody knows I'm at 40 nanometers they'll really buy my product." Well nobody really cares but that's okay.

Remacle: You're right. It is a semiconductor mindset.

Frantz: Yes. And what I had in the DSP division when I was in charge of the applications engineers, all of my apps engineers, I tried to bring in as systems people and so we went and talked to garage shops. We talked to the innovators and if you think about the innovators in the mid-1980s that were using DSP, let's see if I can list them. There was DSL and cable modem were being innovated in the mid-1980s. The voice band modem was going through great innovations during that period, digital TV, digital audio, digital still cameras. Those were the things that were being incubated in different companies all of which needed some sort of a signal processor to actually do the work.

Remacle: Why don't we stop here and start with the story of Speak & Spell and Fred Bucy?

Frantz: That's one of the stories that I really don't tell often because it can only get me in trouble, but anyway when we first had the Speak & Spell up and running on a simulator and it kind of goes along with the story of having all the children in, we decided it would be good to take it to Dallas and introduce it to the board of directors so they could see this new innovation that was going on in TI and kind of get some momentum behind it. And so we flew the simulators on the corporate jet to Dallas, set them up next to the board room and the way I had learned to demonstrate because now I had done it several times, there was one part of the product where it was called "Say It" mode where it would just start saying the ten words it was about to give you to spell. Now the reason we did that is we felt that speech synthesis was so bad that they may not be able to figure out which utterance went with which word. And so if you had this Say It mode you could see the word as it was being spoken and then it would come through again and have you spell those words. And so that helped and as a demo I would start on "Say It" mode and then explain what it was doing and what was going on. I had never met Fred Bucy, our CEO up until that time ,and Fred was there and I hit "Say It" and it started speaking and I started telling what it was doing. And he looked me in the eye and said, "Would you please shut up and let me listen to the Speak & Spell?" Now I never considered that a good first impression, but I didn't get fired on the spot, lived through it, and I can tell other stories.

When we introduced it at CES it showed up on the Today Show. We had a demo board to show off the technology and we had decided, for good reason, not to obviously have Texas Instruments anywhere on the product. It was there. It just wasn't obvious. And so Fred sent an email. We had email at the time to all of my management and me and said, "Nowhere did it say Texas Instruments on that. Who made that decision? And, fix it." And so we worked through that and if you look at the Speak & Spell now it has a blue Texas Instruments bug down in the lower right hand corner and "Texas Instruments" is on the display window in gold lettering.

Remacle: That grew out of that experience?

Frantz: Grew out of that experience, yes, and I was relatively unhappy because I knew the reason we had done those things and they were both good reasons. And so I assigned him the task of determining how to do that. And I remember a lot of people saying, "Boy, you're gutsy assigning the CEO to the project as a line item on your action list." I said, "He's the one that wanted it changed. He can change it."

Remacle: Let's talk about the transition from Speak & Spell to DSP. You alluded to it earlier.

Frantz: Yes.

Remacle: Introduced it a little bit earlier but carry that through a little bit more.

Frantz: Sure. Once you could demonstrate that DSP might have value to a broader audience than the military. We as a corporation began to look at the next generation.

Remacle: What was the value to the military that was going to carry forward, or not, into the commercial market?

Frantz: Well, when I talk about DSP just in eras, once again in decades. The decade of the 1960s, DSP was a university curiosity, a lot of stuff going in university labs, nothing really happening useful. In the 1970s, the first early adopters were military who could afford the very, very expensive circuitry to do signal processing and that's where it was determined that the cost of integrated circuits and the technology of integrated circuits was not capable of actually doing everything they wanted it to do. And what Speak & Spell did was say, "Ah-ha, yes it is." Not only did we do it in one integrated circuit but it was PMOS. At one point we had, I don't remember what country it was from, but we had a military group come to us to talk to us about the product and their first words out of their mouth were, "We feel a little strange coming to a toy company to talk about technology but could you tell us about the Speak & Spell?" And so it became that opener, eye opener of what else could we do? If you can sell it for $50 what else can we do? And so we in the consumer group began the next generation device to do speech recognition. And in the semiconductor group they began to do the next generation device to do speech recognition and speech I/O and ended up we killed our project and went on with the semiconductor project and that's the group I moved to in the early 1980s.

