Oral History of David Bogy

Interviewed by:
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Yamashita: Okay. This is an oral history interview for Professor Bogy, at UC Berkeley. This oral history records Professor Bogy's contribution in three areas: the establishment of a very successful computer mechanics laboratory at UC Berkeley, a joint university industry research center, and his research on HDD data topics, especially in the areas of tribology, head dynamics and simulations, and various measurement techniques related to head disk interface, and educating many students that went into HDD industry to make key contribution to the HDD technology. Hope that is a short introduction. So, like to begin this interview by asking you about your background, family background. Where you were born, grew up, and where you received your education.

Bogy: All right. I was born and grew up in a small farming village in southeastern Arkansas, and I went through the first 10 years of my education at the school there. This town had a population of about 325 people. Typically, I would have 7 to 10 people in the class and I did the first three years in the same room with the same teacher, so it was a fairly low output organizations. I went there through the 10th grade and then transferred to a prep school in Tennessee, actually, called Columbia Military Academy, and I graduated from there. From there, I went to Rice University, and <laughs> I received two bachelor's degrees there, one in Mechanical Engineering and one in Geology. So the reason for that was somewhat unusual in that I, after my second year in Mechanical Engineering, I took a summer job in industry, an internship, -- this was in Indianapolis at General Motors where they made aircraft engines. I saw just acres of engineers with slide rules designing turbine blades for jet engines, and so it seemed to me that didn't appeal to me a whole lot, so when I went back to the university to start my junior year I decided I'd change my major to Geology because I was more of an outdoor person, and so I changed my major to Geology and I also completed that degree. I was in second semester of senior year and decided I'd made a big mistake.

<laughter>

Bogy: So, I added the Mechanical Engineering major. I went back to Rice, and one of the great things about a smaller university like Rice University, they didn't just kick me out. They said, "Well, you can-- well, okay." The registrar said, "One thing that works in your favor is you've taken math every year even though that wasn't required, and so if you take in your senior year seven courses, five of which have labs, and complete those and then go to summer school and take three more required courses, then you can come back as a senior again. You can finish the geology and come back as a senior in mechanical engineering the next year." So that's what I did, and so after five years I had completed both of those degrees and then I stayed there for a master's degree in Mechanical Engineering, and after that --I had been in ROTC-- so I was obligated to go into the Army for six months, actually, so I went at first to Fort Belvoir, Virginia, and then to Fort Leonard Wood, Missouri, and just as I was about to get out, there was the Cuban Missile Crisis, and so I was told I needed to stay an extra year, and after <laughs> that year was up, there was the Berlin Wall crisis and they said, "Oh, you may have to stay another year." But finally, I was let out and then I worked for Shell Research, Shell Development Company, it was called, in

Houston for a while until I could go to graduate school. I went to Brown University to study Mechanics. Actually, it was called Applied Mathematics there, but it was really Applied Mechanics, and so I went there to work with a particular professor who was well-known in the field of elasticity and when I got there he was actually not there. He was on a one-year sabbatical leave in Japan, and so when he came back after that first year, he agreed I could work for him and… But after a short time, he advised me he was leaving there and going to Caltech, <laughs> so I said, "Oh, well, maybe I'll just go with you to Caltech," and he said, "OK… So then it was worked out, well, if I finished my courses and passed my qualifying exams, then I could go to Caltech and do my research, and so I did that, and went to Caltech. So, I was at Brown about one and a half years and then I went to Caltech and did my research there. I finished my Ph.D. there -- after about a year-- and then I stayed as a post-doc in Caltech in Applied Mechanics. So that's pretty much my education.

Yamashita: So, while you were growing up in Arkansas, was your family in farming or something else?

Bogy: Oh, yes. My father was in, he was a partner in a company that owned a farm and also a sort of a large general store and a cotton gin.

Yamashita: Wow.

Bogy: They raised cotton in those days--

Yamashita: So, it was quite a big, good-sized enterprise then.

Bogy: Yeah, it was an enterprise. So actually, almost all of my teenage years I worked in the field, drove tractors.

Yamashita: Wow, wow.

Bogy: Plowing the ground for cotton and soybeans and things of that nature.

Yamashita: I see.

Bogy: <laughs> So it was quite a bit different <laughs> from my later life.

Yamashita: I see. So you were interested originally in mechanical engineering.

Bogy: Yeah.

Yamashita: So how did that come about?

Bogy: Well, I can't say my life has been very planned. It just sort of happened. So I went to, I first was going to go-- my sisters had all told me, oh, I should go to the University of Arkansas, and so I, the summer after I graduated, I <laughs> went to some fraternity parties around to see how that was at the university and I found I definitely did not like that and so one of the persons who was there told me, he was a student at Rice, and he said, "Well, if you want to be serious, why don't you go to Rice and be, study, engineering?" and so I decided, "Well, yeah. That probably sounds more like me." <laughs> So I contacted them at Rice and oddly enough they allowed me to come. I had not contacted them before that summer, but they allowed me to come there, and so I went there and was somewhat lost, and I just kind of fell in with some other students and they were going to be engineers and so I said, "Oh, okay. Yeah. Well, I'll be a mechanical engineer also."

Yamashita: I see.

Bogy: And that's how I got into mechanical engineering <laughs> without knowing much about it and so that's why after two years I decided, well, maybe that was a mistake as--

Yamashita: What was it about that you decided you didn't like mechanical engineering?

Bogy: Well, it was that summer internship--

Yamashita: Was it?

Bogy: --where I saw what mechanical engineers were doing. I decided--

Yamashita: I see. <laughs>

Bogy: --that didn't seem like my life, to be cooped up with a bunch of people trying to--

Yamashita: I see.

Bogy: --sit there all day and operate slide rules.

Yamashita: I see.

Bogy: <laughs> So, you know, I changed to geology and enjoyed that. We had summer trips out in Colorado where we'd go and peck on rocks with hammers and things like that, and so-- but the thing that got me out of that was that in my senior year we studied seismology and typically geology is a descriptive science, it's not an analytical science, and so it was rather hard for them to teach seismology in that way. So in going through their course in seismology I realized that I would like something a little more rigorous <laughs> and so-- because it was impossible to understand wave theory and wave propagation and earthquakes and all of that within knowing some mechanics and mathematics. So, that's why I decided I had made a mistake.

Yamashita: I see.

Bogy: I was more inclined for that.

Yamashita: Changed back. I see.

Bogy: <laughs>

Yamashita: And you say you were an ROTC?

Bogy: Yeah.

Yamashita: So right from the beginning you decided to do that at the school?

Bogy: Well, actually, as I said, I went-- my last two years of high school was in a military academy.

Yamashita: Ah, right.

Bogy: And so basically that was, I was in ROTC when I was in high school and then when I went to college, I was sort of in third year ROTC already as a freshman, and so…

Yamashita: So, it seemed like a natural thing to do is to join?

Bogy: Well, yeah. I mean, just looked like a good thing to do. I mean, most people sort of figured they somehow had to go in the military in those days and it was, you know, things were a bit unsettled in those times. You know, there was-- there were rumblings already about Vietnam, and I figured it's better be a-- better to be an officer than a--

Yamashita: I see.

Bogy: --private.

Yamashita: So, you really didn't have to go overseas or anything like that?

Bogy: No, I never did, actually. Once I got out, I was obligated to be in the Reserves for several years, and to go to summer Reserve camps or something, but somehow, I didn't do it. <laughs> I don't know why or how, but I-- so after I got out in Fort Leonard Wood after my year and a half in, that was pretty much the end of it for me in the military.

