Oral History of Charles Phipps

Interviewed by:
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Rosemary Remacle: Why don't we start with some of your personal background-- how did you get to where you are today, your family, school, so forth. And maybe we should really start with where are you today?

Charles Phipps: Where am I today?

Remacle: What are you doing career-wise right now?

Phipps: Well, I'm an Emeritus Partner at [venture capital firm] Sevin Rosen, which means I have a few companies that I'm continuing to work out, and I sit in on the staff meetings and review the activities at newer funds, and some of the projects which they are looking at. In addition, in the past year, I continue currently to be a consultant with Hunt Energy and their venture activity. It's a newly formed venture activity focusing just on energy and energy infrastructure as apart from the traditional venture activity they've pursued for the past 20 years, which is very similar to Sevin Rosen's orientation. So those are the main two activities. In addition, I'm on visiting committees at Case for the engineering school and at the University of Wisconsin for the business school, and we have meetings several times a year with those activities.

Remacle: Then let's start with where were you born, parents, schooling-- all of that kind of stuff.

Phipps: I was born and largely spent my youth in Northern Ohio, in various cities. My father worked for a railroad, and he had hope for a college education after World War I, but his family couldn't swing it. So he started to work his way up in the railroad, and eventually became president of the railroad in the early '60s. He was on the operating side, which means that we would move every few years to a different division point, or location. So we lived in cities between Chicago, Fort Wayne, Fostoria, Cleveland, and Bellevue, Conneaut, Ohio. I went to high school in Conneaut, which is...

Remacle: I've never heard or Conneaut, Ohio.

Phipps: It's on Lake Erie, right next to the Pennsylvania border. Its claim to fame at the time was it was the home port of U.S. Steel, for the ore coming down from Minnesota. And it was linked by a rail line to the mills in the Pittsburg area, and they shuttled ore down regularly all through the shipping season. Conneaut, at the time, had about 10,000 people, and its industry was the docks, and the major division point, and car shops for the railroad. Since then, it's slipped into more of a quiet, almost bedroom community of about 5000 people, since the docks have largely closed, and the railroad no longer has that as a division point.

Remacle: So what were your favorite subjects in school, and how did you get on the path of engineering?

Phipps: I did well in the physics and sciences, which was mainly chemistry, and math. I started in a smaller school that didn't have the breadth of curriculum as a city school would have, certainly not as

schools have today. We stayed pretty much with basic courses. It was considered either a college prep courses, or vocational courses.

Remacle: I would imagine that since your father had wanted to go college and didn't get to go, that was an important thing for him.

Phipps: He was an important influence in what we did. I was really the first generation of the family of going on to college, at least on my father's side.

Remacle: You had brothers and sisters?

Phipps: Yes, I have an older brother, and he also went to Case, but he studied chemical engineering. He's a couple years older than I am.

Remacle: A very young man, in other words [laughs].

Phipps: Yes, yes. Anyway, it was about then my high school years were during World War II, and I finished up high school while the war was still underway. I applied at Case and was accepted in my senior year, but then went into the Army upon graduation. It was in 1944. It was the time of the AST programs, so my first six months was...

Remacle: I'm sorry, what is AST?

Phipps: AST?

Remacle: Yes, what is...

Phipps: Army Specialized Training Program. So I spent my first six months at Ohio University down at Athens in an engineering curriculum, as a freshman year sort of curriculum. The Battle of the Bulge occurred about that time, and we were all shipped off to the infantry and went through infantry training over in East Texas for about four months. By that time, things looked much better in Europe, so we were sent back to-- some of us were sent back to school. I was sent to Texas A&M here in Texas.

Remacle: When you say you were sent, did you have any say-so where you went?

Phipps: No. No,not at all.

Remacle: The Army said, "This is where you're going."

Phipps: "This is where you're going." We were sort of glad to get out of living in tents and bivouac and things in infantry training, and it seemed delightful to go back to a college campus..

<crew talk>

Remacle: I was going to say, this is your history.

Phipps: This is history, all right. So we spent another six months at Texas A&M, accomplishing much of my sophomore year of engineering. By that time, the war in Japan was over, and pursuing the transition to peace. I did not have enough time in to be discharged, so we were picked up and sent to the Central Signal Corps School in southwestern Missouri, near Joplin, Missouri. This was in the fall of '46 by now.

Remacle: Are you married at this point?

Phipps: No. No, fall of '45. Wrong year.

Remacle: So you were a bachelor.

Phipps: A bachelor. That's right. And we spent a good three or four months there in the radio repair school, and some radar school. At that time, the Army decided to close down Camp Crowder and the Central Signal Corps School. So we packed up the gear and the instruments and things, shipped them to Fort Monmouth, and then we followed by about a month to Fort Monmouth and unpacked it, and reset up that part of the school at Fort Monmouth.

Remacle: At this point, had the lexicon of computing entered into your universe?

Phipps: No, it hadn't.

Remacle: You're still on signals and...

Phipps: Yeah, radio signals and amplifiers and oscillators and things like that.

Remacle: So from Fort Monmouth...

Phipps: So at Monmouth, by that time, I had sufficient time that I was discharged in the summer of '46. When I got home, I found my father had already notified Case that I was coming and enrolled me. So as I recall, I got home about the first week of August. Case had a requirement that each summer you had to spend two weeks on a particular course. Between the freshman and sophomore year, they required you spend two weeks in a state forest at a surveying camp. So I remember I came home the first week of

August, and then the second week of August I was off to the surveying camp for two weeks [living in a tent]

Remacle: Did your father consult with you about going to Case and signing you up?

Phipps: Oh, he did when I was in high school, we talked. But from there on... It was a <inaudible>, you could say.

Remacle: It was ordained.

Phipps: Ordained, that's right. I essentially got all my freshman year credits from the Army courses. So I started Case as a sophomore, placing out ahead even in some of the sophomore courses. It was a time when the campus was filled with fellows returning from the war on the GI bill. We were all eager to get on with our education and get started working. So it was sort of a rush almost, to finish the courses. Probably not as thorough as it would be if it was not that environment.

Remacle: By now you were how old, 24?

Phipps: I was 21 at that time. I went in when I was 17.

Remacle: Hard to imagine.

Phipps: Yeah. So anyway, I would have done better if I had thought more about it, because some of the courses I took at Texas A&M in math and things were not as strong as they should have been, and some of it was more memory courses, and I jumped into the following courses at Case, which were more rigorous in training, and I struggled with my math courses there. I would have done much better if I had gone back and refreshed myself on the math courses. But I didn't do that. Even so though, I managed to graduate with honors at Case, having got some moderate C courses in math, but the rest of the courses I did much better in. By that time...

Remacle: So now you're ready to go out into the real world.

Phipps: Yeah, by that time, by my junior year or so at Case, between the Army courses, the Signal Corps, what they had and training for radio, none of them I deemed very challenging or exciting to me. It was more you could get through it either by memory or rote, or just by logic of figuring things out. At that time, electrical engineering was largely devoted to power, rotating machinery, transmission of high voltage. Had some controls, which were Servo controllers, a little bit of electronics, which was all vacuum tube circuitry. And at Case being in Cleveland, they had several courses in illumination, because of GE's Nela Park, which was their research and engineering in the lighting field. And I took several of those courses and enjoyed them. But because of the course selection, my history with engineering to date, I decided by my junior year that I was not going to be a practicing engineer. That was not something that I felt interested me. I began looking around, and in my senior year, I applied to Harvard for their graduate

school of business. I had enough time left over on the GI bill that that gave me a start on that. My father was somewhat against it. He felt I'd be better off with practical experience, which is the way he developed his career. Nevertheless, I took the interviews at Harvard. At that time, the dean of admissions traveled around the cities and you met him at a downtown hotel and interviewed one by one. I asked as many questions of him as he asked of me, and I was a little taken aback when he said in your first year the class sizes are generally one hundred persons.

Remacle: How big had your classes been at Case?

Phipps: In my junior and senior year, there were often 10, 15.

Remacle: So this was a big change.

Phipps: It was a big change, and I didn't-- for graduate work, I wasn't sure that was an environment of real learning, and I told him so.

Remacle: I'm shocked that you would do that, Charles.[laughs]

Phipps: I am too. [laughs] As a consequence, I got a letter saying they didn't think I was quite ready, but they were interested if I had some work experience, to come back and talk to them. So my professors at Case were closely aligned with GE, and I had offers from either the power field, from Dayton Power and Light, which I liked the people there, or from General Electric to go on their engineering training program, which was called Test Engineering. And I opted for the latter, on the recommendation from a professor.

Remacle: I was going to say, what was the tiebreaker?

Phipps: So with that, the Test Engineering program was the traditional entry point for new engineers at GE at the time, and it was a familiarization program. It was mainly...

Remacle: So it was like an education program?

Phipps: No, rather on their large apparatus-- their turbines, their motor generators, their high-voltage transformers-- things they'd been making for years for the public utilities. And all of this apparatus would go on a large test floor and be tested to the custom specs. It might be on the test floor for three, four, six weeks, doing specialized testing. So they used the new engineers to run these test programs, set them up and collect the data for them. And you had three month assignments at each location, then you would-- you'd say one, two, and three for what you wanted for your next assignment. They'd try to work it out that you'd get your series of assignment. And after a year or two, you were encouraged to locate with one of the divisions where you became acquainted with the engineers. Since I was uncertain about engineering-- in fact, I was pretty certain I really didn't want to be an engineer, but here I was. I brought my golf clubs with me, and at each location I signed up for second shift so I could play golf during the

day. GE had, at their old sites like Schenectady and Pittsfield, they had large golf courses, and they had a country club and clubhouse for the employees. So, as an employee...

Remacle: A big difference from today…

Phipps: Oh yes. I could play golf all day. All I had to do was pay for the golf balls. I'm not sure there was any charge. So that's what I did.

Remacle: Sounds like a pretty soft life, Charles.