Remacle: So you left the system side of the house?

Frantz: Yeah and went to the semiconductor side of the house as the strange system guy in a semiconductor building and it was kind of fun to try to move us from a system made up of a bag of components thinking that way, to a system that really starts at the system and then you go down to figure out the minimum set of components you need to do the system and it was I just build components and they all fit or do I start with a system and design down?

Remacle: Was that a transition or a change that was occurring in the industry widely or was TI a starting point for that?

Frantz: Oh, I don't know much of the whole industry but it was a fairly new concept. You mean these going in a system?

Remacle: No, the decision is: "okay we're going to do something and now let's figure out what the minimum set of components are".

Frantz: What you're describing is the beginnings of a system on a chip effectively because the idea of system on a chip is "Where do I stick all these things together and how do I make it with a minimum chip count? What I tell people now is system on a chip is impossible?" It cannot be done and the reason I say that is in my calculator experience my (our) goal was to do a single chip calculator. We never did it. Now you may think, "Well yes you did." We never integrated the keyboard, the display and the battery onto the chip. And what I tried to get across on system on a chip is it's better noted as subsystem on a chip because by the time I get the system on the chip it becomes a subsystem of a bigger system. And as I see technology today where digital is going down to one volt then my world's going higher in voltage. And as we look at the analog circuits which need hundreds of volts how do we integrate that onto the same circuit when two or three volts will kill it? And so that's that whole system going to a chip rather than a chip going to a system. And we begin to drive at least in our DSP division of let's talk about the system and then figure out what device goes with it and how do we work them all together.

Remacle: So where did you fit in, in the design process on the semiconductor side of the house?

Frantz: I actually didn't fit in at all officially because I had the applications team. We were just trying to figure out how to apply and support our customers.

Remacle: Well I guess I didn't mean fit in with the design but kind of how did you—

Frantz: No, no, and I'm right down your path.

Remacle: Okay, good.

Frantz: Because that's how we were set up. When I joined the organization we did application reports but nobody's name went on the application report. It was done by "Texas Instruments staff". And I immediately said, "I want everybody's name on their app reports." "Oh, the headhunters will find them." That's what I want. I want my staff to be so sought after by headhunters that they know it's better to be here and be sought after, than to be pulled away. And so I gave them that ability to be recognized throughout the industry. Internally, it allowed us to gain our reputation with the architects of the devices and of the IC designers and so actually it was kind of the way we did it back in calculators where the IC designers, the system designers kind of all liked each other and worked together because that was the goal.

Remacle: What were the key accomplishments of the DSP group?

Frantz: If you begin to look at what we had, we had this brand new science called digital signal processing of which was only taught at the Ph.D. level in a handful of schools around the world. That doesn't make for a big market. We also found that the Ph.D.s who were graduating from college and wanted to do something in the world of signal processing were not going to large corporations. They were starting up their own little companies. In fact, I've since then made a comment that innovation is inversely proportional to the size of the company and I think that's still true today, but we found that to be true. So we had two significant problems. One was there weren't enough Ph.D.s in the world to be a market; and,

two, the few that were out there had started their own little companies. And we began a journey of finding three or four universities that we could work closely with to begin to push the education of DSP down from the Ph.D. level to the Master's level to the senior level undergraduate. Now the latest is DSP is being taught in high schools. And so we have moved that education down because we needed a larger group of people, not for us, but for our customers. And so our intent was in one sense for the better good of the industry how do we get more signal processing savvy engineers into the world to use our products? So that was one. The second one is once we realized it was the small companies that were doing innovation, we set up a network we called the "third party" network, where we had a strong relationship with these little, bitty companies and worked with them to grow.

Remacle: How did you work with them?

