



## **Oral History of Jack Clemens**

Interviewed by:  
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**Jim Porter:** Well, today, we're here with Jack Clemens, who is a veteran of a lot of things in the disk drive industry. And we're going to explore, with Jack, how and why a lot of development's happened, over the years, in the disk drive industry, what were the causes, what were the causes from the markets, from people's attitudes, who are participants, and what the technology let them do. So to get started, Jack, I wonder if we could just start with your talking about where you came from originally and where you went to school.

**Jack Clemens:** Real name is John, but I've always preferred Jack. I'd appreciate that. I was born and raised in a small town outside of Chicago, Naperville, Illinois. It was a suburb much like, oh, Palo Alto might be to San Francisco out on the commuter bare road. And went to high school there. Then I went off to University of Illinois for four years, got my degree, bachelor, in electrical engineering, there. Older sister had gone to New Mexico to work as a teacher and recommended it highly. So during my junior and senior year in college, I went out on an internship program to Los Alamos. And first time, really, away from the Midwest. And I was wowed by the mountains and the clean air and the blue sky. So I went back there after I graduated and worked at Los Alamos Laboratory, for two years, in an electronics division, which supported the physics group, doing various experiments. So we've done all sorts of kooky electronic stuff, nothing off-the-shelf. They were all figments of a physicist's imagination, very interesting work. But I was getting of an age where I was looking for a bride, and women were few and far between. I was briefly dating a girl in Laramie, Wyoming. A 750-mile-one-way trip to go out on a date on Saturday night wasn't working real well. And a friend of mine said, "San Francisco's the place to go." So one day I read that some company that I really had no familiarity with, called IBM was interviewing people for a place in San Jose. And it was supposedly close to San Francisco. So off I went to Albuquerque and talked to them. And they hired me. And in May of 1957, I left Los Alamos and moved to San Jose, where I was assigned to a product engineering group. Almost immediately, I was transferred to a development group to go work on the RAMAC.

**Porter:** Which was, of course, the first disk drive.

**Clemens:** First 24-inch big disk drive.

**Porter:** When you worked on it, was that before it had shipped?

**Clemens:** The A units, or ten A units had shipped in '56. But, no, it had not gone into production yet. It was still in the – we were trying to work out problems. The original A Model had a lot of problems. One of which, the whole logic of the disk drive controller was done in, what were called, wire relays, which was a technology IBM had developed for their old accounting machines and punch card equipment. And when this thing ran, it sounded like a swarm of bees with all these relays <makes buzzing sound>. It was being converted to vacuum tubes. There were a number of other technical problems. Power supply and the voltages required to control the server were bad. The machine didn't meet its access time. It was too slow. And lot of other cleanup stuff. But I was assigned the job of the magnetic clutches, which basically drove off an AC motor. One spun in one direction. The other one spun the other direction in a common shaft. And by energizing the magnetic powder in these clutches, you

could drive the shaft one way or the other. That was the basic power, mechanical power, supply with the RAMAC. And they handed me these things, "We don't know what the problem is, but they're not working right." Finally figured out that they were aging too rapidly. The iron powder that was in the clutches was rusting. We put in, I think it was, zinc oxide, as a drying agent, to solve that problem. But that was the summer, about four months that I worked for IBM before being drafted. It was...

**Porter:** What time was this?

**Clemens:** This was May of '57 to September of '57. And the machine was just about ready to be shipped. The factory, Building Five, down in Cottle Road, had been completed. And there were machines being assembled. Most of the activity of manufacturing was applying engineering changes at that time, because the design was still quite volatile. And it was my first experience after working at kind of a civil service job, a eight-hour in a-day job, seven -- six -- five days a week, at Los Alamos. This was seven days a week, eight, ten, twelve-hour days, pretty routine. I remember one Sunday afternoon, about six o'clock, as we left the lab, one of the guys said, "Have a nice weekend," because we're going to be back at about seven o'clock the next morning. But anyway, it was an exciting time. It was a lot of fun. And the RAMAC was the most animated disk drive ever built. It was an exciting thing to just watch it. So I went off to the army. I'd been drafted. And I went to Fort Ord, for eight weeks, basic training. And I was recruited -- was selected for the army scientific and professional program, sent off to Redstone Arsenal for two years. That was the time when the first Explorer satellite was launched. That was an exciting time at Redstone Arsenal. And it was, also, the time that Kennedy decided to send us to the moon. And the mission of the army military aspects of the base changed to the -- what become NASA. I didn't participate in any of that. I was just kind of there when it was happening. Our -- my job was in soldier civil service in a group called Missile Electronics Laboratory. And we spent two years that I was there in search of a mission. As only the government can do, they -- never occurred to them to shut the place down because they have nothing to do. It was more the challenge of finding something useful for this group of about 20 people to do. Anyway, I spent the time burning up transistors and learning about circuit design and so on, playing games. You had a lot of money, and it was a fun time. And periodically, when I was out of the laboratory, where I worked, then, I was on KP or barracks orderly, or other things that the army does. When I got out of the service, I looked around for a number of jobs. I had some interest in moving to the East Coast and interviewed a number of companies around the country and decided, in the final analysis, to go back to IBM. And so I returned in September of '59 and was assigned to a group called Basic Development, which was charged with moving products quickly, or, I should say, ideas quickly out of research and development into development, and to products. It was sort of a bridge organization. It lasted about three or four years before they realized the folly of this concept. But while I was there, worked on a number of interesting things. But was really going nowhere. And it was all game playing. And most of us, like myself, with a bachelor's degree, were working with technologies well beyond our abilities. So I was pretty bored was -- when I was approached by Bill Goddard, who was the director of education at IBM, asked me if I wanted to participate in a program, an exchange program, with the sales organization. And the idea was that they would take a couple of engineers out of the lab, move them into the sales offices so they learn something about what selling and customers were about, and they took a couple of salesmen and moved them into the lab as planners so that they could learn what development was about. And I was at the point where I said, "Almost anything would be better than what I'm doing." So off I went. Next thing I

knew, I was sitting out at 1955 the Alameda, with the IBM sales office, studying punch card equipment catalogs and manuals, trying to learn -- and so I went through, what was called then, unit records school, learned all about sorters and accounting machines and plug boards, all the stuff, and then went back to the sales office, spent a lot of time with the food processing industries, which were still very active in the Sunnyvale area, Del Monte, Shuckle [ph?] Foods, Contadina, Sunkist. Sunkist had one of the early RAMACs.