Yamashita: Mmm. So, you worked for Shell and that was oil business. That didn't suit you either or…

Bogy: Well, that, again, that was sort of related to my geology and my mechanical engineering in that I was working in what they call production research and it had to do with oil well drilling and prospecting for oil using seismology and activities like that, but mostly I worked in mechanics of oil well drilling and the first papers that I'd written had to do with vibrations of drill strings caused by drill bits that were grinding around on the bottom of rocks and things of that nature, and stability of them too. These drill strings-- one drills holes couple of miles deep in the earth and they are a lot of heavy steel pipes and they're unstable and they buckle and twist and there's a lot of interesting mechanics problems that take place in that area, so I worked in those fields and had a few papers in that area.

Yamashita: Oh. You actually wrote papers, huh?

Bogy: Yeah. Actually, I--

Yamashita: Wow.

Bogy: I worked with a person who actually inspired me a lot at Rice University. His name was Paul Paslay . He had recently come there and he was so excited about his work that it was contagious, and so I got into-- he kind of-- we worked together in that area when I was working at Shell. He also was a consultant at Shell and we worked together in that and wrote papers in that area.

Yamashita: Then you decided to go to Brown. What was the reason for choosing Brown?

Bogy: Again, it was this professor who had sort of inspired me and so the question arose, "Well, should I stay at Rice and do a Ph.D.?" and he said, "No, you should go somewhere else. You shouldn't get all your education in one place," and so he said the best place to go was Brown where they had a lot of activity in this area that I was interested in at that time, and he knew it very well and so I applied to half a dozen universities, including I guess three on the East Coast and three on the West Coast. The typical ones, MIT and Brown and, I don't know, maybe Cornell in the East and Berkeley and Stanford and Caltech in the West, so… <laughs> But he told me Brown was the best place for me to go, so I went there.

Yamashita: I see. So, I know your advisor was this Eli Sternberg.

Bogy: Eli Sternberg, yeah.

Yamashita: Sternberg. Very famous guy, right?

Bogy: Yeah.

Yamashita: Yeah.

Bogy: Yeah.

Yamashita: Did you pick him right away or…

Bogy: I went to Brown, as I said, to work for him. My advisor at Rice had told me that based on what I was interested in he was the right person for me, so as I said, I went there specifically to work with him to only find out that he was away for the whole year.

Yamashita: He wasn't there.

Bogy: Right. Yeah. <laughs>

Yamashita: But he still took you in.

Bogy: Yeah, right. <laughs>

Yamashita: Got going.

Bogy: Yeah, when he came back, he took, me as a student, as I said, and we started working in a certain area and he said, well, he's leaving, going to Caltech, which he did do.

Yamashita: I see.

Bogy: And I went with him. Or I went, like, a few months later.

Yamashita: So, my understanding, this Professor Sternberg is very famous elasticity guy.

Bogy: Oh, yeah. He was in linear elasticity. Right.

Yamashita: This is very theoretical and highly mathematical.

Bogy: Yeah. That was it. That was my education in graduate school and my, as I said, my degree was Applied Mathematics, and it was applied to the area of Mechanics and…

Yamashita: So that kind of topic suited you.

Bogy: It was purely theoretical, yeah.

Yamashita: Right. But, you know, I mean, I've seen some of his coursework on it. It's very dry.

Bogy: Yeah.

<laughter>

Bogy: Well, it was only dry if you didn't like it, you know, but…

Yamashita: But you were very much interested in this topic.

Bogy: I liked it, yeah.

Yamashita: I see.

Bogy: So, it was, it was quite exciting, yeah.

Yamashita: I see.

Bogy: Yeah.

Yamashita: So specifically, what sort of topic did you do your work on?

Bogy: Oh, at that time?

Yamashita: Yes.

Bogy: Oh, we're working in a couple of areas. At that time, and this was sort of a very interesting time in the field of Mechanics, and Brown University had a whole collection of professors who were very big in that area. There was a professor in addition to Sternberg, there was Rivlin and there was Shield and several others and there were all kinds of seminars and activity. It was a very exciting place at the time, but at that particular time, there was a new field. I mean, there was sort of a revolution in the areas of Mechanics going back to the fundamentals and trying to get everything squared away, and so they began looking at what's called higher-order strain theories, coupled stresses and things of that nature, and so these new theories were coming about. So, Sternberg was very interested in elasticity and in particular, and also at that time in these couple stresses and also in stress singularities caused by various discontinuities or material interfaces or things of that nature, and so I worked initially in that area, these couple stress theories and…

Yamashita: I see.

Bogy: And eventually, skipping forward a little bit, but eventually down the road when I was in Berkeley, I was also one of the senior professors there, Naghdi, Paul Naghdi. They were working in these director theories, which had some similarities to the coupled stress theories and working with them in connection with all kind of structures and plates and shells and actually water waves and fluid jets, and I eventually applied that theory to inkjet studies, which I'll get into a little later on when we get to that part. But these coupled stress things had, eventually had some application.

Yamashita: I see. So, from Caltech, you did some post-doc. What was that?

Bogy: That was-- I worked-- well, actually, I just got-- my thesis work was rather esoteric problem that I was able to solve in the theory of elasticity related to Saint-Venant's problem for cylinder and Sternberg, working at Caltech with a professor named James Knowles, they had proved that all of these more or less solutions that came about, they were approximate solutions for things like long cylinders. They were solutions for extension, bending, torsion and flexure, and they had proved that the particular solution for those problems, were the optimal solutions amongst a class of solutions that might satisfy those conditions, for all except the flexure and they couldn't, they didn't prove it for the flexure. <laughs> Or at least they proved there was a solution for the flexure but they couldn't solve that problem, so they worked on that for I think a half year or something. And it turned out then that my work wasn't going so well in this couple stress theory. I kind of got bogged down in that, and so I said, "Well, let me have a go at that problem that you guys have been working on." They kind of set it aside, and he said, "Well, okay, you can do that." <laughs> And so I set out. I started scratching my head and working on it and day and night and finally I got <laughs> this idea and…

Yamashita: A solution.

Bogy: Yeah, <laughs> I got this idea and it paid off and I was able to solve it and so <laughs> Sternberg said, "Okay. That's your thesis."

<laughter>

Yamashita: I see.

Bogy: "That's all you have to do."

Yamashita: I see.

Bogy: Because he was impressed by that and so, so that's, I wrote that up and published it. I don't know if anyone <laughs> ever, ever sited it or not, because it was rather esoteric.

Yamashita: I see. So, this post-doc work was with Sternberg also?

Bogy: Yeah, right, yeah.

Yamashita: Yeah, so just continued….

Bogy: Yeah, pretty much continued what I was doing, and then, and then we went back <laughs> to the couple stress business and started looking at the effect of couple stresses on some stress singularities that occurred in certain plain solutions in elasticity to see if maybe they would do away with these singularities or something like that if you included these extra ingredients into the theory, and <laughs> so, you know, I solved several of those problems and we published papers based on those, published a few papers based on those. It wasn't all that, all of that, successful in the sense that it didn't do anything that gave great insight into the world of mechanics.

Yamashita: So, I imagine back then there was no simulations or modeling. Just all partial differential equations <laughs> and…

Bogy: Well, it's interesting that you say that. Back then there was, of course, numerical calculations. One would solve problems usually using Fourier methods, you know.

Yamashita: I see.

Bogy: Fourier series methods. But you still needed to do computations, and so the computations were either slide rules or machines. Like, they had these Frieden machines and Marchant machines <laughs> that, you know, they could add, multiply, subtract, divide and take the square root. That was the extent of their capability, and it took a long time.

Yamashita: Right.

Bogy: But anyway, one still had to do computation, but in those days, <laughs> and later on when I got to Berkeley, when one did computations, one was very careful about <laughs> what you were computing because it took a lot of time to compute, right, so you--

Yamashita: All in that mainframe and…

Bogy: Yeah. <laughs> Oh, yeah, yeah. That was when I got to Berkeley. Then we, you know, working like that, yeah.