Phipps: It was probably. My first test was in Pittsfield, Massachusetts on high voltage transformers. It made you respectful of high voltages. I got knocked out of the cage more than once by a short on the transformer in the pit below us. And you were soaked in PVC oils, was the insulating oils they put into it. You had to fill the transformer when it came off the assembly line using large hoses, crawling up on top of it, and at the bottom of the pit there was usually two or three inches of such oil. Today they'd be horrified, as that's cancerous. But you'd buy your work shoes and your khakis when you started, and you wore the same ones every day. After three months, they were so stiff from oil, they'd just about stand up by themselves. You just threw them out and went on to your next test.

Remacle: Where was the EPA?

Phipps: OSHA or EPA, or whatever.

Remacle: OSHA or EPA would be pushing back hard on that today.

Phipps: Yes, they would. So from there, I went on a specialized test assignment in Houston, Texas, which I didn't ask for, but they were in a fire drill. GE had entered the automatic washing machine market in a hurry. Westinghouse and Bendix were ahead of them with the tumbler type of washing machines after World War II. GE wanted to do something different, and they developed an agitating washing machine with a drive shaft, where the agitate and the spin cycle were all in one, and it had a hydraulic system where a relay would close the hydraulics and expand the bellows and lift up and disengage from the gears and go into a spin mode, and come back down again. It was very clever at the time. The only problem was that some of the major parts were failing rather rapidly, and they had gotten some million of them in the field, and they were beginning to come back. The drive units were warranted for five years at the time, and they were coming back as fast as they could make them, after about six months.

Remacle: That kind of cuts into the profit margin.

Phipps: It sure does. So we quickly had to set up repair stations at four locations around the country. Two of us were assigned to do that in Houston in a warehouse that GE had there. And we had looked for blocks by serial numbers. I remember the serial number below 64,000 we just threw away, and then

64,000 to 200 and some thousand, you looked for certain items. We started to repair them only when you got to serial numbers above 400,000 or 500,000,.

Remacle: How long were you at GE altogether?

Phipps: A little over a year.

Remacle: Sounds like a lot of jobs in one year.

Phipps: Yeah. From there, I went back to-- I was at Houston for six months. That was a longer assignment. Then I went back to Schenectady on induction motors. That was in the summer of '50. At that time, I got a letter from Harvard saying that they would be pleased to have me start the following fall.

Remacle: Had you reapplied, or did this letter come...

Phipps: I think I must have reapplied and then written them and updated my experience or something like that. Yes, there was some change. I don't recall exactly what took place. So I left GE, and departed for Harvard. I did not have a car, so all the traveling was by train from Ohio to Boston, which worked out well, since my father was one of the senior managers for the railroad. I always had a railroad pass on the thing. Harvard was a really more abrupt change for me, not only for the class size, but I was from a small town in Ohio of pretty modest means.

<crew talk>

Phipps: More modest means than many of my classmates there. While they said they tried to bring in 20 to 30 percent of the fellows with engineering backgrounds, it was probably less. Most of them had liberal arts, and probably over half of them were directly from college to this school. They didn't have the work experience in between.

Remacle: So you were a couple of years older than the average.

Phipps: Other than the veterans coming back, yes. But the biggest shock was that my academic training in engineering was much more analytical-- was probably all analytical, you could say. And the [HBS] case program was not very analytical at all, particularly in the freshman year. The case programs are in human relations, administrative problems.

Remacle: To make it clear, these are the Harvard cases.

Phipps: These are the Harvard cases. I had a hard time picking up on that thread. And the courses were all in the Socratic mode, where the professor just asked questions and got you further and further

out on a limb 'til you just recognized that and sort of chopped or fell off, and go onto the next one. So I was not a person who spoke up very often in class, and I was called in a few times. "Why aren't you saying something?" I told them, "Well, I just can't figure this out. I don't have a philosophy undergraduate or something else these other fellows may have." But they encouraged me to keep plugging away. Fortunately they stayed with me and I finished the program there. I did enjoy most the courses in finance and marketing. In my second year I took manufacturing courses in that field.

Remacle: When you were all the way through the program and could kind of stand back from it, what do you think were the biggest lessons in the total experience at Harvard?

Phipps: Oh boy.

Remacle: That had helped you carry through in the business world, is where I'm going with it.

Phipps: I think the case mentoring, of asking a series of questions just to try to understand how the other person thinks. Not trying to seek the answers themselves, but get the other fellow to express himself, and through that to understand where he is and his mindset, and what he's apt to do. This is particularly valuable in the ventures where you're on the board and trying to understand what the management team is really up to and what they're going to do, and of the things that are in front of them what they accept and what they reject. And it's this type of questioning. So I think that was...

Remacle: <inaudible> you went to...

Phipps: Because of the GE experience, maybe because of the Army or what it was, I had-- you get some strange thoughts at that age, and I had a disdain for large organizations, or at least I thought I did. And I didn't interview with many of the large companies that came by. I thought I wanted-- this is a transitional time; I'd like to go with a small company. In the sense that I'd get a better feel for the overall flow of business, how things got done. Where GE are very compartmentalized as an engineer, and you did your task at the desk and worked with engineer doing similar things, but had no idea how the flow of materials, how sales interacted, and all these other things. So I ended up for a while with a small company in Ohio that were friends of the family. And it wasn't in my field of engineering at all. It was in the fire protection business. After six months, I realized I'd made a mistake. I left them and went through sort of a direct mail campaign solicitation of electronic firms in the Midwest.

Remacle: You're kind of hop-scotching around here?

Phipps: Oh yes. And I made contact with Motorola in Chicago, and accepted a position with them early in '53 as assistant to the director of their military engineering department. That was a very unique experience. Motorola completely abandoned all their military work at the end of World War in order to devote their resources to the black and white TV, to the consumer markets and phonographic equipment, and to the emerging two-way FM market. With the beginning of the Korean War in 1950, the Signal Corps asked Paul Galvin to come back into the military business and make communication gear for them, and he wouldn't do it. He said, "No, this is just going to be a short-term affair." Finally by a year later, he

finally agreed he'd do it, but his heart wasn't in it. So he formed a hybrid organization. He took the engineering management from the two-way radio communication operation; he took the manufacturing from his consumer operation, which made things in steady volumes, and he took purchasing from a corporate person staff and others, and put together this hybrid organization in one of the old Deering twine mills near downtown Chicago. It was a four-story wooden truss building that had been vacant for a number of years. They had to clean and renovate it, and then we moved in.

Remacle: Again, pre-OSHA.

Phipps: Pre-OSHA. They mainly were a second-source suppliers on airborne radar systems, communications gear, countermeasure gear, and they made-- some of the communication gear they designed and put in production themselves. We went from a zero start in '52. By the time I was there, they were already six, nine months along, to a revenue rate of about 35 million dollars a year within about two years' time, for the Korean War effort.

Remacle: That sounds like really fast growth.

Phipps: It was fast.

Remacle: As you know, even for a venture today, that would be fast?

Phipps: And then with the end of the Korean War at the end of '54-'55, it fell off just as quickly. Dan Noble, who had the two-way and the communications part of it, had already started a government electronic operations in Phoenix by renting some space down there. He didn't want this rag-tag, more production-oriented military engineering effort in Chicago. He said obviously it was going to disappear. So in '56, I looked around to see-- I had the opportunity to go to Phoenix, but I thought, "Well, so long as I have to..." By this time I was married. I'd have to disrupt our life and move somewhere, why not just look around? So again, I did my direct mail campaign and made contact with Texas Instruments here in Dallas, and came down here in their product marketing for semiconductor activity.

Remacle: So this was in '55-'56?

Phipps: The beginning of '57.

Remacle: '57.

Phipps: And they were booming with their growing junction transistors, both germanium and silicon. They were one of the early ones with a silicon transistor. So they were growing very rapidly, and very profitable.

Remacle: What was TI's footprint in the overall electronics industry at this point in time?

Phipps: They had a small government electronics operation that they started after World War II that was doing also sort of second-source work on airborne radar systems, some of which were duplicate of what I'd seen at Motorola. And they started the semiconductor business after the Western Electronic Licensing seminars in '52, and they were fortunate that Gordon Teal, who did the materials science and crystal growing work at Bell Labs, he was from Texas. He was a graduate of Rice, and he wanted to come back to Texas. So he agreed to join this little struggling company, that was known largely for its geophysical work. And he did. And he brought-- he hired a half dozen other men who were...

Remacle: When did TI change it's name to be...

Phipps: In '51.

Remacle: Go ahead and, I'm sorry. <inaudible>

Phipps: And he hired other materials scientists and physicists, more from the oil companies R&D. Like Willis Adcock was with Standard in R&D in Tulsa. Some of the others were down in Houston. Because R&D efforts in this area were mainly oil-related. But he had half a dozen of them come together in Dallas, and he continued his work in crystal growing, and experimenting with forming PN junctions doing the crystal growth, and after about a year's time, they worked out the problems and were able to do this. So there's...

Remacle: Who was your first boss at TI?

Phipps: Well, in marketing, it was Harry Goff, who headed the marketing area of the semiconductor area. But when I went into the development department, it was Willis Adcock, who was with Gordon Teal. He had been recruited from Tulsa, Stanolind Labs. My first assignment was really not to do product marketing work on the transistor programs. They had that pretty well staffed. Haggerty had the idea that...

Remacle: Pat Haggerty?

Phipps: Pat Haggerty was executive vice president at that time, and very much strategically oriented, and very much a student of industry structure and how things got done, how companies organized. And he had the strategy that if you're going to into the component business, which they we're already in, that you needed to be a broad component supplier. Just being a transistor supplier was probably not going to be enough. So he had acquired a panel instrument company out of Iowa. He had acquired a carbon film resistor company, and he was moving them into tantalum capacitors. So he had a basket, and he was looking for components that would fit the current capability of transistors, not vacuum tubes. [CP: By the erly 1960s, the integrated circuit market developed and the passive component strategy was dropped]. And so it was a transition in component performance at that time going on. So I was assigned the responsibility to look at new emerging device markets that might complement those, in his thoughts. One of the early assignments was to study the silicon solar cell market. It had been invented and announced

by Bell Labs the year before. I remember I had the opportunity to make a visit to Bell Labs to interview John Pierce, the inventor of the solar cell.