**Porter:** The orchard business was basically the business in San Jose at that point.

**Clemens:** Yeah, and the other side activity -- periodically, I would spend some time at Lockheed. IBM had a big installation there. It had a big -- about four 7090 computers and a lot of small stuff and a lot of unit record punch card equipment. And so I taught unit record school for the Lockheed employees and did some their odds and ends, learned 1401 programming, Autocoder, really enjoyed that. But at the end of a year, I was asked if I wanted to stay on in sales and I said, "No. I think the real future is in engineering. I'm just not the glib, tall, well-dressed guy with the image of the IBM salesman," at the time. So I returned to the development lab, and I was assigned to a group that was working on the 1311. The 1311 was the first 14-inch disk. And...

**Porter:** And the first disk pack drive.

**Clemens:** In its initial form, it had a removable disk pack, much like a parrot tape drive, where you could store information, put it on the shelf, when you're not using it, bring it back, put it online and have access to the computer. But in the original form, it used a hydraulic actuator and the actuator was very slow. The actuator being the mechanical part that moved the heads over the disk surface. It would cock back to a position called the home position. And then it would step out in a forward direction only. So depending where you were on the disk, you had to retract and then go back out again. And the big key was going direct access, where you'd move directly from one track, one cylinder, to another. And we worked on that. There was a lot of problems with the heads, which are using laminated new metal, and trying to upgrade the heads to a higher technology. The 1311 was just an excellent product for IBM. Had some contact with the marketing people. IBM had some formulas by which they calculated the value of a product and what kind of what would be termed gross margins in outside world. But the theoretical limit was, I think, 35 percent that the product could reach. And that's where the 1311 was at IBM. It was just a goldmine.

**Porter:** Course, in those days, most of those products weren't sold. They were leased.

**Clemens:** Yes. But they had some formulas for calculating, very complex. But anyway, this was right at the top of a heap, as far as its rating goes, as far as what it was contributing to the coffers of IBM.

**Porter:** Now, were you working on the 1311 refinements after it had first shipped?

**Clemens:** Yes. It was already in production. The direct access was a major step up. And I think it was introduced in conjunction with one of the IBM systems as an attachment to one of the IBM systems could've been the 1410. I'm not sure. It was also attached to a small scientific computer called a 1620. And they were -- IBM was very much interested in process control and trying to improve the reliability of that system, and so we went off on a program called Stamina, which was designed to improve the reliability of the 1311. So we made a lot of changes to the basic unit, for a small production run, for the Stamina Program. Turned out all our reliability improvements, because they were produced in such small number in kind of a half-bake way -- the Stamina Programs were the worst reliable version of the 1311. Let's see. If I could look at my notes for a second, I'll try to figure out where I went then. The -- oh, the next thing was IBM had decided to build the System/360. Big, big decision, decision that, I guess, technically bankrupt IBM briefly. But they were so confused. They didn't know it at the time. It was only after the fact they figured it out. And one of the key decisions of that was that every System/360 would have a disk drive attached to it, and that was a big move. Because up till that time, all of IBM's thinking had been tape drive, tape drive, tape drives -- input, output device for the systems. And, okay, you can add a disk drive if you've got some random access applications. But the tape drive was still where all the action was, so every system was going to have a 360. And I was moved into a technical planning group. And so we did the technical planning for the System/360 and flattened out a lot of problems, but that was a lot of fun. Got to go back East and meet Gene Amdahl and Fred Brooks, who are the two architects. Brooks had the software architecture, 360, and Gene Amdahl had the hardware architecture. And the various engineering groups around the country, at IBM, when they had trouble, they would gather their troops together. They would traipse back to Poughkeepsie or White Plains. And they would sit down with these guys, and they would come out with a solution or a direction to go. Fred Brooks had an interesting office. He had a conference room but no table. He was having so many meetings, the meetings would typically last 5, 10, 15 minutes. And you would go in there. Everyone would stand. So nobody would get comfortable in the meeting <snaps his fingers three times>. And he had -- it was like going to the doctor's office. You checked in at the front desk, and you stood in line. You got your audience with the Pope. Forget what we back on. Was some problem that required a universal solution. And he was the guy. He was the dictator. He did -- well, anyway, that was the technical planning group. Then I was -- one interesting aside that I -- maybe you've heard this story before. But just about the time the 360 was to be shipped, the people in Poughkeepsie, in the tape group, came up with something called the tape loop. A tape loop was -- somebody discovered the section of a sausage wrapper was a complete circle, no seam, and it could be coated with magnetic tape, or, magnetic paint. And this -- these were put in chambers. There was a central tube, and they were shunted out of these chambers, down the central tube, into a heart-shaped, triangular, cavity, where puff of air would inflate the loop to fill it. Small capstan in the core would spin it, and this loop would spin free-form overhead. And because it had all these chambers for storage, it could be a couple of chambers or a lot of chambers or huge number of chambers, very fast access. It could replace the 2311. It could replace the 2321. It could replace all of the random access storage devices. And I got involved with it because my assignment was what are we going to do with all these engineers in San Jose, because we're not going to build disk drives anymore, we're going to build tape loops. And so I had that assignment. And I went back to Poughkeepsie. Well, I went back to the tape loop program. There was this big huge shed that was built in one of the labs, wooden shed. And the guys were running around with these big muffs like you find at the airport with -- and they were going to demonstrate a tape loop, put on one of these things. This -- they dropped the loop, and this thing -- shrill high-pitched huge sound <makes squealing sound> as it spun around. Well, it was -- because it was

free-form and unsupported and a very light weight, this -- they never solved the acoustical problem, along with other things. That program was killed. But Bob Evans, who was in charge of the big systems area, really pushed this thing like crazy. And there was a little bit of a panic, in San Jose, that, my god, all our products are going to go away, we have no work here. Anyway, that tape loop disappeared. That's just a little aside.