Yamashita: Mm-hm. So, just want to touch on Professor Sternberg. He's very interesting guy in his own right. Did you get to be very close to him or was he just--

Bogy: Well, I don't know. Probably not real close but close enough that I was-- I and one other person were his ownly graduate students at that time because he had just come there from Brown and he started getting set up and he didn't have a large research operation. He was always funded by the Office of Naval Research.

Yamashita: I see.

Bogy: And he had, he did his totally, you might say, esoteric, theoretical studies in mechanics that you would wonder why the Navy would be interested in it, but anyway, in those days, funding was for basic science that people did, you know. I got to be as close to him, I think, as any of his graduate students ever did. I mean, he would, for example, I would see him fairly regularly, go to his home two or three times a year for some kind of party or dinner or something like that, and… But, you know, that's pretty much, it was pretty formal. He was like, you know, I was, what, 20-- I was in my late twenties and he was in his late sixties, so…

Yamashita: He was a refugee from Vienna or someplace, wasn't he?

Bogy: Oh, yeah. He had come, yeah, during…

Yamashita: During the war. Or just before the war.

Bogy: Yeah, yeah, he had come--

Yamashita: I guess.

Bogy: Yeah. Well, probably before the war. He had come and done his Ph.D., I think, in IIT, in Illinois, Institute of Technology, and then he was on the faculty there. He worked with a professor there named Sadowsky. He was also a theoretical elastician, and then he went to Brown and joined that group, that large group, in Mechanics, yeah.

Yamashita: So, let's see. So, after your post-doc, you went to Berkeley.

Bogy: Yep. I decided in, near the end of my post-doc, that I would pursue a career in academia.

Yamashita: Uh-huh.

Bogy: So, I was office mate with another person there and we kicked it around back and forth what we were going to do when we graduated. He decided to go to work for Los Alamos. <laughs> He finished and went to work at Los Alamos, and I said, "Well, I think I'll go for academia," so fortunately at that time there were quite a few faculty positions available. I interviewed, again, at <laughs> a few places on the East Coast and a few places on the West Coast and I think I had four offers to be faculty member at MIT and Berkeley and UCLA and UCSD was a very new university at that time and I had some offer to go there, so I, the way I got-- <laughs> it's interesting. It was so different in those days than how it is now. There was a professor in our ME department. We had a division, it had a division, of Applied Mechanics and he was, Paul Naghdi, was the professor who was head of that, and so when they had an opening, he would just go around to various known places and interview, find people, or he would actually ask faculty that he knew at those place, "Hey, do you have any guy coming up that might be good…" <laughs> and so he came down and interviewed me in Caltech and we went out for dinner and hit it off pretty well, so he invited me up to Berkeley to have an interview and I came here and I liked the academic climate and the weather climate. It was in February. Was a beautiful day, <laughs> and…

Yamashita: Oh, I see.

Bogy: So, my wife and I decided, well, we'd go to Berkeley.

Yamashita: I see.

Bogy: Yeah. Yeah.

Yamashita: So, you were already married by then and-- yeah.

Bogy: Yeah, I was married. I had gotten married before I left Rice, yeah.

Yamashita: I see. Yeah.

Bogy: My wife also, I met her at Rice, actually. So, she, she was a History major there and she got her-- she finished there.

Yamashita: Oh, I see.

Bogy: Yeah.

Yamashita: So, when they hired you at Berkeley, did they have some specific thing. I mean, you were elasticity guy, so--

Bogy: Yeah.

Yamashita: --is that what they expected from you or was--

Bogy: Yeah. I would, of course, well, I was assigned courses to teach in mechanics and, I mean, the job description at Berkeley was, and I gather still is, that you're half teaching and half researching, and so, you know, we had, we were on <laughs> a semester system and we typically taught three semester courses per year and was supposed to do research and publish and also what they call service. Service on various committees and all this kind of stuff and so yeah. I taught undergraduate courses in Mechanics like statics and dynamics and graduate courses and elasticity and plasticity, and things of that nature, so yeah.

Yamashita: This is late '60s or early '70s?

Bogy: Yeah, '60s. I went there almost exactly 50 years ago this month. <laughs>

Yamashita: Oh, wow, 50 years then.

Bogy: I mean, 50 years in Berkeley.

Yamashita: That's a long time.

Bogy: <laughs>

Yamashita: I see. So, what were some of the research topics that you picked up at that time?

Bogy: Oh. At that time, course, I started… Oh, I, before I actually had left Caltech, I had discussed with Sternberg some really important stress concentration problems related to interfaces and geometrical discontinuities and interfaces between materials and things of that nature, and so when I got to Berkeley I thought, "Well, I think I will look into those problems," and so I started looking into those problems and I worked on, I worked on that really hard for the first couple of years and I eventually, I published a few papers and then one of the papers I published in that has turned out to be quite important. It's been cited more than 800 times--

Yamashita: Oh, wow. Wow.

Bogy: --and in literature.

Yamashita: So, could you say little bit about that?

Bogy: Well, it basically was this problem. If you have, let's say, for example, that you have, say a half space. Let's just say this. Suppose you have a half space, and it's really two quarter spaces that are glued together. Then you somehow pull on that. Then at the interface of the materials and the boundary, it turns out that according to elasticity, there will be unbounded stresses there. So that would be the place where failure would initiate. So that turns out, that was the first problem that I solved in that regard. Then after I solved that problem, another professor in Northwestern looked at my solution and said, "Hey, this has some real promise," he said. "Instead of that solution depending on three parameters, it really only depends on two material parameters." And so, he defined those parameters and we kind of published a joint thing based on that. Then with that, I could really take off. I could then solve the problem of any wedges of any angle in any materials coming together and forming stress concentrations at that interface, all the way around to where it became even if it were a crack between something. So that's the paper that I wrote, that has been cited--

Yamashita: So there's a lot of practical applications for this--

Bogy: Oh yes, very practical applications. A lot of people, even in integrated circuits and where there are a lot of material interfaces and things like that, and where there tend to be delamination, where there are things that have been delaminated. You can typically, without a lot of effort, figure out, based on some of the work I did, what are the severe stress concentration situations and what are not.

Yamashita: So you had a pretty good start.

Bogy: Well, yes, I worked on that too. And then, yeah...

Yamashita: I mean, you're doing mostly theoretical work. Did you need a lot of funding, or--?

Bogy: Well, I was funded by National Science Foundation. I applied for-- in those days, which are different now, the foundations and the Defense establishment tended to fund individual faculty that they somehow thought had promise. So, you know, you wrote proposals to National Science Foundation. They'd get reviewed and you'd get, not a whole lot of funding, enough to support a graduate students and maybe have one month's summer pay. Because, you know, at the university, you got paid for nine

months. The other three months are up to you. So, I did that. So, then I think your next question is, well, how did I get into this?

Yamashita: Yes.

Bogy: That's an interesting question. It again comes back to myself, and that was, although I was intrigued by this theoretical and highly mathematical business, it really wasn't quite me. As I said, I had kind of been more-- I had grown up driving tractors. I was more of an applied type person, so I decided I wanted to get into more applied research activities. The opportunity arose, after about my third year, to get a summer position-- it's called a summer faculty position and it was at IBM in San Jose. It turned out that was with Frank Talke. Frank had finished his PhD, the first year I was in Berkeley. He finished his PhD in '68; I came there in '67, and he had gone to work at IBM. He had a group that were doing mechanics in data storage systems. They were doing all sorts of things. So, I went down there, first that summer, and worked with him, and it was great, because he had all these experiments going, but no one was doing analysis on them. So, I said, "Okay, I'll analyze-- I'll define and analyze these problems, and we'll see how it goes." So that's what we did. We first worked on, basically, magnetic recording for flexible media. They were working on rotating head type systems, like VHS or something.