Frantz: There's a lot of things you can do with a little company because usually a little company has a lot of talent, a lot of capability, but doesn't particularly know what things are happening. And so we could go to them and say, "Here's a market. Here's something you can do." One of my favorite stories is we were working with a little company by the name of Loughborough Sound in England and at the time the PC was not the place you did development on and we were introducing the world to using a PC to do the development and we were wanting to put a hardware board in the PC for the emulator.

Remacle: Let me just back up and clarify. They were using development systems?

Frantz: They were using VAXs. They were using mainframes or minis. And so this was the first real big transition into a PC. And so we went to Loughborough Sound. We said, "You need to do a plug-in board to a PC that would be the emulator" and they said, "But aren't you designing one also?" I said, "Yeah, yeah, yeah, but just go ahead. Don't worry." They said, "I don't know." I said, "No, no, just don't worry. Just go do your board." I think they had a design that only cost them 1,000 pounds to design the board and they got it in production. They were selling it at 2000 pounds. No. It was-- They were selling at 1000 pounds so it was about $2000, worried stiff that as soon as we introduced ours we'd drive them out of business. Well, as usual, a large corporation delays, delays, delays, delays, delays, and they had a couple of years of nothing but them selling it and TI saying, "We're going to come out. We're going to come out, but if you need it now go to them." So we were their marketing staff.

Remacle: How did big companies like TI and how did TI specifically, foster innovation and keep innovative people engaged inside the corporate walls?

Frantz: Yeah. Not easily. The trouble with innovation is you can either see it as something that the immune system needs to kill off, a virus, or you can see it as this group of stupid people that don't really understand where we're heading. They're just not part of the company, and that's why I said earlier that every decade or so TI has reinvented itself. You hide it until it grows big enough and then it becomes the corporation, and the first time we heard that- for example that there might be a digital cell market it was from one of our European managers, and the first time he presented it to us, if we could have strung him up we would have.

Remacle: The reason for that would be—

Frantz: That is the dumbest idea we have ever heard. Why would anybody want to do a digital cell phone? The cell networking is working fine. And I listened to him and began to talk to him and we went underground for about a year or so, him working in Europe and I began to build a business unit in Dallas. The way I built it I was needing to have a contract signed off to have the U.S. standard software written on our DSP so I was in with our now CEO Rich Templeton early morning, seven o'clock, saying, "I need you to sign off this contract." And during the meeting he said, "You know, we probably should start a business unit in doing cell phones and it needs to start in Dallas." We were in Houston at the time so I called a friend of mine in Dallas, Mike McMahan, and said, "Mike, do you want to start a business?" He said, "Sure." So I pulled him into my call center, took one of my marketing guys, started a business unit, and a couple of weeks later I got a note from- or I think actually Rich called me and said, "Gene, what have you done?" I said, "What do you mean what have I done?" And he said, "The head of our research center caught me in the elevator and said, "That is brilliant, starting a business unit on wireless," and he said, "I didn't know we had started one." I said, "Oh, okay. Yeah, we did." And so we started it, but the fun of it is my first job as running the business in the U.S. was to win Motorola. Gilles Delfassy, who was the guy in Europe I was working with, his first job was to go win this little unknown company called Nokia. And you can kind of look at the history and say, "Well, Nokia was the one that took it over and made it happen." Well, they were the startup. I had the well-established company, who every time I'd go to them and talk to them, they'd say, "Who are you? We don't need you," very politely, very- with great integrity, but still “we don't need you.”

Remacle: This is Motorola?

Frantz: Motorola, and I say that because I had a lot of people inside of TI who said, "Don't even talk to Motorola 'cause everything you tell them they'll tell their semiconductor group and you're just telling our competitors what we're doing." And I found Motorola to be of highest integrity and so I kept saying, "No. I will talk to them because I don't see them telling me anything about anybody else's parts and I'm assuming they'll have the same integrity with us." And I was just making an aside. Motorola was a great competitor.

Remacle: On the semiconductor side.

Frantz: On the DSP side for me, and the reason I say that it was a great competitor: They were good. They were ethical. We could go nose to nose and have a good fight and I loved that.