Remacle: To a young engineer/scientist kind of a person, was that a pretty big deal to...

Phipps: Yeah, it was. I thought it was.

Remacle: To be able to go into Bell Labs.

Phipps: Yes, very much so.

Remacle: They had such a huge impact.

Phipps: They did, particularly in the solid state, the semiconductor area in the '50s. And I talked to other people and tried to make comparisons and understand the power requirements for air conditioners. After struggling with it about four months, I wrote a report that this was not going to be a market of any consequence. I issued the report about a month before Sputnik went off, which gave some truth that there might be a role for solar cells anyway. We all got a laugh. Anyway.

Remacle: At this point, is the military and military government applications, is that pretty much where everybody was focused with the transistors?

Phipps: Many of the engineers were, because that's where much the engineering development work. It's either that or the consumer markets, and some industrial controls. Not very much other than those three. The military probably had-- I'm guessing-- but I would think 30, 40 percent of the electronics effort in the U.S. was probably military, and consumer was probably an equal amount [in dollar volumes].

Remacle: And what were the key applications in the consumer area?

Phipps: TV assembly. Chicago was quite a center of the electronics industry in the '50s because they were large assembly houses. You had Zenith, Admiral and Motorola, and a number of smaller companies like Hallicrafter, Wells Gardner.

Remacle: Sylvania?

Phipps: No, they were in the east. And RCA was in Bloomington, Indiana, which was not too far away. They didn't do any development work. They just did engineering the next model, and selecting the components and assembling them.

Remacle: So you were like the product marketing guy, in essence?

Phipps: Yes. One of the things that struck me very different between Motorola and TI, Motorola was in the midst of this, say, electronics infrastructure in Chicago, and you had coil manufacturers, you had people that made wave guides. All the components were largely being made within a 50-mile radius. You had special machine shops that made the chassis or other things for them, and they're coming in, and you just assemble them. Here was TI down in Dallas with no infrastructure around, and they had to-- and you're still traveling by train, I think in '56-'57. So when they went to the east, they went by train. If they went to Chicago, they largely went by train. They didn't fly that often. So they had to integrate very vertically. I was shocked when I would-- we were all in the same building on Lemon Avenue and I'd go over and see the folks working on the radar and other military gear, and they made their own wave guide. They wound their own coils; they made their own transformers. They bought an optics shop. They were in the early infrared. So infrared lenses they made in their own optics shop.

Remacle: Do you think that they had some kind of an advantage by having to do everything by scratch rather than having to deal with...

Phipps: At the time, they thought they did. Certainly they had the response time and for tailoring and customizing, they could make a good argument for doing that. It gave them an inward look though, and feel, the isolation, the vertical integration. That persisted into the '70s; that worked against them by that period of time. But that became part of the culture that we could do it ourselves quite well.

Remacle: Not Invented Here?

Phipps: Yes, very strongly.

Remacle: Which can be lethal sometimes.

Phipps: During '57, TI began building their new campus [north of Dallas], what they called the Expressway Hillside. That's where they were located. And the first building was finished at the end of '57. It wasn't quite finished. They had tarpaulins hanging on the walls. But under the IRS code, if they occupied it before the end of the year, they could take depreciation on it. So the Development Department was formed about November, and I was made part of it under Willis Adcock. And since we were a fledging department, we were moved up to the new building before the end of the year, and began to occupy and set up lab space there.

Remacle: And the new department's name was?

Phipps: The Development Department of the Semiconductor Group.

Remacle: How big a group was that?

Phipps: Oh my. Goodness sakes.

Remacle: Approximately. Ten? Twenty? Forty?

Phipps: Oh, the Development Department? Oh, probably 20, 25 people, and counting secretaries and technicians.

Remacle: Well, they're people too…

Phipps: Oh yes. The new building was laid out so that the professionals had offices-- full standing wall offices and two to an office. I had the office next to Willis, and my office space had only desk in it. The other space was unassigned at the time, and it remained that way for the first four months. Then when Kilby was hired, a desk was put in there and he was assigned to that office. So Jack and I met each other about the first day he came to TI and were officemates there for a while, and moved around the building together for a while.

Remacle: How were you as officemates?

Phipps: We were pretty compatible. He was from the Midwest and I was from the Midwest. Jack had a much better grounding in semiconductors. He had attended the Western Electric Licensing seminar in '52 for Central Lab in Milwaukee, where he worked. He was working mainly on silk-screening substrates for small hearing aids, and they set up a germanium transistor line, which Jack was responsible for getting it operating. So he had some feel of semiconductor processing from that.

Remacle: Did he come into TI just as any other old-- I don't mean old by age-- but any other person, or did he have any...

Phipps: He came in as a result of a search that Adcock undertook, and he undertook it at the suggestion of Pat Haggerty. In '56, '57 there were emerging in the military labs the development effort and different approaches to miniaturization, or integration of components. Some of the more thoughtful papers had develop papers expressing that now with the first transistorized equipments going into production and the amazing gains that were made in reliability and reduced power, much smaller size than vacuum tubes, people were using this to project equipment densities. Instead of just 10, 20 circuits, of going to 100 or 1000 circuits. And then in parallel with that you had the emerging computer market, which was hungry for circuit density. So the expression ""tyranny of numbers" came into being, that as you tried to build equipments, those density of components...

Remacle: Was that Jack Morton at...

Phipps: That was the point Jack Morton at Bell Labs made that paper, pointing out that dissimilar material interfaces you had-- a half a dozen in each component --- a capacitor, resistor, or transistor --- going to a PC board, and added all these up, you were really pushing the limits of reliability, and you were

just going to see a constant stream of equipment failures if you tried to do these things. And we weren't there yet, but enough people recognized it so that development activities were started trying to solve it. Haggerty had suggested to Adcock that semiconductor technology may be something that would be helpful in this area. We're not saying he envisaged the integrated circuit at all, just that it might help relieve some of these interconnection problems. But he told Adcock to find...

Remacle: I'm going to interrupt you again, Charles. Which was the driving force, the need for miniaturization drove integration, or the need to have things be smaller...

Phipps: From Haggerty's comments, the direction was integration at TI that was the driving force, and that Kilby was seeking a solution. So Adcock began a search for a person who had worked with circuitry and assembly of circuitry using preferably different materials technologies. He came across Kilby, and he was hired and joined TI the end of April, May sometime, '58. And he began working on that problem. His thoughts initially were some type of assembly process. Using standard form factors, he used cylinders for one form factor. He'd use several different form factors, how they might fit together to ease the assembly as well as minimize the number of different contacts. Then industrial engineering assessed it from a cost viewpoint; they were all going to be much more costly than what was being pursued for print circuit boards. So about that time when we closed the plant down to take our summer vacations, and Jack stayed there and...

Remacle: This is the famous story….

Phipps: This is the main story where sometime during those two or three weeks, he stepped back and took a new perspective. Semiconductors have many of the parameters that circuits do; it's resistance, or you can form a dielectric and get a capacitor. And he sketched out several circuits that could be formed in situ in silicon. And when we came back he went and he showed his sketches to Adcock. Willis encouraged him to make feasibility models, which he did with his technician. It took about a month to grab parts off the line, but we were in a laboratories and had to handcraft everything ourselves in a lab with lab equipment. And it wasn't until early September that...

Remacle: And the reason you had to handcraft all this equipment was that it really didn't exist to deal with semiconductor-level problems?

Phipps: Well, just the way that lab equipment was. You made things one at a time. We had the process lines upstairs. We had germanium-diffused mesa. That's why the first devices were germanium, because he borrowed the hunks, a slab of germanium wafer with diffuse devices on, and removed some, and formed the diffused path for resistors or capacitors-- the technician did.

Remacle: So it wasn't because he thought germanium would be better inherently. That's just what was available to him.

Phipps: No, that was available. All the silicon transistors had grown junctions and you couldn't use those for this type of thing. So Jack showed the phase shift oscillator early in September, and a flip-flop

not too long afterwards. As Jay Lathrop said, we were using air isolation because we didn't have the planar process, and really didn't know about the planar process at that time. This was in August/September of '58.

Remacle: That would have been a little early?

Phipps: It was early, before Fairchild announced it. Haggerty and Shepherd and other managers were called upon by Jack and Willis to come see this oscillator on the bench, looking at scope traces to see that it indeed was oscillating. Haggerty grasped the significance, I'd say very immediately. He had something like that in his mind, and he could see where this is a step forward.

Remacle: A big step forward.

Phipps: A big step forward.

Remacle: Do you think he had any applications in mind specifically? Or just he was solving a problem that he recognized.

Phipps: He recognized that this could be a new business for TI at once, because he called a seminar that was held within two weeks, and we had it in the auditorium at the new building that probably could seat 60 or 80, and we filled that with the business managers and senior technologists. Jack Kilby talked about what it was, and Pat emphasized the significance of this, even though it was pretty crude, rudimentary at that time.

Remacle: As Jay Lathrop said, it looked like a smashed bug.

Phipps: Yeah. Haggerty immediately began puzzling on what did we have to do to make a business of this, and what would be the nature of the strategy. And he began asking a number of questions. How many circuits were assembled a year in the United States, and what was the cost, and what was the performance range? Well, you could look back into shipments and quickly deduce that 99 percent of them were analog circuits, some power ones. From that, we worked out, over a year's time, a means of using the vacuum tube shipments and other active element shipments to correlate that to the number of circuits being assembled, figured out on average how many resistors and capacitors were added, and inductors, what those cost, and add in PC board assembly, roughly, and largely dominated by consumer electronics, and come up with probably what the average cost was for them in the States. And then from that, how this might grow. And then against that, you always want to know what part of that might-- this integrated circuit technology penetrate in five to ten years' time. The semiconductor group on the transistor side had become familiar with learning curves. They picked it up from Vought Aircraft and the airframe manufacturers over here, and people who worked there during World War II, and used that for development of some of their assembly equipment, figuring out cost. So Jack and I were somewhat exposed to it, or understood it a little better, and we tried to use that to project what would cost be. We'd get into these discussions with Pat, and we'd project that, gee, five, seven years out, integrated circuits would probably be maybe only 20 to 30 percent the cost of assembling these things. It could be you sell

it for 30 percent. And Pat would get mad and said, “Why would you sell it so low? We’ll sell it for 50-70 percent of the cost.” It made quite a difference in market potential and we’d get in arguments along that line over it all.