Yamashita: So this was on tape?

Bogy: It was on tape, yeah. Tape wrapped around a mandrel and had a rotating head on it, but it was for data storage, not for-- and IBM actually had a library system, made of those tape cartridges that had these rotating head devices on them. The real interesting problem, from my perspective, was when you wrapped this tape around something, it had edges. I mean, it eventually comes together, and so this rotating head, which has to establish its air bearing as it rotates, it comes to a place where there's a gap and it loses its entire bearing and has to start all over. So, what was going on at those edges is what was interesting, and it's what I worked on and analyzed.

Yamashita: Did you know Frank Talke when he was a student?

Bogy: Not really. He worked for a colleague, for Stanley Berger in fluid mechanics, and worked in some rather esoteric problems, I think, on turbulence at the trailing edge of some boundary layer device or something. I didn't really know him. I might have known of him. So, it was kind of like, when I went there to IBM, we kind of got together. Then we realized we had a lot of things in common, in interests, in particular, climbing mountains, walking in the mountains.

Yamashita: Right, yeah, he loves hiking.

Bogy: Yeah, right. So yeah, we worked on those problems, and also on some linear tape problems also.

Yamashita: So this began your very long, fruitful relationship with him.

Bogy: Yeah, right, so that was the beginning. That was probably-- it may have been in '71 or '72, after I had been in Berkeley about three, three or four years.

Yamashita: I see.

Bogy: Yeah, right.

Yamashita: So was it mostly with IBM initially?

Bogy: Oh yeah, it was with IBM. So, I did that several summers in a row.

Yamashita: I see.

Bogy: Then in between, I also was a consultant with IBM. We worked on various problems.

Yamashita: During the regular year. You just continued…

Bogy: Yeah, right, during the school year. I worked basically one day a week or something on that sort of stuff. So that's actually how I got into that business of mechanics of data storage system. I had, at that time, I think-- it then became possible, IBM had something they called graduate student fellowships, so we could apply for that. Frank would help me apply for that and I got one. I think the first graduate student project I had on that was a person named George Adams, who's been a faculty member ever since he graduated at Northeastern University, but he worked on moving loads on layered flexible media, basically tape problem, you know.

Yamashita: So this is IBM? He was IBM--

Bogy: No, he was my graduate student at Berkeley.

Yamashita: Oh, it was funded by IBM.

Bogy: Yeah, right.

Yamashita: Oh, wonderful.

Bogy: Then I had another student-- he probably finished in '75, and then I had another student, Richard Benson, who worked on-- that was a floppy disk system that had a solid base. It was called a Bernoulli, Bernoulli drive. You may remember something called a Bernoulli drive.

Yamashita: Yes.

Bogy: So Richard Benson worked on that problem and found some very interesting results, essentially that the equations that described the waves in the disk changed their character in the inner region of the disk to the outer region of the disk. In the inner region of the disk, there were parabolic differential equations, and outer region, they were hyperbolic. So, there was a region where they changed, and that was something quite interesting. We did experiments on that also in Berkeley. So, he's now the president of the University of Texas at Dallas.

Yamashita: Oh wow.

Bogy: In Dallas. There's a University of Texas, he's in his second year of doing that. So, he's an interesting fellow.

Yamashita: He's done very well, from Bernouilli equations, to president of a university.

Bogy: Yeah. So, then I had another student. We set up a lab. I didn't have a laboratory, but I began setting up a laboratory at Berkeley. There was this issue with regard to floppy disks, in which you wanted to have high density and a lot of data tracks. Floppy disks were made out of Mylar, essentially was their substrate for it, or polyethylene terephthalate, it was called. That is made in a big sheet and extruded, and it's tensiled in both directions while it's extruding. So, it ends up, it's not an isotropic material, it's orthotropic. It has two different axes of, where its material properties are different, and it's viscoelastic. So, the idea was this, you stamp a disk out of this web somewhere, either on the outside, the middle or the inside. It ends up not only orthotropic, but it's viscoelastic and it also recovers. It creeps into recovery, because it has been stretched in its manufacture. So, it creeps into recovery. So, if that happens, if you have recorded a circle on it and you put it up somewhere for a few years and you come back, it's no longer a circle. So, I did analysis on that. I analyzed that problem, and I think I wrote some IBM research, some papers in an IBM research development journal-- they had an IBM Journal of Research and Development-- and did analysis of that. I also set up this experiment in Berkeley and had this student who worked on that experiment. So that's pretty much the early days of working in that.

Yamashita: Then IBM started to provide you equipment to do measurements?

Bogy: Well, then we started-- let's see. So, I have to move myself forward into about 1980. I was working on other things at that time. Because, I had kind of gotten out of the theoretical elasticity, but I was working on, and funded in an area of nondestructive evaluation. In other words, using elastic wave theory to detect flaws in structures, I mean, if you can imagine a large pressure vessel...

Yamashita: So this is completely not…this is your work up at Berkeley, your other work…

Bogy: Yes, this is my work there, my continued elasticity work. I was still doing that. I didn't switch over everything at once, right? So, I got into something. I was still doing that work in this nondestructive evaluation, and that was fairly well-organized. That was funded by National Science Foundation. It was fairly well-organized out of Iowa State University, some people. We had these annual meetings down in La Jolla. So, I used to go there every summer and take my family and kids and enjoy the beaches in La Jolla. We got to know UCSD quite well there. So, I was doing experimental work related to that, as well, in various issues. So that kind of got phased out as the data storage business got phased in while I was doing that.

Yamashita: When did you start moving into the hard disk space? How did that come about?

Bogy: Let's see here. It's interesting, to me at least. In about 1980, '81 or '82, started looking at that, and I had this graduate student who helped me a lot at that time. His name was Denny Miu. He helped me set up my laboratory. My first lab computer was a DEC PDP-11-40. We set that up in the lab, and dual floppies is the only storage it had. We started writing programs for doing calculations on various aspects of that. But he also set up-- we were interested in hard drive, head disk interface dynamics. So, I started doing work in that, and he built, in our lab, a large-- on a big isolation table-- a large LDV system. We used that system to show that we could detect some slider motion in an old Seagate, first hard drive, Seagate hard drive. I've forgotten exactly what it was. It's about a 20 megabyte hard drive, 5-1/4 inch hard drive. We used that to show that-- actually took the top off, and cut a hole in it and put a window on it, put a glass window on it, so we could shine through it into the drive and show that we could make some measurements and import interesting measurements of that.

Yamashita: So like the first time people were doing that type of work?

Bogy: Yeah, it was the first time people were doing that. Then it turned out, my relationship with Frank Talke continued, and we continued working together on those things. We worked on some other things too though, before we got there. We also worked on inkjet printing.

Yamashita: Right, right.

Bogy: I mentioned to you, that I probably was the first person who ever applied this esoteric Cosserat theory to stability of--

Yamashita: Inkjet.

Bogy: Inkjets. We studied inkjets-- the first inkjets-- so I'm kind of wandering back and forth, but it kind of all goes together. First inkjets they were doing at IBM were what they called continuous jets. The idea there was, they would spray a jet of fluid out of the head, and actually put enough ink out to cover the page black. So,but they could charge every drop that came out, and so it would charge the drop and then run it through some capacitance plates and could deflect it that way.

Yamashita: Deflect it, yeah.