Remacle: Who were the other DSP competitors?

Frantz: We had AT&T, ADI and—

Remacle: ADI is Analog Devices?

Frantz: --NEC. Analog Devices and NEC were basically the competitors at the time, but the one I respected most was Motorola 'cause as soon as they figured out they wanted to do it they were hard to beat and I like that.

Remacle: What besides cell phones? What other applications, going back to the original question about what the military was fishing around—

Frantz: Well, we always had military, but when we came out with the 32010, our first DSP, general purpose DSP, we aimed it at the voice market, text to speech, voice I/O, recognition, vocoders, what we noticed one day is that our market were actually using them for modems, hard disk drives and video accelerators, 3D accelerators. And we were kind of blindsided by that and so we went back and changed all of our marketing literature to say we designed the 32010 for hard drives, modems and 3D graphics. That was the wise thing to do and then went off and did our second generation to try to do better at those three, and once again our market blindsided us with new things. And so what we found that made this- the signal processing world fun was that our customers were more innovative than we were, and I had dinner with a friend of mine who was my direct competitor at AT&T, my direct competitor as an individual.

Remacle: A personal direct competitor?

Frantz: And every time we'd go to a conference we'd go over in the corner and talk about family, talk about friends, because the market was growing so well and doing so well that we, as competitors, could be friends and that made it just a fun—

Remacle: How big is the DSP market today?

Frantz: Well, it depends how you call it, and the reason I say that—

Remacle: I'm thinking the number of units shipped, total revenues—

Frantz: Sure, and the trouble you had with that is, as I've tried to explain to our management in TI for several years, we've moving from TI as- or DSP as a product to DSP as an enabler to every product that goes out. And so now it's hard to tell that because you have a lot of FPGAs that are doing DSP, you have a lot of microprocessors doing DSP, you have a lot of microcontrollers doing DSP, and I have to go back to what I told our salespeople very early. You want to know whether they're doing DSP. If they need an A to D or a D to A they're doing DSP but it doesn't mean they're using a digital signal processor, and so now as we move forward in the industry it's less and less you can tell what a DSP is and what that market is and more and more you find that it's just a significant part of what we would now call embedded processors.

Remacle: Is that reality driven by the ability to design and produce ever more complicated chips or is it driven by customers saying, "We have to have this functionality on a given chip" or once again is it kind of a combination of—

Frantz: So it's back to what I said, the innovation. Was it the market that pulled the innovation or the technology that pushed it? And then one of the examples I give is 30 years ago computers were in big rooms. Now they're in our pockets. What—

Remacle: And they're much more powerful in our pockets….

Frantz: What was the innovation that got them to our pockets? And it wasn't technology. It was somebody figuring out why we as a society needed a computer in our pocket, and so you begin to see as customers begin and users begin to say, "I need to be on the internet. I need a modem. I need DSL. I want mp3. I want that kind of music," until that happened, we had the technology but what drove it was the pulling out of "I need it and, I need it in my pocket."

Remacle: What were the key challenges in getting the DSP broadly accepted? Was there a key customer that shared your vision or how did you get over that early product hurdle of who's going to buy this thing in volumes as opposed to play around with it?

Frantz: And it's just you didn't-- If you think about we were fairly naïve as a society on what I could do with a signal processor because they just weren't taught at that level, and most of the places the innovation were going on were small companies trying to get a start, you had that working against you. You had continually working against you the management not understanding what can I really do with this, what is it really good at, what is it not good at, and so there was this- just this chaos of forming up what could happen. In the mid-1980s we spent a lot of time, I and my application team, being more marketing people than technologists and going to a customer like a DSL and saying, "Oh, yeah, yeah, yeah, but we can get you some signal processing to do that" or an example I give in lectures is the answering machine. There was a ten-year period, maybe 1985 to 1995, in that range, where at the beginning of that period if I had an answering machine and you called my house you would say, "How rude of him to have an answering machine. I didn't want to talk to a machine. I wanted to talk to him. Should have just let it ring." A decade later—

Remacle: You're irritated if they don't have one……

Frantz: --if I did not have an answering machine you would say, "How rude of him. At least I could have left a message," and so it was that decade where we began to have the science but society wasn't willing to accept it and then they accepted it, and you can see that with the cell phone, you can see that with the internet. You could begin to see that what slows us as much as anything is society's acceptance of the technology.