Remacle: What about the rest of TI outside of Haggerty down? Did other executives recognize the significance of this?

Phipps: I think they went along with Pat. They had their plate full in just trying to keep up with the markets they were already in. And about the same time, Haggerty was successful in winning the second-source contract from IBM for their transistors, and we were setting up lines to produce those. And those were mainly germanium mesa diffused, germanium alloys. Not very much silicon. In two or three years we went to some of the silicon alloys for core drivers for them and other things. And that business, from a standing start in ’58, we were shipping over 50 million a year in transistors to IBM by ’63 or so. So that was...

Remacle: Big growth.

Phipps: A big growth. It absorbed all the management attention and finances that TI could muster just to keep up with that.

Remacle: What kind of budget were you guys working with?

Phipps: A small development budget, enough to probably support-- I’m trying to remember-- probably not more than six, eight people.

Remacle: So just to make that clear, Willis Adcock had the development side, and reported to Haggerty.

Phipps: He reported to Shepherd really, who was the SC General Manager, and Haggerty was the executive vice president. But Haggerty had a strong interest in this area, and Mark and he came-- so I gather-- to an agreement that Mark would spend his full time on the existing products, development of that business, and Haggerty would oversee this integrated circuit...

Remacle: And you reported to Haggerty?

Phipps: I reported to Adcock, who reported to...

Remacle: To Shepherd, but really Haggerty.

Phipps: But Haggerty was there at least once or twice a month, knocking on our doors and seeing what we were doing and following up on things.

Remacle: Did you ever see Shepherd? Was he...

Phipps: Very rarely.

Remacle: So really Pat was the guy.

Phipps: Pat and Adcock were the ones we saw.

Remacle: Did they share the same vision?

Phipps: It was hard to put the vision together, but Pat said this was the way it could work out. We were willing to pursue it and work at it.

Remacle: At what point did people start to get a sense that Jack Kilby was this-- and I don't mean physically larger than life-- but that he was going to have the kind of impact that he had, not only at TI but on the semiconductor industry?

Phipps: Oh my. That probably gradually developed over, I'd say, a three or four year period of time, when the integrated circuits were in the market were being used and applied for military programs. People believed that it really was a product line of substance. It was probably '62, '63. Certainly by '64 period of time.

Remacle: Did any of you have a sense at the time-- that '62, '63, '64 period-- that the integrated circuit silicon, planar-- where it got to eventually-- would have anywhere near the impact it's had?

Phipps: I think we did begin to see it, close to it by '62 or so. We would see the development people from IBM. They would come down to TI because of the second-source transistor program. Each time, if they would tolerate it, Shepherd or Haggerty would come and show them what was being done in integrated circuits and why weren't they doing this? Well, they had their own approach, which was SLT or ceramic-based, and they had automated that for assembly of circuits. And they would get irritated with us continually, showing them what was happening with silicon integrated circuits. It almost made them more determined not to do it, to a degree. SCT was all ECL, and we weren't at that speed range at all. So it was very easy for them to defend their position and point to us the shortcomings.

Remacle: What were the most challenging problems that you all ran into in turning Jack's workbench integrated circuit into standard production-ready products?

Phipps: Well, I thought about that since the panel early this month [May 6, 2009 IC@50 program], because Gordon [Moore] came up afterwards and said, "Jeez, I never really understood TI's internal practice, what was going on at the time of integrated circuit development." It's an interesting perspective. I would have liked to have shared the viewpoint...

Remacle: And the Gordon we're talking about is Gordon Moore?

Phipps: Gordon Moore. I would like to have shared his thoughts more, but we were interrupted and never got to do that. But thinking about it, the environment at TI was very different from that of Fairchild. We were a separate, newly formed Development Department that was really sort of isolated from the business units, and our resources was laboratory instruments, laboratory furnaces for the diffusion, vacuum deposition equipment-- things of that nature. They were small chambers. The transistor departments were mainly grown junction or alloy devices. Germanium was just starting with diffusion and mesa etching, isolate or shape the base and collector regions. Silicon did not have diffusion going at all. And even by '60, '61, I think silicon may have had a diffused epitaxial device by '61. By they did not have the strength in the planar technology. They were trying to duplicate it. We got our own...

Remacle: What were their difficulties in applying or implementing...

Phipps: Applying it that we had to develop our own facility.

Remacle: Just to be clear, Fairchild by then had a pretty good leg up…

Phipps: For processing technology. And then on top of that, Kilby was determined that the integrated circuit be differentiated from the transistor, and he designed the flat package to highlight that this was a different product than a transistor and did not want to put it in a round transistor can. He wanted the die to be more complex and designed a larger die, and he put initially 12 circuit elements on the die for series 51. Subsequent ones went up 20, 30 elements on the die. So he purposely made it as different as he could from the transistor.

Remacle: Why was he so determined to have it look different from the transistor?

Phipps: He thought the capability was there to do it, and he thought it could make more of an impact in the marketplace at least for TI. We didn't have the silicon planar technology reputation that Fairchild had the right on, so we're using this other-- we were learning how to use it. We got our own front end, largely with Air Force money, installed about early 1961. And the lab, with Jay Lathrop and others that worked enough that had a starting point where they could start with planar technology and that line. That was really-- I think it was probably really the first regular practice of silicon planar technology at TI was in that integrated circuit line, not in the silicon transistor area. So those are some of the differences. We had overcome that...

Remacle: Fairchild didn't...

Phipps: And then that jumped from a development lab of developing and implementing planar process, putting in a new facility, which we had to build, which was not much larger than a pilot line, but at least it was a dedicated station that could move a flow of material through. We could go to the business units and ask for help, and they would give us some, but there wasn't any direct help. The assembling into a

flat package was different than the headers they used; the testing was different; the handling was different; the photolithographic process was all different.

Remacle: I would imagine that you would be actually ahead of where they were in their thinking, in many ways. In other words, you were the next generation processes and...

Phipps: To a degree we were, certainly in our experiences. The photolithographic process we were.

Remacle: And that was Jay?

Phipps: That was Jay Lathrop.

Remacle: Who else was on your team, name-wise? People, name-wise. Or does it not matter?

Phipps: Yeah. We had design engineers like Jim Hull and Bob Cook, [CP: Jerry Luecke; Development; Bob Biard,and Marketing, Gene McFarland] come to mind. Let's see, in the process area, I think Jim Nall was there. He was at Diamond Ordinance Fuze Lab with Jay, and he came down after Jay.

Remacle: But he didn't stay as long as Jay did. He left.

Phipps: No, he left. Jay asked me last month ago whatever happened to him. We lost track of him. I don't know. I haven't heard of Jim Nall in 20 years, 30 years. Or more.

Remacle: So when did LJ [Sevin] get onto the team?

Phipps: LJ, he got out of school at LSU in the late '50s, came to TI in the group application engineering. We had a central application engineering effort that worked on the application of transistors. He worked with that for a few years, and then, I don't know when, he-- somewhere in the '63-'64 period of time he became fascinated with the emerging field of MOS devices, and circuitry particularly. He was a circuit design person. I don't know how he accomplished it, but he gained enough depth and experience in the lab that he was the author of the McGraw-Hill book, the yellow books, the one on MOS circuitry, LJ was the author of. And that came out in, I believe, '66 or some such time.

Remacle: Was he reporting to you at this time?

Phipps: No, he was in the development lab, and I was in the business unit, integrated circuit departments. I didn't know of LJ. Jack went back in the development labs in '64 from the business unit, and the bipolar department got back on its feet, regaining momentum in the marketplace by '64-'65. At the end of '66, I went back into the development lab to pick up new projects and to groom them for becoming businesses. And the major one of them was the MOS device development. And LJ, together

with some of the people in central marketing, were conniving together with-- Willis Adcock had left TI by them. Dick Petritz was head of development-- as to how to get enough funding to do something in MOS. And what they did...

Remacle: Why did they have to connive to get funded? What was the built-in...

Phipps: Well, the excitement I think, and emphasis was on bipolar devices at TI at the time. And they didn't have, let's say, the understanding of surface states that Fairchild did. They got—Shah was his name, out of University of Illinois, that had just graduated.

Remacle: Tom Shah

Phipps: Yeah.

Phipps:. On surface states and how to stabilize them and those things. NSA had become keenly interested in MOS devices, largely through the promotion of AMI and some of other people out there on the West Coast, and they began funding exploratory circuits. They were interested in the device because you could get enough circuits on one die to do a basic part of a key generator in their crypto work, and you didn't have to expose it on a PC board. It meant quite a bit to them security-wise to have it all in capped in one package, and you could-- they went so far as to put explosive powder under the lid so if it were tampered with, it would blow away the metal and you couldn't see what was done. <inaudible>

Remacle: Sounds like serious spy stuff.

Phipps: Oh yes. And AMI had a couple contracts with them by the end of '66 to make trial circuits. I think GME¸ a split-off of Fairchild, with Phil Ferguson-- or I don't-- anyway, they were a new company, and they had some contracts. I don't think Fairchild did. Bob Noyce didn't believe much in government funding.

Remacle: I don't think so.

Phipps: Anyway, Petritz and...

Phipps: Petritz, LJ and some of the people connived that the way to push this thing to a priority was to get committed to a government program, and the group would have to recognize that support, and that's what they did. They prepared a bid and won a contract at a favorable price. And here they were with LJ and one or two engineers, and they had this...

Phipps: The MOS project was trying to work on these NSA circuits. And they had to cut the rubyliths by hand and carry them out to a mask shop and make mask which all took time. I recall the density was probably in the range of 200 to 300 circuits per die. And then after that just understand the process and

advance the process to make the surfaces more stable and learn how to test them with specialized test equipment and circuitry involvement. So it was a learning process, again, as is often the case with developed programs you really sort of over promise what you can do. And so we were in the soup from the summer of '67 until early '68 when we finally delivered circuits that met their performance requirements. And my job was to hold hands with the agency and try to hold them off and that would buy us some time so we could do these things. It wasn't a very pleasant task because agency people were pretty rough

Remacle: He who has the money rules, as they say.