Bogy: So they essentially would send out enough drops to cover the page black, and send all the drops they didn't need to write text off to a recycle path, and that was the first concept for their inkjet printing, and it had all kind of problems, because it would get all jammed up and stuff. So anyway, we did a lot of work on that, and it was a lot of fun, but that eventually didn't win the day and so it became something called drop on demand inkjet. So, Frank had in his lab, he had these drop on demand inkjet systems all set up there, and we could make these measurements. I did do the analysis of these drop on demand inkjet printers, and what that required is to extrude a jet-- is to just somehow kick out one drop when you needed it. Initially, the technology was to have a little reservoir with a little nozzle on it and a back plate. The back plate was a piezo electric plate, so you would just pulse that plate when you wanted to kick a drop out. So that was the first scheme for the drop on demand. But then later came along both HP and Canon, came up with the scheme of what they called a bubble jet. So, it just had a little heater in it, and no one would have ever figured that to work too well, but they just had this heater in it, and they would shoot some power to that heater. It would immediately cause a bubble and the bubble would then expand, and the that would eject the drop. So that was another even more complex problem to analyze, but we worked on that one.

Yamashita: On that too.

Bogy: Also too. So that was in the inkjet business, but then at the university, I was beginning to get more interested in this hard drive stuff. Frank spent the year 1984 in my lab in Berkeley, and we worked on those problems together with my student, Denny Miu, and another student, Gilles Bouchard. We wrote two or three joint papers on that where we had-- but Denny Miu was actually the first student that I had who then made a real impact in that area, and he got from, I think Ampex, we got-- you probably know about this, because this was the first thin film disk. They had something called an Alar disk.

Yamashita: A plated disk.

Bogy: Yeah, a plated Alar disk. But they were somehow able then to sputter some little steps on those disks, and so we had a well characterized disturbance.

Yamashita: You can measure now.

Bogy: Yeah. So, we knew what the step was and we could do this experiment where we'd fly this head across these steps and then measure the dynamics with this LDV. And, so, Denny did that experiment, and he also wrote air bearing software to analyze the dynamics of the slider under that situation. That was really our first recognition in the area of head disk interface studies.

Yamashita: I see. So, this is 1983 or '84?

Bogy: This was in '83. Well, Frank was there in '84, so in '84, and Denny finished his degree in '85 and he went to UCLA on the faculty there. He was more of an entrepreneur. He left there and formed some companies, and then worked at-- but anyway.

Yamashita: Clearly you had some really good grad students also.

Bogy: Oh yeah, grad students are the only way. That's the most important thing for a faculty member is using good graduate students, yeah. Because they teach you-- as technology changes, they teach you. So yeah.

Yamashita: Could you say a little bit more about the LDV technology? How did you come to be aware of that, and you could use this?

Bogy: Well, that's interesting. There was a professor at Stanford who had published a paper on it, Cal Quate.

Yamashita: Oh, Professor Quate [Calvin Quate], yeah, okay.

Bogy: Cal Quate. He had, I think they called it an applied physics lab at Stanford. You probably know what that lab was, but Cal Quate was there. He had published a paper where he had shown this laid out LDV system and had shown it making some measurement of something, a dynamic measurement of

something. So, we got the idea that somehow we could use that to make-- so I contacted him and asked him, "Could we come and visit your lab and copy your LDV system?"

Yamashita: I see.

Bogy: He said, "Sure, come on." So, I took my student, Denny Miu and maybe one other student and we went down there. We looked it all over, went back and indeed, copied it. They had also had some other experience with that from somewhere. I'm not quite sure. But that's kind of how we got--

Yamashita: Got started.

Bogy: It was a paper of Cal Quate's.

Yamashita: I see. You must have realized-- used this to measure some minute perturbations…

Bogy: Well yeah, so I'll tell you, the idea was, in reading his paper-- I've forgotten what it was now, but it said that you could shine this on something that was moving and measure its movement, down where the movement was only in the nanometer range, and in high frequency range.

Yamashita: It evolved to become one of the most key measurement tools?

Bogy: Do what?

Yamashita: It evolved to become one of the key measurement tools.

Bogy: Yeah, I think so. We used it. I have many systems like that in my laboratory right now. We use it all the time, every day almost, and I think everybody does too.

Yamashita: So it must have taken some doing to develop all the lasers, electronics and everything to go with it.

Bogy: Well, at that time, we didn't have to develop it all. There existed a box, a phase demodulator we could buy.

Yamashita: I see.

Bogy: It was basically the optics and these phase demodulators and then just software for analyzing it, figuring out what it was. But that's where I relied heavily on good graduate students.

Yamashita: I see. So, moving on, you set up a computer mechanics laboratory. How did that come about? When was that?

Bogy: That's interesting also, in the sense that I guess, if I look back on my life, very little of it was planned, you know, laid out as a plan. It was always reacting to some opportunity. So, in about 1980, the National Science Foundation began to change the way it funded university research. They said, instead of having all these individual guys out here doing these small projects by themselves that are unrelated to anything, we're going to set up these centers. They called them National Science Foundation's engineering research centers. So, they announced that and told several universities, or anybody, to apply for these engineering research centers. They said, in order for it-- some of the requirements are that it have industry--

Yamashita: Participation.

Bogy: Support, somehow. So, we were, by that time, doing work in the area, as I had indicated, not only of inkjet printing, but also wire. There was a printing technique where they had little wires that would peck on carbon paper.

Yamashita: Oh, I remember that.

Bogy: Some kind of wire printing, wire hammer printing, and then laser printing. There were a lot of good mechanics problems in laser printing. In particular, there was one called the cold fusion problem, where they had these rollers. The interesting thing about the rollers and the stress concentration is, you have a piece of paper that has to be rolled through two rollers and mashed rather hard between them and heated. The rollers were heated. This was to cure the printing part. At the edges of the papers, there were stress concentrations. They would eventually cause these rollers to fail, basically wear them out, where the stress concentrations were at their-- so I had a student whose thesis was to analyze the hot roll fusion problem.

Yamashita: This was being funded by somebody?

Bogy: Probably. It might have been funded by IBM. I'm not sure. Student's name was David Glaze. He eventually went to work for IBM in Rochester, Minnesota.

Yamashita: I see.

Bogy: He worked in that area. Then we had... so we were doing other kind of printing research as well. So, the other, the HDD work we were doing, I would call storage. Then there were some faculty in our department that were looking at problems related to integrated circuits, in particular, packaging issues in integrated circuits. We had some faculty in our thermal science area who were doing heat transfer problems, cooling. Heat transfer, actually, in hard disk drives, as well as in integrated circuit issues. So, we decided, I and some of my colleagues decided, we would put together a National Science Foundation engineering research center proposal and call it "Storage, Printing, Packaging and Cooling." So, we had faculty who contributed parts in that and all in. We did a lot of work and got companies to-- at least someone in a company who knew of our work to write letters saying they supported this concept and this would be good. So, I had people at IBM and DEC and many other drive companies around. They wrote letters for us and everything. So, we put that proposal in but we didn't get it. So, we didn't get it, but we had a lot of good contacts in industry by that time, right?

Yamashita: I see.

Bogy: And some ideas about some stuff to do.

Yamashita: Maybe the name was too long.

Bogy: Yeah, the name had been too long, I think you're right. So, then we kind of kept going, then we started getting some funding from some other companies besides IBM to do stuff and equipment. IBM supported us a lot though, in those days, with equipment, computer, workstations, a lot of workstations. We had workstations, and that was very helpful. And also, these graduate fellowships, and they had also something called a faculty research fellowship, or something. That was just something they would-- these were gifts that they would give the university, so they weren't contracts or anything, and got a couple of those and stuff, and we had some funding from other places. Our stuff was getting going, you know, it was getting going, and so then, then something happened that was sort of interesting. At about that time, I would say in about 1981, or so, Al Hoagland and Jim Lemke. Hoagland at IBM and Lemke at that time was president of something called--

Yamashita: USCD.