Remacle: And in your opinion what is it that forces or enables society or individuals like me and you to say, "I really can see how important that is to me or how valuable that is to me."?

Frantz: So these things called early adopters or these- I shouldn't say things. These people called early adopters that like gadgets and we're seeing a few right now. If you look at something like Kindle, still not the first time eBooks has been brought up as a good idea, still then that experiment. I have in my briefcase, didn't bring it in to show you, but I have a cell phone with a projector on it, and so I can project on the wall with my cell phone as if I were in a home theater or in a conference room with a projector. And so what would you do with that? Who in the world is crazy enough to walk around with a cell phone with a projector? Okay. We're early on that one. It's going to be early adopters like me. When TiVo came out in the late 1990s I had a TiVo, I think the first month it was available, and I had a friend of mine who I said

to him, "Mike, you need to have a TiVo," and it was two weeks of him and I having this long discussion or many discussions over the phone with him saying, "Why? What's the good of a TiVo?" And I finally just said, "Mike, buy it. Quit asking. Just buy it," and he was amazed at what it could do once he had it, and so it's the early adopters who look at it and play with it and begin this word of mouth push-out of gee, you got to have this; this is neat.

Remacle: I think there's another thing, and I use myself as an example and I want you to comment on it: Cell phones. I was not excited and then I got my first cell phone in probably about 1993 and it was the Motorola Brick, and it was five or six hundred dollars, and what pushed me over the line was I heard an advertisement talking about salespeople who were on the road and needed to call a client and that's the way I lived. I was a consultant and I can see the utility in that, and then once I had it--

Frantz: And state law has not allowed us to do that now.

Remacle: Of course not, but my point is I could see how I would use it as opposed to somebody saying to me, "Rosemary, that's cool technology." What role do you think that kind of application specific, speaking directly to a problem that I could recognize—

Frantz: Well, but those are early adopters when all of a sudden as a user, not as a technologist, you say, "That solves a problem. I'm going to get that," and then you probably were not quiet in telling everybody else, "Do you know how this has changed my work day?"

Remacle: I became an evangelist very quickly.

Frantz: Yes. All that free paid advertisement that somebody got, and that happens and in a sense that was- we very quickly realized that it wasn't our selling to DSP designers, designers of signal processing systems, that was going to win. It was how do we get out to the end user, and so we had to partner with these little companies, partner-- I don't know. My legal guys hear me and they say, "Don't ever use the word 'partner,'" but partner in the sense of I needed to be a good vendor to them and they needed to be a good system designer and together we needed to go out to a market. I'm doing one right now with a little company in Israel. The first time they came to me, they had a camera and a PC and as we were sitting there about the distance we're far apart right now, about, well, three meters, and he pointed the camera at me and said, "Your blood pressure is so and so and your pulse rate is so and so," and with a camera he could read my blood pressure and pulse rate without ever getting close to me. And you look at that and you say, "That's just got to be the craziest thing in the world," and it is but he's now almost ready to take it to market. And over the years you see- I've seen a lot of those crazy ideas and you say, "Wow. That's going to be neat." And so that's been a lot of what's gotten us there is these very, very innovative guys- engineers who have created products and then somehow we and they and other people helped get them out to end users for the end users to finally say, "This is neat. I'm going to take it."

Remacle: Do you consider yourself an entrepreneur?

Frantz: I prefer to call myself an intrapreneur 'cause I'm within a corporation.

Remacle: To extend that, an entrepreneur in your mind is somebody who takes his idea and goes and builds a business around it?