Phipps: That's right. Well, they were hard living fellows, hard drinking, hard living and they were very outspoken. They always came in and tell me how well AMI was doing and GME was doing, "how could you guys be so dumb and why did we ever give you a contract?" And then we'd start from there.

Remacle: It made you feel real good.

Phipps: Oh, yes. But as we learned how to make them we added to the team and started to develop some products which could be catalog items. They' were mainly character generated. A fellow in development named Bob Biard had developed the device, essentially the early read-only memory and I think he had some of the early patents on the read-only memories. And from that-- and then you could code in the metallization over the gate area and code in the characters that you would produce. So we used that technology since it was there at hand and knowledge and put in the market some early character generators that people were interested in and we started to sell some.

Remacle: What kind of revenues are we talking about?

Phipps: A hundred thousand, 200,000 in there somewhere. L.J. had an interest in memory and he developed the static memory and a few of other memories. He had one of 256 bits by the end of '68 which was static memory but without the read and write. They had the sense lines on and then off chip, separate chip for the read and write circuits at the time. But we were getting our feet on the ground and beginning to show some momentum and show some success.

Remacle: Now, is Haggerty overseeing this at all?

Phipps: No.

Remacle: He was just in it for the IC part?

Phipps: He was president by this time and he was off. This was just another advance in IC's. And by this time [Fred] Bucy had come in and taken over the semiconductor group from [Mark]Shepherd and Shepherd had gone off to corporate as Executive Vice President, so Bucy was really the general manager of the Semiconductor Group at the time. We were building up the team. We added some

marketing people. Berry Cash came over from Bipolar to handle the marketing for IC's. Then Vince Prothro came over from Bipolar. He was in production planning, head of production planning. Louay Sharif headed up process development, he was in development. Bob Palmer had just graduated from Texas Tech, I think that year and he joined the process development activity.

Remacle: You had a pretty high class team.

Phipps: Well, they had the potential anyway certainly. And so by the fall of '68 we were-- had a half dozen products in the marketplace and we were getting engineering orders so we needed some consistency of making other than on lab equipment. And so we made known our requirements for capital to build our own front end for MOS. TI had continued to expand very greatly. They had just finished building the Sherman plant for the IBM products up in Sherman, Texas. And I remember at the time they were running so hard in multiple shifts that we had vans with personnel and a nurse and other things, the large vans that would travel to all of the farming communities within a 50 mile radius every weekend recruiting people. And then interview them, give them a physical and sign them up right there and tell them report to work Monday.

Remacle: And what were their positions that they were…

Phipps: They were line operators largely that they were trying to find but we had exhausted the labor market in Dallas, …within 10 to 20 miles of Dallas. So here we were. We went in for a front end, but the T-squared L department had run into the same problem earlier in the year and they decided to develop a new site west of Houston that's in Stafford, southwest of Houston and all ready built the first building there, and TTL was getting their front end up and running in Houston. So with this request I looked over things and in February they announced a decision that was made that the MOS department would have its front end in Houston and the whole department would be moved to Houston in '69. That blindsided me. I had no expectation that would happen. In fact, I had rationalized my mind because we were so close to development labs and leaning on process development largely in the development labs and the people would stay with development who was doing that work. I never thought that they would make a break physically for us.

Remacle: How did they tell you? Who told you?

Phipps: Bucy told us. He called us in and told us that this was going to be done this way. And Penniston was marketing, Vice President of Marketing. For some reason I reported to him at that time with these new ventures coming out of labs. So that's it. It was in February of '69 that the announcement was made.

Remacle: What was the immediate response of everybody?

Phipps: Surprise but cautious as to what this meant. And we knew there would [have to] be a selling of the 'pick your families up and move them 240 miles south'. So we arranged a series of trips about every other week we flew down 20 or 30 fellows and their wives to Houston. They spent the day in Houston.

We had the Chamber of Commerce. We had some real estate people. We had other people talk about Houston and that area. We showed them the plant site, what TTL had done so far, gave then tours of the schools and tried to answer their questions. And made it generally about as enjoyable as we could. And you could sort of see an interest in Houston in March and into April and we picked up and people were sort of looking forward to moving down there. I'll continue on that path and then go back and pick up the Mostek part of it. Since our building, where we were going to be was just being built and it wouldn't finished, parts of it, until the fall as far as putting the front end in place and operating it would be the fall or almost end of the year, we phased our move so that about every six weeks we would move another 20 to 30 people down there. And that went on through the end of the year, unfortunately. So try to move 140 people in phases like that and you can tell from about the end of April on you could just see it [building].

Remacle: Productivity…

Phipps: Well, not only that but the enthusiasm, interest just began to roll over as the wife began to realize and ask questions, about realizing that the disruption this made with her friends, with schools, and their classmates, do we really have to move? What's so good about Houston? And by summer and fall there was not much enthusiasm for it at all. We did move 110 or so people, families down there we got that much done. Well, going back then it was some time around the end of March, early April that L.J. had talked to his designers that worked with him and were loyal to him. He had about a half a dozen of them or more and Berry Cash and then Prothro and then Louay Sharif for the process work and Bob Palmer. So there were about 16 engineers in all. He talked to them and tested the waters about not going to Houston and staying here and trying to get money for their own little company to pursue MOS. And he had Dick Hauachen who was VP Sales and left TI in '67 or so was struggling as a venture capitalist here copying what he saw out in the West Coast. And he wasn't fully funded. But L.J. tied up with him and he promised to find money and he did find money with Sprague and Sprague put the major money into it. So they had a commitment about the end of March, early April, on paper, not the money in hand.

Remacle: Has he left TI at this point?

Phipps: Yes, he had left TI about a year earlier.

Remacle: And when he left TI what was the response?

Phipps: I don't know. There wasn't any strong feeling there. He worked for Shepherd. Shepherd went over to Corporate. And Dick left. And Bucy came over and picked up the Semiconductor Group and Bucy brought Penniston over from the government electronics to be the new marketing manager. So there was a transition in the team and he was just part of it. So L.J. I believe had a commitment from Hansen [ph] that he'd find funding for it. And so he announced that, I think, initially there was just six that were going to resign from TI and start the work to develop this company. I was out in Phoenix on a trip in a hotel and with the time difference he called me I guess it was about seven o'clock in the morning in my hotel room out there and said, "Charlie I need to talk to you." And I said, "I'll be back tomorrow." "No, I need to talk to you this morning." I said, "Well, I'm out of town, I'm out here." I said, "But hold on and I'll see what I can do." So I called back to Dallas. Penniston was out of town also. And I got a hold of Bucy and told him that L.J. and some of the engineers, wanted to talk to me and I was out of town and he said, "Certainly, send them down to my office." So they went down and I called them back and told them, "Go

see Fred, he'll be waiting to see you." I guess L.J. did tell me on the phone that he was going to leave TI. That was the purpose of the meeting. So I told Fred that. So they came to the office and I guess he had a short discussion with them. They told him that they wanted to form this company and leave TI. And he says, "Are you sure you want to do that?" And they said, "Yes." And he said, "Well, thank you gentlemen" and he reached over and took their badges and marched them out the door.

Remacle: That was the end of it.

Phipps: That was the way Shepherd and Bucy would act. Loyalty was black and white with no room in between in their minds.

Remacle: Did you consider going off with them at any point?

Phipps: No, not really. I didn't know enough about it. And when Bucy made the announcement, he gave me a pretty big financial incentive to stay with TI and he asked for my personal commitment that I would stay with TI so I felt I had made a commitment to do that. So I came back and found the empty desks and it was a period of over three months of hard work to keep people focused on their jobs. There was constant milling around and talking. And when L.J. did get his funding, I think about in June or so, another 12 or so departed, which was the nucleus of Mostek. I was pretty frustrated by it all. The corporate counsel and our outside counsel would come by and I talked to them, "Can't we do something to stop this?" And he'd say, "No not really." And I was flabbergasted that we couldn't legally do something. We didn't have any real spin off at TI up to that point in time. So they sort of disappeared and went about setting up their company and I was absorbed in the move and getting people to move down there and I moved down to Houston in September of that year and set up shop down there. And then we had to re-recruit and fill those holes and then get things moving again which gradually took place over the next year.

Remacle: So what was your next position, how much longer did you stay running the MOS team?

Phipps: Well, Haggerty to a degree and certainly Bucy and Shepherd were convinced by the way this worked out that I was not a line manager. I was not disciplined enough and certainly not confrontational enough. In fact, Shepherd developed a theory that had Charlie just been more aggressive and confrontational we may not have lost that many engineers. We could have saved them. He believed that. I wasn't that-- that wasn't part of my character. And I didn't understand just what were the things I didn't do or should have done but that sort of put a mark against my name as not being a line manager. And my career path was either to probably leave TI or do something else. Well, I think Haggerty probably intervened. I don't know that for sure but the next thing I knew I was brought back to Dallas and worked directly with Bucy working on the longer range strategies for the Semiconductor Group. And then after the year-- early in '72 or so Bucy went over to corporate Executive Vice President. Haggerty moved up to Chairman and Shepherd President and Bucy Executive Vice President. And then Bucy asked me to come over to corporate with him in a role of being responsible for the strategy development for the corporation. And so that was sort of a staff role and I think that's where Haggerty felt I best fit into the scheme of things.

Remacle: And how much longer were you then at TI?

Phipps: I was there until '86. I was there for another 14 years, 10 years in corporate staff in that role, and the last four years reassigned back to the semiconductor group. I was an Assistant Vice President, and then Vice President for Market Development [Semiconductor Group].

Remacle: What were the key either programs or projects that you were involved in over that 14-year period of time?