**Porter:** And the 2314 went into production.

**Clemens:** The 2314 was little later, but the 2311 went into production at that time, yeah.

**Porter:** 2311 was in production before the System/360. But then when the 360 was announced, didn't they announce the 2314?

**Clemens:** I thought the 2311 was introduced with 360. Maybe it was there beforehand. For some reason, I associate 2314 with -- hum.

**Porter:** Yeah, it came out with System/360. But when they came out with 370 later...

**Clemens:** Yeah, guess -- I guess you're right. I guess you're right. It was not with the original shipment. But it came in soon after Model 40. After that, the -- once System/360 was shipped, there was no real need for the technical planning group anymore. So I went off and was assigned job of electrical manager on a small disk drive program called RAMKIT, which became the 2310 first cartridge drives. And it had a host of mechanical problems, and so we -- I was part of the redesigning of the whole thing. And it was brought out as a low-end storage device, had one megabyte capacity, as I recall. And that lasted for a couple years. Then I was promoted to take over the whole program and do a fast version of it. The RAMKIT -- the 2310 was the first voice coil actuator machine, as far as I know, in industry.

**Porter:** And it was the first removable disk cartridge drive.

**Clemens:** Yeah, but it used a voice coil motor. But it used it as a stepper motor, only stepped one or two cogs at a time. And it had a rack and pinion detanning scheme to locate it -- and it was decided to do an advanced version of that, turn the voice coil into a full servo version. And that product was aimed at the System/360 Model 44. Model 44 was a throwback, actually. It was a scientific only computer. It didn't fit the rest of the 360 line at all. It was being done in England, and I just have to believe it was some sort of political gratuity to the English lab or something like that -- that it was done. I always said, "The System 44 not only was the type number but was -- total forecast for the product, I believe, was 44 System." Anyway, we developed the full voice coil version of the RAMKIT. Because I had some experience in sales, I was then selected to become a taskforce manager at the Bank of America. Bank of America was one of ten sites that IBM had selected to solve problems with System/360. The stuff was in production, but it just wasn't working right. The Model 65 was top end. I remember that it had some sort of crack stripe problem on the semiconductors that were used on the machine. And

reliability was just terrible. At this time, you'll find this amusing, Jim, Bank of America's entire data processing requirements were two Model 40s in San Francisco and two in Los Angeles, each of which had four 2314s attached to them. And that was going to solve Bank of America's computing problems for the rest of their lives. We had all sorta problems with not being able to initialize disk packs, that is, to prepare them for -- do the preliminary formatting of the disk drives so it could be programmed. There were problems with the bull's-eye, the drive assignment, buttons. But anyway, I got lot of exposure meeting executives with the Bank of America pounding on the desk and wondering what was wrong. And we spent about three or four months resolving various problems. And I was wondering, as I got towards the end of it, when will this end. And blessedly, I got appendicitis, about that time, was rushed off to the hospital. And when I came back, the taskforce was all gone. So sort of took care of itself.

**Porter:** At that time, Bank of America was headquartered in San Francisco, which is where most of that had to happen, right?

**Clemens:** Yeah, this was 1966. I then had various assignments. I worked for the storage products manager as a staff assistant for a few months. And I was moved over to a program called 2321, the strip file, was working for Jerry Harries, who had the program at that time, as a staff assistant. And, I suppose, it was part of the setup that I was being groomed for taking over that program. And in the summer of '67, Jerry Harries was promoted to take over all the disk drive storage product activity. And I was moved up to take over the 2321 program. This was a big event. Jerry Harries I characterized as being, at that time -- what's the secretary of state, brinksmanship guy? Can't remember his name. The United States Secretary of State had the policy of brinksmanship, of pushing Russia right up to the brink and then backing off, testing, continually testing, how far we could go. Jerry had the same idea. But he'd push you up to the brink, and then he'd boot you in the butt, kick you over the edge. He was not a well liked individual at all. And so when this reorganization came, he was promoted, I took over the 2321, a lot of people looked at it very, very askance. I believe triggered the exodus of the Dirty Dozen. And the people I knew quite well on -- in that program had...

**Porter:** That idiom called Dirty Dozen who started ISS?

**Clemens:** Yes. Yes. And most of them were off of disk drive programs. Jerry Harries was not known as a disk drive guy. He was working on that crazy strip program. There was some turbulence in the organization over the value of that particular product program. Anyway, the -- I think it was December of '67 when the Dirty Dozen left, an unusual event, in fact, a very unusual event. IBM had never lost 12 people at the same time to anything. Nobody had ever quit. And I was given the job of working with the attorney out of New York that they sent out to write letters to all these guys of ours, what they knew and what they didn't know and what they could do with their knowledge and what they wouldn't be able to do with their knowledge. Bardo Farr was the attorney's name. And so these were all good friends of mine. And I viewed it with shock and, I guess, a little disappointment because I wasn't asked to go with them. If I'd been presented with the opportunity, I don't know what my reaction would be. I was, I think, known as a pretty loyal IBM guy. And I think maybe, if there was any thought of talking to me about it, probably thought that I would probably rat them out if I did. So I never knew anything about it till suddenly all occurred. So anyway, Jerry's promotion was short-lived. The people back East got

very upset with what went on, and they insisted that they bring Mr. Al Shugart back in. And he was brought in to replace Jerry Harries, taking over all the disk programs. And he was -- job primarily was to settle the troops. Al was a very popular guy. And, indeed, it did settle everything down.