Bogy: --Spin Physics.

Yamashita: Spin Physics.

Bogy: Yeah. <laughs> At a place, outfit, called Spin Physics. So, Hoagland and Lemke showed up and said, "We want to have, at some university-- we want to have at a university a magnetic storage center, magnetic center, and we want you, we invite Berkeley, to write a proposal for it." Of course, no one really knew if those guys had enough power <laughs> to do anything like that, but they invited us to do that. They also invited Stanford too, and I think UCLA and UCSD, to write a proposal to start a magnetic center at the university. So, it turned out… So, we wrote a proposal. We were the only of those universities, we were the only ones that are doing any work in magnetic storage, mechanics of it, you know, and so we wrote ours, proposal as mechanics and magnetic storage, which included our work in head-disk interface and also our work in some thermal work that was going on and kind of put this together. Again, we kind of dusted off our NSF proposal--

Yamashita: Previous one. Mm-hm.

Bogy: --and it shortened the name.

<laughter>

Yamashita: I see. I see.

Bogy: And put that in, and it turned out we didn't get that either. We didn't get that for a good reason though, and that reason was that Lemke was very tight with Richard Atkinson, who was the chancellor at UCSD, and so they, whereas Berkeley wouldn't, Berkeley wouldn't say, "We will cough up something for this activity," at UCSD, they were promised a building and four chaired professorships for that, and so that center went, that center went there to become CMRR, <laughs> and so it was established there, but there was nothing there, and so… But they got, they got started. So, they formed a committee and this committee was for the CMRR and I was initially, served on their committee, as did some other persons. There was a person named Norm Talsoe, who I think was, had been, at something called Magnetic Peripherals, which Seagate eventually bought, but he had been there and there was a guy at IBM, I think his name was Bhat. Bhat, and two or three other people. So, they were on his committee and we were kind of, yeah, get stuff going. Well, anyway, so they had some funding and they were interested in having some research going on at university, and so they actually funded my research in Berkeley with <laughs> the CMRR. The first research report written from CMRR, was one of mine.

Yamashita: Was yours.

<laughter>

Bogy: And we wrote, I think we probably wrote, we were probably funded for three years from CMRR.

Yamashita: Until they get going.

Bogy: Huh?

Yamashita: Until they get going?

Bogy: Yeah. While they were getting going.

Yamashita: Ah.

Bogy: And so, they, they then offered me one of their chair positions there.

Yamashita: I see.

Bogy: And because they were, had to recruit these faculty too, you know, so I, I didn't want to leave Berkeley, and so I said, "No, I won't leave Berkeley," but, you know, and Frank was, then, in '84, he was in my lab and I said, "You guys should hire Talke," you know, and so they tried for quite a while. He was a hard guy <laughs> for them to hire, but eventually he went there in '86, and became their guy.

Yamashita: So, you were responsible for him leaving IBM?

Bogy: Well, well, I mean, he…

<laughter>

Bogy: I mean, you know, we had a great relationship at IBM, and then he went to UCSD and then we had a different great relationship when he was in UCSD, but yeah, he left IBM to become one of those chair professors down there at UCSD and they got their building going and everything. They funded work until they finally got their people on board and had to spend their money there, but then, so then… So now we're getting on up into the mid '80s and we were beginning to get quite a bit of funding from various companies and…

Yamashita: Lot of startups then, so…

Bogy: Yeah, yeah, lot of-- we had a lot of drive companies and component companies. You know, head companies and <laughs> disk company. You know about the disk company, <laughs> and drive companies. So, we decided, "Okay. We will start this computer mechanics laboratory," and <laughs> so at the university, at that time, there were quite al lot of restrictions on what you could call yourself. If you wanted to call yourself… So, we first were going to call ourself a center, because that's way they did at UCSD. They called themself a center. <laughs> So we said, "We'll call ourself a center," but it turned out in Berkeley there were very strict requirements on calling yourself a center, and you couldn't just call yourself a center. You had to go through basically lot of legal issues and lot of organizational structural issues and basically be over, have, and report to the dean and various other things like that, you know, if you were going to be a center, <laughs> and so we decided, "Well--"I guess I decided, I said, "That's too much trouble." But you could call yourself a laboratory. <laughs> They didn't have-- in fact, there was something called an electronics research laboratory that had been very successful in EECS Department and so I said, "I think we'll call ourself the Computer Mechanics Laboratory," and so that. So, we chose that name and just went to these companies. Oh. I sat down the rules for what it-- so we said, "We'll have membership, company membership," and so I drafted myself without any <laughs> other organization in the university saying anything about it, what the terms of these memberships were, and the biggest problem with working with industry at that time were patent problems, patent issues. Essentially, if the industry wanted to fund research at the university, they wanted to have, and if any patents came out of that, they wanted to have--

Yamashita: Patent rights. Yeah.

Bogy: --patent right. They actually wanted to own the patents at first. <laughs> Yeah. They wanted to get the, have the patents, and of course, I told them, I said, "Well, you know, when I signed up here at the university, I signed an agreement that said if I, in my research, I find anything patentable I'm obligated to disclose it to the university patent office," you know, so… But I said, "So far, I've never found anything I thought was patentable," and so that is up to me. So actually, we had funding, I would say, two or three times funding, even from IBM at the beginning. That was agreed on technically, agreed on by the source of funds, but the legal department, so, then they would get tied up with writing some kind of contract or grant between IBM and University of California, Berkeley, and so all these lawyers would get involved and eventually nothing came of it, <laughs> so… And so-- and the patents were the main issue. Patents were the issue, and so I basically just told these companies, you know, I knew people. You know, I talked to people. I said, "Look. I don't-- I have a very high bar in what I think is patentable and so far, I've never written a patent," and so far still I've never written a patent, <laughs> and I said, "Here's what our plan will be in CML. When we're doing research, when we find something that we think is suitable for writing a research paper, we will write a paper and we will submit it to a journal and then members of our CML will get that document at the time we send it to the journal, so that basically gives you a six-months' lead time on whatever we--"

Yamashita: You do afterwards.

Bogy: "--have found and we give to a journal," so that-- I said, and, you know, I can't say that I won't write a patent, but I can say I haven't written a patent and I don't really like patents that much. I think they kind of are not in the spirit of a university where you can share what you're doing with everybody, you know, and so I said, "That's my philosophy," and so we were able to, I was able to write up this three-page document that said what the benefit of a company would be to be a member of CML and what it would cost and then it, essentially, was this. We'll have a one-year agreement, a contract, more or less, and you'll pay a certain fund. You'll be a certain level member in CML. You will receive certain benefits, and if at the end of that year you don't like it, well, don't come back. If you do, well, we'll do it again, and so that's how we did it, so <inaudible> we got going.

Yamashita: So many company did sign up for that?

Bogy: What?

Yamashita: Many company did sign up for that.

Bogy: In the late, in about '97 or '98, we had 26 companies that were members of CML.

Yamashita: Right.

Bogy: All the drive companies almost except Toshiba, and all of the component, a lot of component companies, head companies and media companies, and so it was really an interesting and good group and we held these annual research meetings and held a-- but we had some big problems in that area too, and I'd like to tell you about some of those, so …..

Yamashita: Okay. <laughs> Maybe, I don't know. You want to do that now or talk about some other subject about the CML?

Bogy: Well, I think it's in connection with starting the CML-- it's part of starting CML.

Yamashita: Mm-hm. Right.

Bogy: One was I had traveled in Japan and had visited lot of these Japanese companies, and so when we set up CML, I said, "I want to have Japanese companies as members," and that caused a big problem, because IBM--

Yamashita: Ah, they were paranoid about. <laughs>

Bogy: They had just sued Hitachi.