Frantz: Yeah. I think the idea of an entrepreneur could go multiple ways. One is being able to take on an idea and know it's a good idea and move it forward and then to get it out the door for other people to take on. I tend to walk away from them when I found people with passion who really wanted to make it happen. As I tell people, “I stir pots; I don't make soup”. And so I spend my time finding who are those guys that can pull it together, encourage them, play cheerleader, play blocking guard, whatever it takes to get them to a point where they can kind of take it out to market.

Remacle: Before I move in to a different strain of questions, are there any other either incidents, stories, anything else we want to get down for the historians of the future about the DSP and TI's role in the DSP?

Frantz: Oh, I think if there's anything that I'd like to say about Texas Instruments, I said earlier that we do a lot of underground work. The greatness I think of the corporation is our corporate fathers know what's going on and allow it to happen so it isn't a secret handshake organization that is the under belly of the company. It is an allowed innovation process that goes on.

Remacle: It sounds like it's built in to the corporate culture.

Frantz: Yes, it is part of the corporate culture and it's not spoken of, so you won't find a process, a procedure, that says this is allowed, but what you find is this going on and one of the jobs I take on in my position is to encourage the innovators to keep the managers informed and let us all win together. And so maybe that's not always been entrepreneur but it's that idea of how do I handle that. Sometimes I'm the champion of the entrepreneurs and sometimes I'm the entrepreneur. We're doing one right now that's kind of fun, where we're probably turning in a patent disclosure a week or so right now, and this new concept that we're trying to get out and the hardest sales job is not to our customers. The hardest sales job is to our TI management.

Remacle: Here in Silicon Valley it's a little bit unusual to talk with somebody who's spent his entire life inside one company. Of all the experiences you've had, what has been the most exciting, challenging, rewarding?

Frantz: Yes, and I'll give you an obtuse answer: The next one. And I've been at TI for 35 years now but I've not kept the same job more than two years—

Remacle: That's one of the advantages of a big growing company—

Frantz: Of a large corporation is you're allowed to move from place to place, and so what I've found I'm good at is stirring the pot, getting things moving, and then handing them over to a business team that can go make it happen and then I get fired. I tell people I get fired when two words come up in conversation: Schedule and profit. Not good at either one of those, but my management knows what I am good at,

allows me to do that, fires me, which allows me to go to the next one. And so I'm not a-- You can call me a serial innovator because that's what I do well, is go for the next one that's laying there, and so I've seen the educational products of TI. I've seen the calculators of TI. I've seen the DSP. I've seen the wireless. I helped start our DSL, our cable, our audio. As a friend of mine said, we had our fingerprints all over them. They may have forgotten we did it, but they can't wipe our fingerprints off of it, and so that's the fun of that job.

Remacle: Is there any one project or action you've taken of which you're most proud?

Frantz: See, once again I grapple with that question because I really believe that one's still yet to come, and it's when I lecture the young engineers and tell them, "You may think that all the fun is over, that all the fun stuff has been invented. No. The greatest inventions are yet to be had." I want to be part of that.

Remacle: Let's take the future off the table, and of the things that you've done so far is there one that you're most proud of?

Frantz: See, and the reason I have trouble going back is yeah, when we introduced the Speak and Spell- when we started the Speak & Spell program I was 27.

Remacle: A mere baby.

Frantz: When we introduced it to the market I was 29. The other-- Two of the other three were I think-- Larry Brantingham was my contemporary so I think he was probably near 29 or 30. Richard Wiggins was a few years older. He was 31 or 32 and our boss was the old guy in his late thirties, and you look at that and you say, "Why would a corporation let a set of kids go make this breakthrough in the state of the art?" And you look at that and you say- you- somehow you have to be proud of that point of as a young engineer having the privilege of doing something that had never been done before. I use that now in our- to our management because now young engineers in their twenties are not allowed to go innovate. You need to prove yourself first, and yet we were allowed to go do this crazy thing.

Remacle: More than allowed. You were encouraged it sounds like?