**Porter:** In the meantime, are you still with the 2321 Program?

**Clemens:** Hum?

**Porter:** You still with the 2321?

**Clemens:** I was still with the 2321. Yes. I'll tell you about the 2321 -- my part in this was that I got promoted to fill Jerry Harries's job on the 2321. And I have never been so over my head on anything in my life. I was not ready for the job. I didn't know the machine nearly as well. And I had some real mavericks, one of whom you know, Rusty Nagakura, working for me. And Rusty had been on the program a long time, obviously thought he should've been the guy that had my job. And he wasn't about to cooperate with me. And it was the only time in my life, for about four months, where I'd get up in the morning and my guts would just churn because I had to go in the office. And I would typically come into the office at seven o'clock trying to get a jump on things. And there would be a phone message, almost immediately, from Jerry Harries, saying had I heard about the customer, in Akron, Ohio, that had a problem with his 2321. Jerry knew much more about it than I did, and he was all over me. So I was getting it from the top and the bottom -- Al fired me from that job. He took me out, put me in -- a non-job of some kind. I've never been so relieved in my life. But that was one of Al's great virtues. He, you know, really cut to the chase, and he made things happen. And even something unpleasant, like that, was right thing.

**Porter:** Had you known Al at that point?

**Clemens:** Yeah, I'd known him for a long time. He had been -- Al wasn't really involved that much in the disk drive programs. He went off, probably around the late '60s, early '70s, to work on some special projects for the government.

**Porter:** He left in '69.

**Clemens:** I'm way off then. Early '60s, he'd gotten out of the disk drive business. Excuse me. Just a decade off, Jim. And he was working on some special projects, Acorn and Walnut, which were very, very large storage devices using pneumatic tubes and little capsules of images and so on that they would -- they were built for the National Security Agency, the FBI. These are wonderful products for IBM. Because you build them, you ship them and they went into secure area. Nobody could get back into them. Nothing got out. So even if they didn't work, we never found out about it. He was brought back into the mainstream disk drive business, at that time, anyway, in '67. And he took over. There was a product marketing group in San Jose, which, for



one reason or another, I forget who left, the job became open. And Al came to me one day and said, "I've been through 12 people. Nobody wants this job." IBM San Jose was notorious at eating market planners alive. It was a technically driven organization. Engineers were king. And a guy that came in and said, "The customer wants..." or, "The market requires..." just got nowhere. So Al asked me if I would take over the group. I said I would. So off I went and became the marketing manager, for Shugart, for about a year. One of the interesting accomplishments, at that time, we're getting a lot of pressure from the East, the big systems guys, saying, "Why do we want to do the 3330 Program?" It was a troubled program. It was way behind schedule, costing way too much money.

**Porter:** Well, the 3330, we should mention, was the project known by the IBM code name of Merlin. And it was the product which was going to replace the 2314 disk drive and to take the capacity from 29 megabytes per disk pack up to 100 megabytes, quite a big change.

**Clemens:** And when the Dirty Dozen left, one of the Dirty Dozen was the program manager for Merlin. And he basically left saying, "You're never going to make it work." And so there was a lot of doubt whether or not that program was going to succeed or not. But the big -- strange thing was the systems guys back East said, "Why do we want to build a four times capacity to the 2314?" Well, just sell a quarter as many, you know, 100 million, you only need one-fourth the number to do the job and -- which was a preposterous thing to do. So one -- my big contribution was to go through. And we did an analysis of how fast IBM's customer base was growing, as far as capacity requirements go. We found out was quadrupling every three years and was a curve that -- I brought one of my engineers from the RAMKIT program over. He said it was -- the correlation was so high that it was doubtful that it was correct, because it was, like, one percent were the actual numbers. And at that time, IBM owned the storage business. We knew what all the numbers were. So, based on that, we threw that in the face of the guys back East and quieted them down. And the 3330 program took off again under a man named Marty Kelly. Marty was a funny guy. He had -- his big claim to fame was he had worked back east and developed the first 2400 BOD modem, so-called Bisync modem. It was a big breakthrough, and Marty was a hero. And he came out. He took over the 3330 program. He knew nothing about disk drives, and he was not a very popular guy. About 1969, Shugart left. He was actually promoted, upstairs, to a job, back East, which he hated. Two weeks, I think, he lasted. And his comment to me, when he was going -- came back and on his way out the door, was, "They don't make money green enough to take a job like that." So he went out, which left a hole in the organization. And Marty Kelly was promoted to take that. And he asked me to step in and backfill him on the 3330 program, which I did. The program was a mess. We had eight disk drives, none of which were the same, none of which do we have accurate documentation for. This is back in the days when everything was on the small cards and the wire wrap back panels and so on, thousands and thousands of electrical connections and parts and things that were just -- the machine would not meet its access time. It moved -- the actuator was a voice coil actuator. It had resonances in it, which meant it vibrated when it moved. It had vibrated to a point where it was uncontrollable. And, oh, let's see. There were a number of things that were wrong. Anyway, very quickly, things I remember that we fixed was Les Adams, who had the control unit responsibility, came in and took over the drive documentation, went through thousand connections by thousand connections, went through the whole damn thing, straightened out the documentation mess. The mechanical problems -- my old friend, Mr. Dick Charlton, who's a mechanical engineer, he was going to solve that problem by building a base plate that was about four-inches-thick piece of aluminum that was going to stop that vibration.

So -- and all it did is wind at a higher frequency when he got done with it. What the real trick was -- the actuator was built at a very odd asymmetrical configuration, and there was just no way you could control the vibration. So we made a symmetrical configuration, which was the final configuration that fixed the problem. But the vibrations and so on were predictable, controllable. The other one was a disk pack writer. We had -- manufacturing had taken over the responsibility to procure a disk pack writer, which required writing a very precise servo track. They bought this from Grumman Aircraft. It had all sorts of problems. And I spent probably a year trying to tell people that we needed something better, finally got approval to build our own, which went in a bed of sand and a big granite slab. I remember saying, "If -- well, if it doesn't work, they can put R.I.P. Clemens on that granite slab and bury me under it because that's what's going to happen." But Dick Wilmer, who was a brilliant Ph.D. out of the East, did this project. He did a beautiful job. But anyway, he straightened that out. All of a sudden, we had a 3330.