<laughter>

Yamashita: Yeah, they have paranoia about it.

Bogy: Yeah, right, and so there was a big fight in IBM and it went all the way, it went all the way to whoever was the CEO of IBM at the time, and that person declined to make a decision. He said, "You guys do whatever you want to do," and so it turned out that the Product Division was very much opposed to Japanese companies, but the Research Division was not, and so I basically just dealt with the Research Division.

<laughter>

Yamashita: Of course.

Bogy: Of IBM, and not the Product Division, but then-- and so that went along for a while, and lot of other companies also worked too. It cost a lot-- some companies didn't join because of the Japanese companies.

Yamashita: Because of that. Right.

Bogy: Yeah.

Yamashita: I understand.

Bogy: <laughs> And not only that, I'll come to another for you. IBM said, "We will not fund head-disk interface work at the university." In fact, <laughs> it was the case at that time that a person in IBM could not utter the phrase HDI outside of IBM, and if they went to a conference or something, they wouldn't talk about, and they could never publish anything related to that at that time.

Yamashita: Yes, yeah.

Bogy: And that had to do with IBM's problems they had with the 3380, I mean, which you might have known about, but anyway, they said, "We cannot, we will not fund HDI work." I said, "Well, that's what I do," and they… <laughs> And the other companies, they wanted HDI work, you know, so then I said, "Okay. Here's what we'll do. We'll have two bank accounts in CML. One can fund HDI work and one will not fund HDI work and all of IBM's funding <laughs> will go into the one that does not fund HDI work," and somehow they bought that and it went, it went like that. But then about that time, there was something else coming along. You may recall since you were at Komag at that time, I think, there was something called NSIC.

Yamashita: NSIC. Ah.

Bogy: National Storage Industry Consortium. That was formed, I think, in 1991. Nineteen ninety-one they formed this National Storage Industry Consortium and they specifically had National as its first <laughs> word, and they said, "We're not funding CML, because you guys have all these Japanese companies in your CML."

<laughter>

Bogy: So, we went along with that for a while. We attended some meetings and it was a-- I remember there was-- I went-- I think John Simons was the head, was the guy who started, was in charge of that, and there was a guy from Maxtor and a guy from Quantum. They were on this committee and so they say, "Okay." We had this meeting in Colorado. Said, "Okay. You come there and make your case and we'll see whether or not we can fund CML," and so I made my presentation to those guys and they said, "No way." So, they said, "No way." So that went along for a while, but eventually that kind of broke down and they came around and started funding our work and eventually, as you know, they changed their name. They took the National out. They took the NSIC out and it became INSIC, which meant Information Storage Consortium, I think, so then they did the same thing.

Yamashita: No. Japan set up their own…

Bogy: They set up their version called--

Yamashita: And we had joined-venture.

Bogy: --SRC.

Yamashita: Yeah. We had joined-venture, so we were in both. <laughs>

Bogy: Yeah. Right. Well, now they-- I'm sure you may know this, but a few years ago, only three or four, they killed NSIC and started something called ASTC, which is Advanced Storage Technology Consortium, and since that time they worked hard to try to get to make it include the Japanese SRC that they had, and so I think they've now <laughs> combined those two and it's now called AS-- it's ASRC. It was ASTC. Now-- it was ASTC, now it's ASRC, and it includes the Japanese, and so I have been to Japan to give presentations at the joint meeting of that group now, so even though that, the separation of the Japanese and U.S. companies has gone away, there's not much left of either. Right. So yeah.

Yamashita: So needless to say, setting up a laboratory, the cost, variety of issue.

Bogy: Yeah.

Yamashita: But it was out of necessity too, I understand, right?

Bogy: Well--

Yamashita: Yeah. I mean, you had to operate that way in order to just coordinate all this.

Bogy: Well, yeah. I mean, we had--

Yamashita: Activity.

Bogy: --laboratory. We had at one, you know, we had, like, 8 faculty and about 30-some-odd doctoral students, graduate students, who were working in that area, you know, and we were doing all kind of work in there and had all these--

Yamashita: It's quite an enterprise.

Bogy: --20 companies, 26 companies or so that were supporting it and we would go out and visit them all the time and yeah, it was quite an operation, but it was really lot of fun.

Yamashita: So, I don't know about the other company, but I know what we wanted. We wanted your grad students. <laughs>

Bogy: You wanted what?

Yamashita: We wanted your grad students. <laughs>

Bogy: Oh, yeah? Well, no. That's interesting. So, the question came up, and when we put together CML, and for industry, I'd go to them and ask for money and they'd say, "What are you guys going to be able to do for us that we don't do? I mean, we have better laboratories. We're a lot cleaner."

<laughter>

Bogy: "We, you know, we know a lot that we don't tell, so whatever you guys are going to work on, you're not going to know what the, you know, what the current state of the technology is, so what is it you're going to give us?" <laughs> And so basically we told them that, "We will train students who are knowledgeable in this technology and who will almost certainly go to work for your companies and we will do research in this area, and although sometimes, I mean, we will probably not know what's really going on in your company, but we will nevertheless stumble upon something worthwhile every now and then and you will get access to it," and then I said, "We will give you early access to any of our work, because as I told you, we will publish it in a CML report that you have access to immediately as soon as we submit it, have it ready to go," and so those basically are the only three things that we can-- oh, "And then we'll have meetings, we'll have annual meetings where you can come here and we'll make presentations about everything we're doing and we will get your feedback on what we should be doing, and although, since your membership is more or less in the form of a gift, you can't tell us what to do but your feedback is important for us because we want to know what you want done," and so we would do that. We'd get, we'd have all these presentations and then we'd send out a grade sheet and ask all the people from industry <laughs> to grade these areas of research and give it back to us and then I would look at that and I would decide what topics to fund, because all the students would have also prepared a one-page proposal of what they planned to do next year and so they would rank all these proposals and we would use that information to fund our ongoing work. So, I said, "That's how it'll work."

Yamashita: I remember that many of our, you know, top-notch engineers would look forward to attending your CML review meetings--

Bogy: Yeah.

Yamashita: --more so than attending conferences.

Bogy: Yeah.

Yamashita: Because it was that much more stimulating and, course, they get to see good graduate students too.

Bogy: Well, yeah.

Yamashita: <laughs>

Bogy: They were all eager graduate students, you know, and as I said, we were trying to-- we would have show-and-tell in our laboratories and have, you know, PowerPoint presentations by the students and so yes, we're-- and we had our, we had one last year, but we're getting close to not-- the number of members of CML presently-- <laughs>

Yamashita: Right.

Bogy: Two drive companies, right? And all the component companies have been integrated into those drive companies. There's Western Digital. We actually no longer have Seagate since last year, and SAE. That's about it. So, we probably not-- have to operate differently in the future, yeah.

Yamashita: So, moving forward, what is your plan? I mean, doing something different or…

Bogy: Well, here's the thing. Moving forward, I don't know how much forward I should go after 50 years.

<laughter>

Bogy: But anyway, I can tell you that I have--

Yamashita: Sorry I asked the question. <laughs>

Bogy: I mean, <laughs> I don't know how to stop, really. I have five Ph.D. students.

Yamashita: Still? Wow.

Bogy: <laughs> I have two fifth-year, one third-year, one second-year, one first-year. I just took a brand-new <laughs> Ph.D. student and then I have couple of master's students and a research engineer and so I don't quite know how to--

Yamashita: I see.

Bogy: I mean, one of the problems with this laboratory business is that you have to have continuity. You have to have. <laughs> You have to have senior students teaching junior students how to work all of this equipment and how to make all these measurements and <laughs> how to run all these programs and stuff. If you ever break that train, it's almost impossible to get it geared back up.