Phipps: Well, very early on looking over the shoulder, over the team to form to pursue the consumer caculator. And I was the sounding board and helped them. We lined up Booze Allen as a consultant to cross check our marketing plans and the model. TI rarely used consultants. And this was one of the few times we did. It worked out extremely well. They changed our marketing strategy. We felt that the name TI, Texas Instruments, would not be widely recognized by the consumer so we would private brand the product as to what channels we weren't sure to use to reach outlets. And we had prototypes the Data Math, and different colors, white and beige and things. They had a consumer test panel and they had a half-a-dozen units, some with an LED display and some with an early liquid crystal display. The Data Math had a hood over it the reason for it because it was backlit for the LCD display. And the consumer panel really was right on. They said make it beige. Use multicolor keys to identify the keys you most often use. We made orange the equal and assigned one or two other colors. They gave us very specific directions what to do. Do not use the LCD. It was too dim even with backlighting. They liked the LEDs even though it would take more power. They told us not to private brand. Once you go out in private brand it's hard to switch over to your own brand. You have conflicts in the channel and with your other people. And that the name TI was well enough known to the stock market, to much of the consumer here in the south, sophisticated consumer anyway. So we started out with that name. And don't go through jobbers or intermediaries, but sell directly to the specialty department store counters and electronics and things that had to do. And that's what we did and it worked out very well. Our costs were such that we had to price at $149 to start with. But they told us the elasticity point as you got below 100 and certainly by the time you reached $49 that would be the elasticity point for high volume. So we pursued that very aggressively much to the annoyance of the department stores that we put it in. We had been running it and the costs were coming down as we expected. And every four months we had dropped the price. So it went from 149, to 124, and then 99 and then 70 and then down to 49. We reached 49 in about I think 12 to 15 months time. Department store buyers were the people that were greatly annoyed with us. They said, "You dummies don't understand anything about consumer marketing," and they were probably right. They said, "It's terrible that you keep dropping the price every three or four months and you don't change the model number, you don't change the colors, it's the same model. People come back and say last week, I paid 125 and today it's 99, you owe me something. We get this complaint all of the time." And we were just oblivious to it. We were just highly focused on getting down there where we had to be on it.

Remacle: What other projects did you work on?

Phipps: Well, we looked at-- that turned out so well for the company and Haggerty wanted us to leverage the LSI technology to enter new lines of business for TI. And we looked at-- we had a solid state microwave oven. Willis [ph] was back in central research lab and he worked on that. We did a

selective call CB. I can't remember all of them that we worked on but there were …[CP: digital watches and several versions of low cost computers for the engineering desktop and, eventually, home computers.]

Remacle: A variety.

Phipps: A variety. We spent too much money on them over the next five or six years. The first one, the calculator I remember at the time it went to the board for approval we had a plan that we thought the second year we could realize $50 million in revenue on the Data Math and on the coming scientific calculator project started after Hewlett Packard announced theirs. I remember, Haggerty was there and he looked at Paul Smith, project manager and Glen Penniston and told them, "Well, for you fellows $50 million as a plan is probably all right, but if I were running it would be $150 million."

Remacle: There's a little bit of arrogance.

Phipps: Oh yes. But we actually did $200 million in the second year.

Remacle: That's better.

Phipps: Anyway, with that success Shepherd had determined that any of the projects we brought before him to be at least $200 million within three years or it wasn't worth the effort. So a number of things we could do had to be set aside because we just couldn't see a market of that size. And so you really stretch yourself on business potential to get past that barrier. And we didn't do very much market research. These were all new emerging markets to do it. So we went through a series of flops. One of them we did carry all the way through to a pilot line was a video camera for still shots. We had the CCD imager. That's about 77. And we had a magnetic disk that could store 16 stills on it. It took pretty decent pictures. I don't remember what the pixels were. But that was going to cost something like $20 million to put in production and the board just balked on it, they didn't commit. But what we did, we had patents on the thing and four years later when Sony came out with one we wrote nice letter to them and suggested they look at our patents.

Remacle: Did you get money from Sony?

Phipps: Yes, we did. They delighted in that because there was always a rivalry between TI and Sony that went back over 30 years.

Remacle: What caused you or at what point did you decide to leave at TI?

Phipps: By '82, '83 I had been there for 10 years [Corporate Staff]. TI was in trouble. Haggerty had died in 1980. There were conflicts between Bucy and Shepherd and the managers under them and things weren't going well. They got in the mode of making all of the decisions themselves, at least, strategically and trying to out do each other as to who knew more about strategy and computers and other such

things. It was an unpleasant environment. And my involvement was less and less. I just thought I had outgrown my time by quite a bit. So I had decided it was time for me to look outside by '83-'84. Shepherd had in '82 changed the stock option formulas so that he gave each of the managers an extra grant of options but was tied to a new clause that if you left for a company they deemed competitive you forfeited all of the profits on your options, not only of that one, but all of your prior option profits. And since I was thinking about probably leaving I wouldn't sign the damn thing. And I was only one of only eight or ten in the company who would not sign it. So that flagged me as a suspect.

Remacle: A troublemaker.

Phipps: A troublemaker, obviously. Somebody who's loyalty is not 100 percent with TI. So the following year then they announced they were reducing the employment ranks. And for the first time-- they had always had a selective early retire, where if they wanted to reduce the ranks in one department, they'd offer early retirement for just that department or area for people on pretty attractive terms. And they had done this for a few years and the lawyers told him you're going to get in trouble ...

Remacle: By making it selective.

Phipps: You've got to do it for the whole company. So some time, I think, in '84 they announced that before the whole company and I signed up. And I said, I'll take it.

Remacle: And "all my options and all my profits" besides.

Phipps: That's right. And it wasn't that easy, they asked, well, what are you going to do? And I know Shepherd sicced Dick Agnich [on me], who was General Counsel, and Dick and I were pretty good friends. I said, "I don't know what I'm going to do yet." "Well, I'm going to be a consultant." And he said, "Who are you going to consult for?" I said, "I don't have any clients. I have to get out and work them and other things." And this conversation went on all through '84 and into '85 and I just sat there and I wouldn't leave, budge. And Bucy had left at the end of '84, and Bucy would tell me on the phone, "Charlie, don't you dare leave until you get that clarified as to what you can do, otherwise Shepherd will come after you on the thing. He has you in his gun sights." So I couldn't tell them, I couldn't do anything. So we just sat there and stared at each other. And I got a lawyer that would talk to Agnich now and then and neither of us could budge and make any headway. It wasn't until the spring of '86 when Junkins became president and he had been there a few weeks and he called me and he said, "What's going on Charlie? I know you signed up for this but why haven't you left?" So I explained the problem of this thing. And he said, "Well, let me think about it. I'll call you back in a week." Which he did, he said, "Look, you're committed to going outside and starting a career and you should do that. And I'll be fair with you, but let's do it this way, when you get a consultant agreement you're going to work for somebody you call me and tell me what it is and I'll let you know within three or four days whether I consider it competitive or not. If it's not competitive go ahead and do it. I don't care." So that was clear so that's when I left TI in the summer of '86 after getting that cleared up. And Jerry was very fair with me. Jack [Kilby] and I had been talking and we decided we'd office together. And Jack was out through his name.

Remacle: This is Jack Kilby.

Phipps: Jack Kilby. And Jack lined up a consulting job with Hughes and with GM Delco because GM had just bought Hughes the year before. And between them they had something like five or six semiconductor lines, all captive. And they just put in money for another line and the executive vice president for this overall area called a task force to rationalize their semiconductor front ends, and do less and less and do away with this capital request. They looked at each other and came back and increased the request by $30 million and they decided they really needed more of this. So he told the vice president of R&D for Hughes, Mendel was his name, to look at the problem. So he reached out to Kilby and myself and hired us and we went around and talked to people and tried to rationalize this thing. We didn't make much more progress than the others, but we did get free equipment for Delco's front end.

Remacle: How did you then get to Sevin Rosen Funds?

Phipps: Well, I talked to L.J. in …

Remacle: This is L.J. Sevin.

Phipps: In '84-'85 saying I'm thinking about leaving L.J., I don't know what I'm going to do, but I'd be a consultant until I can find something to do. And he appreciated my coming by. And then when I finally made the break and told him I'm leaving, he said-- well before I did and this helped, I guess I was a little risk averse, having been with a corporation for much of my carrier, about just what I was getting into. He says, "Look Charlie, to help the transition I will commit to taking 50 percent of your time as a consultant. You can have other activities and you only give me 10 percent time, that's fine but I'll take up the 50 percent, in some months it may only be 10 or 20 whatever you need I'll fill in the gap." Which that was a pretty generous offer so that helped bridge in moving out. So for that first year from mid '86 to mid '87 I'm working with Kilby and mainly at Hughes. And we did a little bit of ATT Microelectronics. I did some work for L.J. and L.J. and Berry were close. They had separate funds and Berry used me for some of those in his projects. So I did a little consulting for both of them. By the summer of '87 Ben and L.J. were pulling back [from Sevin Rosen Funds]. They were starting their third fund. It was down to just [Jon] Bayless and Dennis Gorman possibly would be the only two ongoing partners. And L.J. told Bayless, "Why don't you talk to Charlie and see if he will join us." So they did and I thought that would be exciting. So I came over and agreed to be a partner in the third fund.

Remacle: And that's how you were partner in seven funds or six funds?

Phipps: I was in partners from fund three through eight. Six funds.

Remacle: What were the key differences between being a venture capitalist and a captive …

Phipps: There are big differences which you don't appreciate, which I saw very early on. In a large company, in an internal venture, particularly as technology driven as TI was was usually the project team that was doing development work. They were not necessarily entrepreneurial. Usually they weren't as such. They weren't that resourceful. They were funded on a level of effort basis. If you didn't quite make all of your milestones you'd get the level of effort from the next year. And I remember even the '70s

Corporate Staff reviewing some of these product problems. We'd come in with six to nine month slippages. If Shepherd and Bucy liked the project they'd rationalize it and so would the people on it thought that look our sales or marketing or something is so strong it doesn't matter if we get in there a year late and we will make up going forward. So you could always rationalize where you were and be funded as a level of effort. Recruiting the team which is internal hires as to people who were available to get an experienced business manager, at least at TI, I expect other companies, to take over one of these internal ventures was very difficult because-- while Shepherd denied it we brought it up to him a couple of times that he plays the game of winner or loser depending on what the manager does. If he gives me a project and the project fails he is classified as a loser and his career is jeopardized and the business managers knew that. And why jeopardize your career joining something like this? Some of them were in line second in command in a business doing $50 to $100 million a year, things are well organized, it's running smoothly well, just stay there and pass up the line. So you couldn't get an experienced business manager to take these things on was part of it. So there a number of differences like that. The capital cycle was completely separate in approval from the expense cycle. So a project would be approved for expenses but may not get approval for 12 months later for its capital, where in a new venture you gave them equity. It was for given milestones. You didn't care whether they use it for expenses or capital just use it most effective manager.