**Porter:** Well, the 3330 finally shipped in '71.

**Clemens:** Yes. I left in November of '70.

**Porter:** Oh, you left before it actually shipped.

**Clemens:** Yeah, yeah, could talk about that a little bit. But it was interesting, because the people at ISS really never anticipate the 3330 would ever see the light of day. But the attitude seemed to be different at Memorex. They seemed to believe it was a credible product. They tried to match it and did. They did. I'll talk about that later.

**Porter:** That took a while. So you left the company in '70.

**Clemens:** I had talked to approximately 100 engineers as they were leaving IBM for various companies. There had been three major exodus. One was the ISS Group, who took the Dirty Dozen and then took many, many more good engineers with them to build a organization at ISS. When Al left, think he had a vendetta against IBM, quite frankly, because he took a huge number of people. And so there was another place that engineers were going and a third group called IOMEC under Hal Eden and Ray Herrera. They had left to build a small eight-inch disk drive product. And they took a bunch of engineers, not nearly as many as Memorex and ISS had. But after watching all these guys go out the door, I finally said, "Maybe I'm the one that's weird. They seem to know something else that I don't." They all seemed to be doing quite well. Companies were all prospering. They all had good salaries. They all had stock options. They were all going to be rich. And I was sitting there at IBM.

**Porter:** Well, that was an interesting time. After 13 years of living high off the hog at IBM, you finally decided to change your style.

**Clemens:** That's right.

**Porter:** And so you left in 1970.

**Clemens:** November of '70.

**Porter:** And you then went to work with one of the independents.

**Clemens:** Yes.

**Porter:** When you left IBM my understanding is you got involved with one of those independent companies called Telex.

**Clemens:** That's right, the 3330 was pretty much out of the woods of the technical problem being solved in November and I was approached by the Vice President of Telex. Dick Martin called me up and said "We're looking for an engineering manager, thought you might be the guy, would you like to have dinner?" Sure, why not, what harm can there be? So we had dinner and he painted a rosy picture of Telex. Telex at the time was a company, I characterize the computer industry as being caught in a propeller blade, most of us back into the propeller blade get our butts chewed off. But every once in a while somebody gets caught just right in and they're caught into stars. Telex had done a couple of fairly smart things, they built tape drives; one day they said "Why don't we build a tape drive that'll record in IBM format so that you could take a tape off our tape drives and move it to another machine that reads IBM tapes?" And then somebody said "Oh why don't we carry that one step further, we'll make the tape drive plug into the same socket that the IBM tape drive plugs into?" and suddenly they had a tape drive that looked just like an IBM tape drive, was half the price and was so called plug compatible drive.

**Porter:** A new term in the industry, plug compatible.

**Clemens:** Yeah.

**Porter:** And where was Telex located?

**Clemens:** They were down in Tulsa, Oklahoma, not exactly the centroid of the computer industry and they had built tape drives primarily for RL exploration, logging applications, data beta collection. At the time IBM had a marketing strategy where they basically gave away the CPU and charged a lot of money for the peripheral products that attached to it. They leased all their equipment or almost all this equipment, you could buy it but it was outrageously expensive, and so a tape drive was a very, very valuable item and by replacing a tape drive, Telex immediately moved into a just an extremely profitable situation. They could offer a lower rental than IBM and still make more money than IBM and this plug compatible business then spread to other companies and so on but Telex was one of the first; Telex also then got involved with this company ISS who built disk drives and decided why don't we build disk drives that plug into IBM

systems and they did and they bought disk drives from ISS and attached 'em to IBM systems and replaced IBM 2314's and unfortunately left Telex with the idea that they had been blessed in some way with superior knowledge and that this computer industry really wasn't that hard at all to make money. They're making money hand over fist, the stock was skyrocketing and they were gonna expand into other things. I think I was hired in retrospect for two purposes, one is I had the ability to develop a 3330 like product for them which they needed as their next generation, plug compatible. It also put them in a position to bargain more intently with ISS and get concessions on price and I think if they had their druthers they would have much rather continued to either buy product from ISS or perhaps even buy ISS, the company, and get their supplies that way. They had really no interest at all in doing product development of disk drives which I found out fairly quickly after I joined them. But we recruited a small group of people, out of IBM to start work on this. The idea was we were going to have the storage products division in California, we would develop and manufacture disk drives here. The first big blow came when I talked to the manager of manufacturing, Telex in Tulsa and he informed me that they would building the product there and I really went through the roof and wrote a very strong letter to the board of directors that's not the ground rules I was hired under and I expect that we will continue under the original agreement we had and I got a nice letter back from 'em said the board of directors will not be dictated to and we hereby accept your resignation, which was I think I got fired. But anyway it was delicate. So I was out of Telex in about 4 months, but not before I recruited a few people, one of whom was Dick Charlton who went on to become very successful and I started a company called Clemens Associates to do consulting. I had met with some CDC people, Control Data was interested in buying the product we were developing and I met John Titsworth and so when I left Telex he contacted me and said "Would you like to come to work for us as a consultant, we've decided we're gonna build our own 3330 here and we need some technical guidance?" So I accepted a job with them so primarily my consulting at that time was with Control Data and I just worked with some Japanese companies, I gave some lectures for Fujitsu, did a number of other things in the consulting field. After a couple of years in that, I got a little nervous there was signs of recession coming on and I thought a consulting job might not be the best place to be. Retrospect it probably was the best place to be but I decided not to and some openings appeared and Memorex. Let me back up for a moment. When I left Telex, one of the early phone calls I got was from a fellow named Al Shugart at Memorex who called me up to say "Jack, come by and say hello." So I thought well maybe he'll offer me a job, I needed one. Well he never offered me a job, it was just kind of pumping me for information but at that time Memorex was developing disk drives, they were shipping disk drives but they'd fallen into I think one of the problems of success of over expanding. They had picked up a bunch of engineers from Control Data Corporation who they'd set up in Minneapolis to design a system, small low end computer system and at that time about the middle of '71 they had just shipped about a dozen of these systems, pretty much prototype kind of stuff. And I remember in talking to Al and he said "Yep, yeah we've started shipping systems it's all up hill from here." And I thought Al you don't understand the business at all, I mean this is the worst time as far as profitability goes when you start shipping systems, they don't work, you got a lot of technical support, there are not enough of 'em to create any revenue but you got all the overhead of a big development organization and software issues and all that and sure enough Memorex really went under because of the burden of trying to bring these systems up. Their disk drive business remained profitable as far as I know but anyway the Memorex fell on very hard times, the stock plummeted, they laid off all the systems people and I don't know how Shugart left, whether he went head first or feet first out the door but that he was one of the victims of the collapse of Memorex. And but there was enough people there with a little bit of life left in the organization, they needed an engineering manager because he'd left too and so