Frantz: No, we weren't, in a sense. The thing that allowed us to do it was our management was so certain it was going to fail they backed off but they let us go. There's a difference between killing it and saying, "I'm pretty sure it's going to fail but I'm going to let them go try it anyway. They're smart enough to know when it's dead." And so I brag on my management because they walked away; they let us innovate.

Remacle: Is there anything that you would do differently? If we had that magic wand we all could wave and say, "If I just hadn't done that or if I'd done that in a different way."

Frantz: Oh, yeah. There are some business starts that we faltered on that I screwed up and I screwed up because I allowed management pressure to push me away from what I knew was the right thing to do, and a few of those. That irritated me, but . . .

Remacle: Can you give me an example of one of them?

Frantz: Yeah. We did a product with this little company called Worlds of Wonder and it was a doll, and the doll had speech recognition and so she talked and listened and that was- I think that it was- she was introduced in 1987. And nobody was doing- nobody was close to doing that. In fact, I think she was shipped with an export control license on it. She was so interesting because she could talk and listen and carry on a complete scenario. The follow-up device was going to be a DSP with the A to D's and the D to A's integrated. Then I let my management talk me out of that device and that would have been four or five years before anybody else had ever done it, and that frustrates me because it held us back from the real goal. The real goal is not to be the greatest DSP manufacturer. The real goal is to be the best partner to a system company that you can be and that includes the ability to integrate analog, digital, RF, everything that's necessary at the right level for the customer, and that didn't allow us to do that four or five years earlier as it should have been done.

Remacle: Is there anything else that I haven't asked you about that you've covered in your career and your experiences that we should put on tape?

Frantz: Let me just go back to the thing we did with Speak & Spell. We did it with a language translator. We did it with the text to speech on a home computer, and it's one of those difficult issues and that's having-- Speak & Spell was out and the people from the repair center came over to me and said, "There's a person on the phone- a lady on the phone that's unhappy with us," and I said, "Why?" And she said, "Her son was spelling dirty words on the Speak & Spell and could you talk to her and explain why?" And so I first said, "Well, did he spell them correctly? That is its purpose, and secondly I would love to have a discussion with this person about parental guidance." And he said, "Oh, no, no. We don't need you. We'll take care of it." Later on when we did the home computer with text-to-speech, we chose not to restrict which words could be spelled and which ones couldn't, and so if you spelled an improper word, a dirty word, it would pronounce it correctly because that's the purpose of the product.

It was not our purpose to decide the moral value of the product. It was our purpose to create the product, and so what I chose us to do was not be the defender of the morality but to be the creator of the technology, and you say, "Well, was that the right thing to do?" And it is that difficulty in the ethics of engineering: “when do I cease to be an engineer and begin to be somebody who decides the best use of it?” And that was the something I learned through those products. If you'd get an early Speak & Spell, it doesn't have an AC adapter on it because I decided that a child---preschool through third grade--was not old enough to use power, plug things into the wall. You can tell when I was taken off the program because somebody else put an adapter on it. We killed the language translator that we did, and it was a very good project, because it had troubles with P's and T's and we had a language translator for Japanese to use in the United States- Japanese people to use in the United States and the word "ship" just didn't quite come out right. And we shut the program down because we wouldn't make that an obvious issue, and so it was this whole area and the word still escapes me.

I refused to be a censor with what the technology could do. My job was to create the technology.

Remacle: How did the fact that TI was the largest semiconductor company in Texas for a long time and must be still be, impact your ability to attract and retain really good people both positively and negatively?

Frantz: What you learned is you could hire people out of University of Texas, Texas A&M, Southern Methodist, so all the schools in Texas were pretty easy to pull engineers out of. Texas Tech I guess I should include. And so you could build engineers that way, but if you're wanting to be a world class company and all of your technology comes from just a few schools out of Texas, you're handicapped so you try to go to places like MIT, Stanford, Berkeley, Cal Tech. You try to get all of the great schools to get students, and what I learned is there is actually a set of students that go to those schools that want to live in Texas. They really do like that and those are the ones I'm looking for. There are others that they want to stay on the East Coast, there's others that want to stay on the West Coast, and so you build your team with the best talent that wants to live in Texas. And it's really not hard to do that because there are a lot of people that kind of like Texas. Our houses are probably four times as big for the money. There's a lot of advantages.