Remacle: Get your results.

Phipps: Get your results. And the leaders were, of course, very passionate about what they're doing. Internally, there's often-- there's some excitement about it and some responsibility and recognition, but it wasn't the same passion as the fellows on the outside had about their ventures.

Remacle: When you look back at your career and you've had a fairly diverse one I think it's fair to say, when were the periods that were the most fun? What were the things that were most interesting and exciting?

Phipps: I knew you'd ask that. Certainly, the early IC period as a small team working together to-- at the time it was very frustrating, it was harder to get things done but it still was exciting. We got into the marketplace in late '61 and '62 and they got some accomplishments. Those were exciting years. And then in '65 and '66 they got back into T-squared L and the plastic packaging and the development of the industrial markets. Those were highlights. MOS was just more frustrations for me than any sense of accomplishments for me. And then in corporate staff there were some good periods with the early entries into the consumer business, the calculator and perhaps the digital watch the digital watch was short-lived though. The rest of it was not that exciting, I'd say.

Remacle: What about in your venture experience?

Phipps: In the venture business, well the early one was Cyrix which was Jerry Rogers out of TI who I knew and worked with the TI. And he was very impulsive but very strong-willed and decisive. And he capitalized on Intel. The product position at the time where the math processor was a separate unit but not all PC's needed but some would so they put an extra socket in the PC and sold the math processor in the aftermarket so we could come in the aftermarket. We didn't go through any long evaluations, move them to the aftermarket and sell the things and go. So it took off very quickly and that gave them the

resources to go on to the microprocessors which several of us had doubts, I certainly had doubts about Jerry going and I tried to discourage him from chasing Intel microprocessors. Let's go do something else. And he said, "What else?" And I would scratch my head and say, "I don't know. Some people are talking about communications processors." And he said, "Well, what do you mean by that?" And I told him, "I don't know Jerry, go find out." But he was hell bent to do the microprocessor.

Remacle: Kind of the flip of what's the most exciting, what was the biggest lesson you learned most painfully?

Phipps: Probably dealing with people. I'm more of an introvert than an extrovert probably. I have small teams and I'm used to interacting with them. And in those early years we were more protective than we were open and outgoing with our ideas and what we were doing. We didn't interact as much as we could have or should have with other elements of the organization, pulling in their advice and things we were trying to do, we'd rather to try and do it ourselves and stumble than look around for help. So learning to communicate, learning the elements of being more open with your ideas and exchanging with a lot of people early before you're well into them. Selecting strong people. I was fortunate in marketing that the area of integrated circuit attracted fairly strongly people. And other areas where we had to pull people in, that took a while, really into the VC period. I learned that you just don't take people who are good enough to do the job. You've got to take people who are better than that.

Remacle: Really good.

Phipps: Yes, really good. So that was a lesson I had to learn over a period of time.

Remacle: Do you consider yourself an entrepreneur?

Phipps: Not really. I think I'm a little risk averse. I'm more of a strategist, the analysis of data, interacting with the customers, understanding the solution, developing the strategy, more of getting the team focused on it, following up with milestones, all of those parts of things. But to say that I would step out away from a secure corporate environment, recruit three or four other fellows to form a team, go out and look for funding to strike out that's probably not. I never did that in my career. And so I don't consider myself really an entrepreneur because of that. Maybe half or 30 percent entrepreneur.

Remacle: When you think about all of the projects you worked on they've certainly had a large dose of entrepreneurial innovation.

Phipps: Yes, embracing change. I relish the challenge of change.

Remacle: So if you were giving advice to a young engineer today who said, how do I go about making sure that I get to work on innovative things, maybe become an entrepreneur and start my own company, what kinds of advice would you give that freshly minted engineer.

Phipps: Yes. You need to understand the problem that's going to be solved pretty well. If it's outside the company go talk to the customer, talk to more than one customer, and they will express the problem differently from the way they talk and what insights they have and how you couple this with your technology. Give some weighting to it and continue to talk to them. Once you have a solution in mind be open-minded about it with others around you, get their advice. Yes, you'll get the arrows and you'll get criticism. Don't be too thin skinned to take it and pick up the best elements and work with it and build on it from there. The people selected to work with have to be good, [people] that can grow with you and have the potential, not just good enough to do the current assignment _____. These are some of the things. And in the venture area itself you learn some axioms. One that I was slow to learn and I really didn't learn it for about 10 to 15 years. I learned it from Desh Depende who was a founder for me in an '89-'90 venture. And he left that one, he couldn't get along …

Desh Depende was a co-founder, a venture funded in '89 up in Boston. And after about a year, he left because he couldn't get along with the other founder that well. And then subsequently [he] went out and formed Cascade Communications,which was very successful. And then he founded about a half dozen [compaies] in a row which about four out of six were pretty big hits. And I'd follow up with him and see him once in a while, and he told me, "One thing I learned at Corol was the specs kept changing." And because of the other VC, which was TA Associates, wanted to enlarge it to a bigger system and all of that, we were moving ourselves further away from the market as far as an entry from 18 months, to 24 and 34 months. And he determined that was the wrong thing to do and it was. So in the other ventures he's done, he always insisted, that you must have some subset of the equipment. And it may not be the grand or final product that you'll get to the market within 12 months, just to get the experience of working with the customer, understanding how it fits and all of this. I watched him and he did this. And he was very successful. So by the late '90s I started to preach that with mine that whatever you do try and break out something less complex that's on the path where you're going and put that in the hands of the customers one way or another so that you get that experience.

Remacle: So two last questions. One of them, is there anything else that we should talk about before we run out of tape here that we haven't talked about in this discussion? Have we covered…

Phipps: Well, we've ranged over much of it, I think. I did some other things that Bucy would get me invovled in and I always was involved with Haggerty on his policy talks which he'd give about once ever two or three years. And I would develop the information and the outline to talk and thoughts for him. So I did this throughout up to the time of his death. He died in October of '80 and I spent a week in August of '80 at his home up in Door County, Wisconsin working on a talk that he gave in September as an example. And Bucy was very much involved with the Department of Defense, he was on the Defense Science Board. And he headed up several important major task forces for them. And I was his spear carrier for them on the design to cost in the early '70s. And then he did develop one on the control of technology exports in the mid '70s. And from that I became a consultant with the DOD and working with the State Department and Commerce on trying to implement technology transfer export control guidelines and things. So with that I had to appear before the House and Senate committees, Jake Garn in the House and Frank Church in the Senate. So that was a different role and challenging in it's own right but very frustrating. You saw how slow and bureaucratic the government was.

Remacle: You just reminded me of one more question I wanted to ask you that I had that's not an any of this piece of paper but you remained good friends with Jack Kilby all of his life.

Phipps: Yes.

Remacle: And were one of the people that delivered a eulogy.

Phipps: Yes.

Remacle: Can you give us a kind of sum up your relationship with Jack and how that affected who Charles Phipps is today if that's not too cosmic a question to ask.

Phipps: Jack was very much the creative inventor. He had some 67 patents in his name. He was a competitive person. He wanted to see his inventions carried into the marketplace be successful. He was a very thoughtful individual. He used his words sparingly in a conversation you might ask a question of a point and he'd sit there and look at you for 10, 15, 20 seconds and then say something but he thought it through in his mind and he delivered a response in the minimum number of words, one or two sentences and that might be it. He was also in a way, in his personal life, very risk averse. Jack never used any of the personal electronic gadgets that came in the main. He didn't use the PC. He didn't have a digital watch. He never had a cell phone. None of these things. He had an IBM Selectric Typewriter in the office and he wrote his letters out in the '90s on the IBM Selectric. TI insisted on communicating with him with e-mail and they put a PC on his desk and showed him how to use and so he would occasionally e-mail or respond to an e-mail from TI but he didn't use e-mail for his own initiated correspondence. He had a great interest in inventors and he had a library of biographies of famous inventors, and the role and the hardships they had to overcome. And he kept current by working with committees or advisory groups and semiconductor technology and going to some of the technical symposia together. But one of the stories I told in the eulogy was that with his sparing words, I would stop by the office over in Hillcrest. Every morning I was in town for about the first hour, you know about 8 o'clock Jack would come in shortly afterwards and we'd have coffee and tea together, compare gossip or notes and who he'd see or he heard from somebody and what they're doing. So we'd talk for about an hour or an hour-and-a-half but the conversation always had long periods of silence where we would say something and Jack would think about it and after a minute or two he might give an answer or he might be off on another topic or something. This was the nature of our conversation. For somebody sitting in they'd think it would be very odd that that's the way that Jack communicated and we got along fine doing that.

Remacle: Thanks, Charles.

END OF INTERVIEW

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A MAJOR BREAKTHROUGH

TI showcases transistors by designing the world's first transistor radio.

By the summer of 1953, Pat Haggerty believed that the future of Texas Instruments was tied to semiconductors. TI was producing germanium transistors, but the market had been slow to respond. The industry was comfortable with vacuum tubes and had taken a wait-and-see attitude. Transistor sales had been just a trickle with a few applications, but Haggerty's goal was to produce them by the hundreds of thousands. A daring plan would herald the world's acceptance of transistors and help launch TI into a new industry.

Haggerty turned his attention to the computer giant, IBM, which he believed one day would buy a lot of transistors. IBM, however, was barely aware of TI and had shown little interest in transistors. Haggerty decided that IBM and the electronics industry in general needed a transistor wake-up call and that a small radio would provide it.