they asked me if I'd take the job. They offered me a good salary and a lotta stock and I said "I don't want a lotta stock in a company like this, I need better money" so they came back with a good salary or excellent salary and a lotta stock and so I took the job and I thought well if this lasts 3 or 4 months it's better than any consultancy assignment I've had.

**Porter:** And this started I think in '73?

**Clemens:** Yep February of '73 I think it was. It was eerie walking around Memorex seeing labs that were empty, equipment standing, some of the equipment was still turned on and nobody there to operate it. I had a group of 90 engineers, the engineer attrition rate was 30 a month and I said I've got 3 months worth of engineers working for me. Fortunately some of 'em decided to stay, Tom Gardner, Tony LaPine, Ron Singleton, other guys stayed behind.

**Porter:** I was just looking at the old copy of Memorex Employee houseorgan and it listed here an organizational chart of how you were organized and it listed for example all kinds of things going on under your direction. For example in the so called Storage Systems Development led by Jack Clemens, some of the responsibilities included end user engineering, which was directed by Tom Gardner, you mentioned, Power Systems Engineering also managed by Gardner but other groups included Control Unit Programs Group by Ron Singleton. Hardware design people etc. etc. managed by Toray Larson, Micro Programming Group, Tom Eidlemans group, Software Credits Group, headed by Jack Kirby. Technical Engineering Support headed by Vince Mirco, Storage Systems Development headed by Tony LaPine whom you mention. Mechanical Engineering Group headed by Bill Montero, the Electrical Engineering Group headed by Mike Popovitch and Recording Head Technology Engineering, directed by Ray Herrera. Electric Circuit Design Group and Head Mechanical Engineering under Howell Lowe and two other groups, Head Materials and Head Design and Processes led by Art Withup and Jill Kareogah. I can't imagine you could keep track of all of that.

**Clemens:** I don't think our organization was ever quite that broad or if it was it was very brief. We generally organized under a drive group and a controller group and a technology group which is what I think we really wound up with. My recollection you just named about 50% of the people in the organization. The facilities Memorex had, they were in many ways superior to those I left at IBM. Memorex had the ability to develop their own ferrite, the material from which the magnetic heads were manufactured. They had a beautiful mechanical analysis lab with an optical interferometry setup that could measure micro inch motions and displacements but far beyond anything we had at IBM so the group had done a good job. The product was sound, the product had a lot of problems, these wire wrap back panels, the tension on the Gardner Denderer machine that wrapped them was too high and it was cutting through the insulation causing short circuits. A lot of sort of bone head things but the basic technology and the basic design. So we got it up and running and about the same time Bob Wilson came into Memorex, took over the company, and he was able to use the 3330 product that we built, 3670 I think was the code name of it at Memorex, and sold these to Bank of America for forgiveness of debt that the company had incurred under the systems program, and Bob Wilson was able to turn the company around. So suddenly Memorex was back on the upswing again and I had the job of the storage products that Memorex got involved in some communications equipment, controllers, they had the media products group and things were going quite well. Bob Wilson

preached a lot of things, he had a lot of catch phrases and so on, one of which was you hire good people. One of the people he hired was a Roger Johnson, Roger went onto become President of Western Digital and went to the Head of the Department of Commerce for a while and he was the guy I worked for and I was gradually promoted to take over all the engineering communications products and everything else. About that time Roger left the company and he was succeeded by Jim Dobbie who I had absolutely no respect for and that just was not going to work so I quit and went back to consulting and that was, let's see...

**Porter:** In '77 right?

**Clemens:** Early 1975, no I'm sorry, 1977, middle of 1977, yeah. There were a lot of frustrations, I had a lot of frustrations with John Scott over the media group who thought he should be running show. I had a lot of conflicts with Keith Plant who was the OEM Product Marketing Group and I saw Memorex lead in floppy disk drive production ooze through the sand under Keith's direction into nothing and Keith was a guy that Bob Wilson loved, he wasn't go anywhere. And I once asked somebody "What does Keith Plant, you know, what's his secret?" He says "He idolizes Bob Wilson" and apparently whatever it was they got along just well. But anyway I just saw a lot of things going to hell in a hand basket and I just didn't wanna be a part of it anymore so I left in '77 and I had in mind developing a small floppy disk. IBM years earlier had come out with an audio dictation system using a small 2½, 3 inch disk and it would record your voice as the old Dictaphone kinda things where you transcribe a message and then you hand it to your secretary and she would type from it. But it had automatic handling, it had magnetic recording and so on and I thought maybe this could be turned into a data product and, you know, perhaps buy the patents and the processes from IBM they were all worked out and they all worked beautifully. Anyway it turned out to be more expensive than I thought and my stock options for Memorex really didn't yield all that much that I could finance a development program on my own. And a friend of mine Jim Woo who is one of the "Dirty Dozen" called me up, he had joined the old Data Disk operation which was now called Amcomp and asked me to join him as Vice President of Engineering and things were not going well with my development program and I had a wife and kids to feed and I said "I think I'll just take a regular job" so I went to work for Jim. Amcomp was being purchased by Datapoint at the time and we became Datapoint Organization. So I spent 4 years working for Datapoint as a Vice President of Engineering with the Sunnyvale operation and we developed disk drives. We had responsibility for the old data disk, fixed head products, we had responsibility for a fine French disk drive called Cynthia. As far as I know we were the only company ever to incorporate Cynthia into a product but it was made by CII-Bull in Belfort, France, and our job was to qualify for use on Datapoint systems. So we bought some models and we took 'em apart and we fixed problems and worked with the French to get the product to a point where it was producible.