Remacle: What about the rivalry that exists in the minds of some Texas semiconductor people against the [perceived] arrogance of Silicon Valley?

Frantz: I like rivalry. As I said earlier about Motorola, I like a good competitor. I like to have that rivalry going on, and this is the fiftieth anniversary of Jack Kilby's invention or Fairchild's invention of the integrated circuit. I don't mind that rivalry.

Remacle: Isn't that a really good example of the messiness of innovation, that if it's a big problem people are trying to solve generally speaking there are people working in parallel?

Frantz: And the way we work things they- it may be more parallel than we think because we all show up to the same conferences, we all show up, read the same literature, and you find out after a while a good idea escapes whether you like it or not. And you look at that and you say, "Well, which is more important? Arguing over the past or looking to the future?" And that's why I say I'm always looking to the future. When DSP at TI turned I think 15 or 25, one of the milestones, and our public relations people said, "Gene, can you talk about where we've been?", and I said, "Let me explain. Let me start by explaining. When you ask a young man about his life he talks about his future. When you ask an old man about his life he talks about his past. I will not talk about my past." And we're still a young industry, and that's why I said earlier the greatest was yet to be and I do that because it's easy to live in the past. It's more fun to go look for that future.

Remacle: How do you see the importance of the role of a place like the Computer History Museum in that scenario you just painted?

Frantz: Sure. The past is important. We need to understand the past but the past should be an encouragement and excitement for moving to the future, and we need to have those things, to go to a

museum and see Mozart's work or see William Shakespeare's work. It isn't there just to show that we had a past. It's there to say you understand that they were in their period of time, revolutionary. We can still do that, and so I always look at that as how does that help excite me to move to the future? And so when I look at the Computer History Museum I look at a place to go look at some of the great men and women of whom we are standing on their shoulders, and it's not our job to celebrate them but to allow them to encourage us.

Remacle: On that note, thank you so much for your time. We really appreciate it.

Frantz: Well, I enjoyed being here.

[The following segment was captured after the interview was formally completed]

Frantz: So my job in the 1980s was to go out and find new businesses for DSP, and one of them was digital TV, and I and three other people at TI started visiting TV design companies to talk about how they could use DSPs in their product. And one of the things, we had a DRAM organization inside of TI at the time, and so one of the four of us was the DRAM engineer who had just created this thing- new thing called a F-RAM, field RAM, me, the DSP guy and two of the field salespeople. So we went to customer to customer and the customers started saying, "But your field RAM doesn't do what we want," and so driving between two customers--I think it was between Zenith and RCA--we invented this thing we called an improved field RAM. Now field RAM was just a big buffer, a FIFO. You started sticking stuff in and then you started taking it out in sequence, and what we decided the customer needed was this big FIFO but you could have two pointers, one where I started to write and the other one where I started to read and they could be independent. And we turned in the patent. I wrote it up, we turned it in and had a real struggle because oh, “What's so new about this idea?” So we struggled, got it through the patent office. About three or four years later one of our patent lawyers called me and said, "Remember that patent on improved field RAM?" And I said, "Oh, gee. We're in trouble again?" And he said, "No, no, no. We've looked at it and it seems to be one of the earliest descriptions of a synchronous DRAM so we're going to use that now to create a portfolio of synchronous DRAMs [patents]."

Remacle: How many patents do you hold in total?

Frantz: I hold I think 44 or 45, not a whole lot for people who have done a lot of patenting but—

Remacle: As somebody who has zero, that sounds like a lot to me.

Frantz: Of course, but it's one of those things where we had these now portfolio patents, synchronous DRAMs, DDR, RAMBUS, all based on this old idea of how do I make a DSP work in a TV? And so there are these things where you're looking in this direction and really you innovate over here, and so that was one of those fun ones.

Remacle: Thank you.

END OF INTERVIEW