Haggerty urged Mark Shepherd's semiconductor business to develop less expensive ways to build transistors. Shepherd directed Boyd Cornelison and Elmer Wolff to create a method for mass-producing germanium transistors. The existing fabrication consisted of skilled operators working through microscopes, assembling tiny bars into individual transistors. It was a slow and tedious task and would never reach the production levels Haggerty envisioned.

Cornelison and Wolff came up with the indium dot ladder process, a radical approach that allowed for batches of transistors to be built at the same time in a furnace. Mort Jones of the Research Group described it as "a pan of cookies." It was a creative method that eliminated the old one-at-a-time procedures.

In the spring of 1954, Haggerty decided TI would develop the transistor radio business, even though, at the time, transistors were poorly suited for the job and much too expensive. Haggerty and S.T. "Buddy" Harris began asking large radio manufacturing companies if they might be interested in teaming up with TI to build a transistor portable radio. Most companies said they would wait and see what happened. Vacuum tubes were cheap and dependable.

Celebrating the introduction of the world's first transistor pocket radio, Pat Haggerty (left) shakes hands with Ed Tudor, president of the Regency division of IDEA, Inc.

ve still did not even comprehend what all the problems were hat lay ahead. It wasn't exactly your typical Friday afternoon."

Roger Webster, an electrical engineer and top-notch ransistor circuit designer, agreed to tackle the toughest ssignment – developing the Intermediate Frequency mplifiers. According to Davis, Webster had to build "a circuit hat would amplify high-frequency electrical signals by a factor of many thousands." He, along with Ed Jackson, fresh from the uccessful silicon transistor team, and Mark Campbell, another xperienced electrical engineer, plunged into the uncharted vorld of designing and building a transistor radio. They had no uitable coils or transformers and were using transistors that erformed poorly at radio frequencies. They were joined by im Nygaard, a fresh Texas A&M graduate. Nygaard recalled, "I vas really quite awed by the fact that I was only out of college or two months and was involved in what was going to be the irst transistor radio in the world. Very few people ever get an pportunity like that."

His opportunity was a chance to work night and day and ver the weekend, on a project that was an extraordinary echnical challenge. But it was also the rare opportunity to vork with some of the best engineers at TI on a Haggerty roject that could alter the course of the company.

Tuesday afternoon, a day early, the weary and jubilant team carried a working radio to Haggerty's office and turned it on. As Davis later reported, "It clearly received all local AM stations, nd the tone quality of the audio was quite good." Haggerty was leased. The team had accomplished their four-day miracle.

When Haggerty welcomed the representatives from IDEA nto his office on Wednesday, he had a transistor radio to show hem. Any doubts they might have had were quickly erased, nd negotiations began in earnest. TI and IDEA would begin mmediately to design the production model jointly, and IDEA vould then assemble and market 100,000 of the Regency-rand radios.

The revolutionary new transistor radio would be introduced n New York and Los Angeles by mid-October 1954 to take dvantage of Christmas sales.

Haggerty, Shepherd, and Harris argued about the retail rice while waiting on a plane at Love Field in Dallas. Shepherd ecalled that the three men finally agreed on $50. He said, "We *ent out and caught our airplanes, and that was it.*" Haggerty aid later that they thought if it was any higher it wouldn't sell, and if it was any lower TI would lose money.

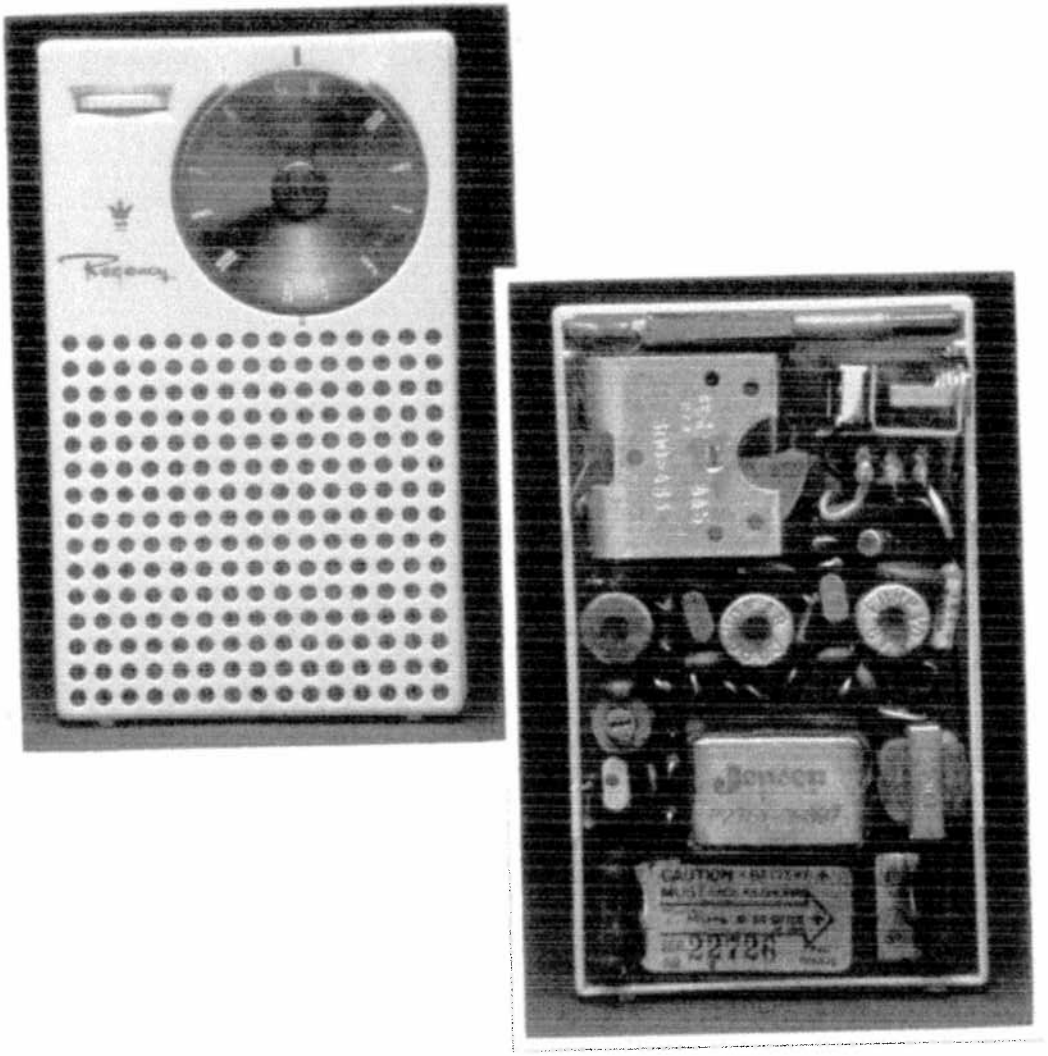
TI was still facing an improbable deadline if IDEA hoped to have a miniature transistor radio in production by October. It was time to design a radio. The TI team of Webster and Nygaard moved into their new home-away-from-home-- a radio-shielded screen room. Along with the IDEA team of Ray Morris and Dick Koch in Indianapolis, they began the radio design in earnest. At the same time, Cornelison, Frank Horak, and Wolff began their night and day project to stretch the performance of the newly developed indium dot transistors far enough to make a practical radio.

Webster's engineering notebook page dated June 30 had a wiring diagram of a six-transistor radio with the optimistic note *"To Ray Morris—final design."* But at the combined design team meeting a few days later, Haggerty insisted that six transistors were too many. It could have no more than five. Koch and Webster consulted briefly, left the meeting, and headed for the screen room. Back within an hour, they reported that they had replaced the detector transistor with a diode, and it "worked just about as good." Five transistors it was.

But this, too, Haggerty rejected. It must be four. Haggerty knew how to reach his original goal of four transistors— one transistor at a time. And Koch of IDEA pulled off the miracle a few weeks later by inventing a method of combining the two transistor functions of oscillator and mixer into one "converter" transistor. And on August 30, Webster's notebook, once again, showed a "final design." Only this time it had four transistors.

IDEA now had six weeks to mass-produce the transistor radio. One of many obstacles was that tooling to stamp out the steel chassis would take a minimum of six weeks to produce. TI's Tool Shop took on the challenge and supplied the tool in nine days. Not to be outdone, TI set up production for the tiny audio transformer to drive the loudspeaker.

On October 18, 1954, the Regency TR-1 radio was officially announced to the world: "The radio receiver measures 5 x 3 x 1 1/4 inches – the smallest set commercially available – with the semiconductor devices themselves occupying less than 1/10 of a cubic inch. The 'pocket size' is a significant achievement since it includes a high-fidelity, high-volume speaker, and single-battery supply, as well as all associated receiver circuit components. The introduction of this first mass-production item to use the tiny transistor to replace the fragile vacuum tube leads the way for *the long-predicted transistorization and miniaturization* of many other mass-production consumer devices."



The first transis the Regency TR models of the fi are in the Smitt Museum and ca on the museum

As Haggerty pondered his next move, a Chicago investment firm inquired about the possibility of TI's merging with a small, innovative Indianapolis electronics manufacturer—Industrial Development Engineering Associates (IDEA), Inc. The firm was producing television accessories such as signal boosters and UHF channel converters, all sold under IDEA's trade name, Regency. Haggerty was interested. The acquisition of IDEA might provide TI with an expeditious, low-cost route to move transistor radios to the consumer market. He and Harris met with IDEA President Ed Tudor to discuss the matter at a consumer electronics show in Chicago in May 1954.

A merger was ruled out, but during discussions with Regency,

stations in Dallas. He could select anybody he want with on the project.

Davis, an electrical engineer who had previously as chief engineer at Watterson Radio of Dallas, no He would begin work immediately.

"Fine," Haggerty said. "I won't need it until next Wednesday." On Wednesday, Haggerty would be with IDEA, and he knew that having a working tr radio playing on his desk would give TI leverage d discussions of a business deal.

Davis later recalled, "As TI engineers, we were to meeting right schedules on development projec of six months for a product where most companie a goal of at least a year. TI engineers seemed to th projects."

His assignment bordered on the impossible. In Davis and his team had to develop and build the model of a transistorized radio at a time "when th