**Porter:** What size disk drives were these, what size disk?

**Clemens:** I think it was a ten inch disk, it was larger than a five and a quarter but it was an odd size disk, it had a metric dimension.

**Porter:** Smaller than the traditional 14 inch.

**Clemens:** Yeah and my one and only experience trying to deal with the French in an engineering way and it's a different kind of an experience anyway. We then turned our attention to develop like our own product which was a five and a quarter inch almost. It was not exactly the same size what became the five and a quarter inch disk drive standard but we were sort of out in front of everybody and we decided to use plated disk which was a magnetic plated film and through some lucky choices, came up with a carbon sputtering process that we could use as an overcoat which solved one of the great problems that everybody had had up to this time using plated media. The head and disk fly so close together that there occasional light contact between the two and the material, the magnetic film used on the plated disk is just awful as far as its reaction to the impact and usually the head would dig in and crash. The carbon gave a lubricious surface for the head to bounce off of and it really solved the problem. We brought that product up to a point of production, we had a quarter inch tape drive as a backup unit, it had this five and a quarter inch disk drive and a controller of our own design and some automated programs for doing automated backup. That was a very, very ambitious technology program for a little organization and Telex was off on a spending spree, they were developing laser printers, they were developing a telephone exchange computer, they were developing just about anything you could name in the computer industry, they had a project. And another company which had a little bit of success and it went to their heads and they just went outta control as far as the scope of the technologies that they were developing. So our program along with a lot of other ones fell victim to cutbacks and money and I became a victim of cutbacks and money too and I disappeared.

**Porter:** Datapoint was a company that several different product divisions operating in different areas, didn't they?

**Clemens:** Yeah.

**Porter:** So they were a diversified company which could just move into their other product lines?

**Clemens:** Yes.

**Porter:** So you left in '82?

**Clemens:** Yeah, it was about April of '82 and went back to consulting and did a lot of odds and ends of jobs. I wrote a column for EE Times called Disk Driven. Some thought it should be called Disk Drivel but anyway various comments on the industry and so a little bit of history in there and so and became a Consulting Engineering Manager for a small company down in Southern California called New World Computers, was building the world's weirdest disk drive. The company never went anywhere and they gave me an income for a while. The only company ever they asked me what I thought of it when I first met with them, I said "I thought it was a terrible idea and I don't think you should invest their money" and they said "Well we're gonna go do it anyway, will you join us?" why not. So New World disappeared. Another person that came along was Tony LaPine who asked me to design something in the way of a removable 3½ inch disk drive so we built a cocoon, I used a mechanical engineer to help me

design a cocoon, you know, slip in the slot, 3½ inch disk drive to incorporate in the LaPine drive. That had a lot of problems, one of which was that after being in the machine for about 15 minutes, it was so hot you'd have to put on an oven mitt to handle it. Then the next thing Tony said "Well we don't want the product but would you join us as Vice President of Engineering?" Which I did and we worked on solving problems with the original LaPine drive which was a design for a high reliability applications, it had a fairly complicated mechanical structure that allowed the heads to separate from the disk when the machine was turned off and prevented the collapse of the heads on the disk. It turned out that mechanical motion caused more problems than any head landing on the disk ever did and it was sort of like a mousetrap going off when you popped it, so you'd get all sorts of springs and levers inside. We cleaned up that and kept it in production but the main effort was on a alternate product which was being designed by Steve Kaczeus called the Spartan Series and it was a rotary actuator machine with a much simpler and more manufacturable configuration and we were able to bring that into production, however LaPine, and Kyocera who is the funding father of the company.

**Porter:** And didn't Kyocera manufacture the machines?

**Clemens:** Yes Tony LaPine had worked a very strange three part company where LaPine would develop products, Kyocera would manufacture them and Prudential Bache would finance the whole thing and that all fell apart, with Kyocera went bye bye and LaPine had no source of funds and it dried up and so we were left without a job.

**Porter:** In '87?

**Clemens:** Yep and but we thought we had a good idea so we said "Why don't we start our own company?" so we started a company called Comport and it went through development stages and we had found a similar kind of a partner in Samsung Electronics in Korea who wanted to get into the disk drive business and same thing happened that we developed the product, started it into production and Samsung decided they didn't wanna put any more money into Comport, they were gonna spend their money on their own engineers designing their own machines and so Comport went belly up.

**Porter:** But that didn't go into Chapter 11 until '89, it had a two year history right?

**Clemens:** Yeah, just about got us through production start. Samsung had a small production line in Korea. I spent a lot of time over there working with their engineers on it but it was really just prototype stuff, and that was about the time that they pulled the plug on it. There were problems and I think Samsung had expectations that because we were expert that somehow this was all gonna go a lot smoother than it did. I had hoped the same thing but knowing disk drives, it never goes as smoothly as you think it should. Anyway, Comport then disappeared and in 1990 I joined Maxtor as a Director of Process Engineering. Maxtor was also losing people and had a number of problems, and a friend of mine Alex Malacort was running the Engineering Group at Maxtor at the time. Alex was the other person that went on this IBM sales exchange program. He was the other half of that two that went out of the San Jose Lab. George Scalise was the President of Maxtor at that time -- somebody who had no concept at all



of what the disk drive industry was about. I only talked to the man a couple of times and I just couldn't believe it when I'd walk out of his office as far as the kind of questions he was asking me. But my job was to flatten out problems with Sun Microsystems who was one of Maxtor's big customers at the time and he had all sorts of operational problems so I was a trouble shooter and had the old daily, weekly meetings with Maxtor people and Sun Microsystems people solving problems. And Maxtor was kind of bobbling around up and down and up and down and I had a big mouth and they fired me from that one, too. We'd straightened out the Sun Microsystems problems but it was after that that I took over some of the disk drive programs and got crosswise. I had expectations from people about how hard they'd work and so on, and that didn't set well with a lot of the troops. So I went back to consulting and I spent the remainder of my career '91 til about 2002, ten, eleven years doing consulting, most of it in litigation work. Prudential Bache decided to sue Kyocera over the demise of LaPine and I spent 18 months I guess working on that lawsuit which we eventually won. Got involved with a company in England who was suing Western Digital over some of their products and I worked for Western Digital to defend their position, and then Mitsui had done a development program with Swan and Mitsui was suing Swan to recover damages and so on, felt there had been some misrepresentation. Then I did a lot of patent work, prior art patent searches one of which was who started the first brushless DC motor for a disk drive and it turns out Memorex was the winner there under John Scott. The first removable disk drive was a five and a quarter inch disk drive done by of all people Data Disk, they had come up with a product with two bays, you could pull the disk out, put 'em on the shelf, replace 'em with another unit and another area which was emergency retract when power's lost the disk drive of pulling the heads of out the disk array and that was a product done by a friend, Mr. Keival, at, I can't remember the company, an 8 inch product. So anyway I made most of money out of the court rooms and which I liked but the hours were short and the money was good, the guys pay a lot of money for extra testimony and technical help and I seem to get along with lawyers pretty well. So one day in 2002 I got up out of bed and I said "You know, I haven't had a consulting client in 6 months, I think I've retired" and I closed up my office and I turned my back on the disk drive industry and I never thought I would do that and I walked away and I haven't missed it a bit.

**Porter:** Jack, you've been through the disk drive industry from the time of the first drive through all of these events, tell me when you saw all of these people moving, leaving the company, start another one, participate in one, what would you characterize as the most frequent reasons why people would want to leave their old company and move on to a new one?

**Clemens:** Well I think selfishness in a way, it's difficult even today if you're a programmer and you look at the guys at Google that are wallowing in billions of dollars of stock options, the temptation to wanna emulate that or even though the chances are miniscule that you win, it's sorta like the big spin in Sacramento. But the pay off and the rewards are so huge that, you know, it's just the devil's temptation and I think people succumb to that after a while. I think a lot of people are driven by marital relations, they may be happy as a clam with the job they've got but their wife says, you know, people we know, you know, they're making all this money, how come you're not, a lot of pressures that way. So I think a lot of it is driven by money -- the other is thinking back over my own career, a lot of choices I made as far as leaving companies have been personnel. When you get locked into a situation working for people you don't respect or don't have a relationship with. The work is hard, I don't know anybody that has succeeded in this business on anything close to a 40 hour a week and the work is hard and I've known a lot of people it's killed. You know, it's a demanding kind of a thing and it's very, very hard to maintain

your spirit and your drive and your energy of doing the things you have to do when you're working with an organization or a person or working for a person that you don't respect or honor and that works both ways. I think that was Shugart's great talent. I'm not a big Al Shugart fan, He's always treated me right, I don't have any animosity to him, but I don't also have the reverence a lot of people do. But Al had a charisma about him. He could sit in a room with ten people around a conference table and say "I want" and nine guys would be crawling all over themselves trying to get what Al wanted. He had this basic earthy charm about him. Remember the big walnut office that he had at IBM when he was directing groups. Al played baseball/softball and here he is, he's got 12 guys in his office they're having a meeting and Al's standing there in his jockstrap putting on his baseball uniform because he's just gonna go play baseball. And I mean they're carrying on a business conference like nothing was happening. He was able to get a lot of that and I think so on the other side is that people like that that people do respect or do honor are the big attraction a big magnet. So bad people are pushing people out and the good people are drawing them someplace else, and there have been people that left IBM and other companies to try something who are not much in the way of personality and you never hear of them, they just disappear because they can't attract the people.

**Porter:** So if we look at all the great progress that was made over the years in disk drives, what were the key reasons why some companies were able to keep up with all those changes and some weren't. Was it all just having the right people?

**Clemens:** Well I don't know if that just applies to the disk drive company, it seems to me that it occurs in all the industries, you know, some companies fade and come back. When I was at Telex we needed a building and the realtor said "There's a building coming available just down the street here on Bowers". It was the Intel building, Intel was in such sad shape at that time that they didn't look like they were gonna -- I think success is one of the poisons of the industry. It's the most difficult thing I think in the business that I've been in to deal with. People succeed, companies succeed and they begin to believe that they're somehow anointed with special powers and have special capability and that's a killer they immediately start doing stupid things and it seems to me that's what I've seen kill most companies. Unless you're running like the devil was behind you at all times it just isn't gonna work and that was the environment of IBM in the '60s, '50s, we're on top of the heap but we're running like we're in last place. It was push, push, push. Vic Witt at one time when I was talking to him said "When, Jack, in this business can you ever sit back, put your feet up on the desk and say I have arrived?" And I thought, you know, that's basically what you don't want to do, It was very prophetic to me that the minute you do that you're a dead man, you're a dead company.

**Porter:** Or as you put you're ready to retire, and, of course, I would point out that you and your wife have become, in a different industry, something of a group to watch because you sponsor ragtime concerts all over Northern California and as some of the people who really enjoy ragtime, of which I am one, it's become something that a lot of people really enjoyed and I'm sure you have too, and I'd like to thank you very much for coming today. It's a lot of insights into very interesting industry that requires a lot of insights to understand why it operates and how it proceeds into the future. Thank you very much.

Clemens: You're welcome, thank you.