Yamashita: To get it going again.

Bogy: Because I don't know how to do all these things that these students do, you know, on a daily basis. But again, I know the higher level version of it but when it really gets down to taking data and these things, I don't really know.

Yamashita: They all still work on the storage or doing other things?

Bogy: All of my students-- well, now you're getting into current--

Yamashita: Current stuff, yeah.

Bogy: --issues. They all-- oh. In addition to those students that I told you I have, I have two visiting Ph.D. students and two visiting scholars, all from China.

Yamashita: Oh.

Bogy: Two visiting students, you know, one from Tsinghua University and one from Xi'an Jiaotong University, and two visiting faculty, one from Nanjing University <laughs> Science and Technology, and another one from Xi'an University, Jiaotong University. So, all of us, almost all of us, are working on problem related to heat-assisted magnetic recording.

Yamashita: Oh, really?

Bogy: Yeah. <laughs>

Yamashita: Yeah. I see.

Bogy: <laughs> That's where the really fun problems are.

Yamashita: Mmm.

Bogy: And that's where the real important problems are.

Yamashita: Still difficult. <laughs>

Bogy: It's very difficult, and I don't know <laughs> what its future holds. It's been promised as a product since 1912, I mean, since 2012, and now it's promised at the end of 2018, but it's hard to know if it will be a product, and I'm sure that there's lot of discussion around. There's so many interesting problems related to this, to it though.

Yamashita: The real difficulty makes for lots of interesting challenges, I guess.

Bogy: Oh, yeah.

Yamashita: I guess, maybe.

Bogy: I mean--

Yamashita: As long you get funding.

Bogy: What?

Yamashita: <laughs> Long as you get funding. <laughs>

Bogy: Yeah, right. Yeah. People fund us for studying, working on that, and we have, we've done some really interesting experiments recently. One of-- now, this is me talking. One of the problems, I believe, with heat-assisted magnetic recording is, and I'm sure you know this, so the idea of being able to get 10 terabits per square inch is that you have passed the superparamagnetic limit for perpendicular recording maybe at one terabit per square inch, right?

Yamashita: Mm-hm.

Bogy: And so, the question is, “Okay. So, what do we do?” So, the answer’s, “Oh, we get higher coercivity magnetic media.” <laughs> And you say, “Oh, well, that’s a good idea. The trouble is, we can’t write on it,” right?

Yamashita: I see. Yeah.

Bogy: So…

<laughter>

Bogy: So how can we write on it? Well, if you heat it up to its Curie temperature <laughs> of about, I don’t know, 500 centigrade, and for a nanosecond, then you can flip its bit and that will move on and it’ll kind of freeze in there and you can write these data bits that close together with that high of coercivity, and so that being the case, they say, “Well, yeah, okay. That’s the way to go.” So, as you probably know, that came out of-- you probably remember the technology of Quinta and TeraStore. You remember those guys? They were going to do some optical recording, with some near-field transducer that would allow them to overcome the diffraction limit, wave, of light, and so there were these two companies and they were going to do great things. They were going to do 10-- they were going to do 10 gigabits per square-- I think they were going to do 10 gigabits per square inch.

Yamashita: Yeah, I don’t remember.

Bogy: Yeah, and-- but before they could get there, the…

<laughter>

Bogy: Hard drives had already passed it up, and so that didn’t work out too well for them. But anyway, I think that was the beginning of this heat-assisted magnetic recording, because Seagate bought that Quinta and they set up in their research lab in Pittsburgh, this activity or this heat-assisted magnetic recording, and one of the problems, I believe, is this, is everything now becomes nanoscale, right. So currently in hard drives that you go and buy, the magnetic spacing between the-- it’s only three or four nanometers, and the physical spacing is like one nanometer. <laughs> It’s all controlled by this thermal fly height control business, right. So, then you start talking about doing, having a laser, that’s sitting on top of a head, that’s, solid-state laser, that’s creating a laser beam going through a wave guide that’s going down and to a near-field transducer that is kind of an antennae of some type that’s allowing this energy to be focused down to a 25- or 50-nanometer spot. Instead of using 800-nanometer wavelength light, and so there’s a huge amount of heat that has to go, power that has to go in there and you need to have really reliable heat transfer theory to deal with that and it turned out that all of these systems have been

designed using commercial packages, codes, that were not based on nano-scaled system. They were based on microscale and above stuff, and the rules for heat transfer and nanoscale are different than they are at [micro]-scale, and so a lot of times they would have these near-field transducers that work for a little while and then they fail, and so that's been a big issue. So, we've done some work on that and it hasn't been very popular because we've kind of been critical of some of it, and it's costly.

Yamashita: Are you doing lot of these type of heat transfer theoretical type of work?

Bogy: Yeah, yeah.

Yamashita: Oh, I see.

Bogy: <laughs> So…

Yamashita: I see.

Bogy: That's, it's cost us some support too.

Yamashita: Oh.

<laughter>

Yamashita: Don't want to hear bad news….

<laughter>

Yamashita: Wow.

Bogy: But anyway, it's very interesting. I mean, it has everything to do with the carbon overcoat, with lube, with, you know, reliability and then there's, there's some really good problems we're working on that you have, it turns out, that they're getting longer and longer, the duration, <laughs> life of these things, but one of the problems is that there's a lot of things that transfer to the head.

Yamashita: Right.

Bogy: And--

Yamashita: It's very hot and…

<laughter>

Bogy: Yeah, and it builds up on there and it, pretty soon it even, it increases the spacing, and so…

Yamashita: I think that's what happened to TeraStore, the lens get all clogged up, in a hurry and so on, so on.

Bogy: Yeah. Right. So anyway, there are lot of great problems. We enjoy working on those problems and I certainly hope it's successful.

Yamashita: So, I forgot to ask question that, you know, of all the work you've done on HDD space, you know, what are some of your favorite one that you think had the most impact?

Bogy: Well, I think it's interesting. Back, this one, Komag may have appreciated. I say Komag because you didn't announce that you were formerly with Komag but I think everybody knows that. In about 1980, in middle '80s, maybe '86 or '7 I had this post-doc Hsia Tsai [Hsiao-Chu Tsai].

Yamashita: Mm-hm. Chao, yeah.

Bogy: Yeah. And we did this work on basically application of diamond-like carbon to over[coat], for thin film magnetic media, and wrote this review article on it of essentially looking at--

Yamashita: Was a massive paper.

Bogy: --all the way-- huh? What?

Yamashita: Massive paper.

Bogy: Massive paper.

Yamashita: <laughs>

Bogy: And that paper had almost 800 citations also. It's been a very highly-cited <laughs> paper.

Yamashita: So, you're very happy with that.

Bogy: Yeah.

Yamashita: With the work.

Bogy: So that was a very, a very good result and so after that, then we went into doing quite a bit of work. Did Hsiao Tsai work for Komag?

Yamashita: Yes, for a few years.

Bogy: Yeah. He--

Yamashita: Yeah.

Bogy: Yeah. I don't know where he is now.

Yamashita: Yeah. He was quite, you know, in age already, so--

Bogy: Yeah, he was pretty old when he was-- even with me, but--

Yamashita: Yeah. We hired him right out of—Berkeley.

Bogy: Yeah.

Yamashita: --Berkeley.

Bogy: I thought you did, yeah. So, there's another <inaudible>--

Yamashita: That resulted in all this work on carbon, nitrogen, in fact, and all this type of work.

Bogy: Yeah. Yeah, right. Yeah. We went into this work on the effect of catalytic reactions, of lubes and--

Yamashita: Ah, right.

Bogy: And had a UHV system there in Berkeley. We also did some of it at Lawrence Berkeley Lab, but we had this system and I had several graduate students, I think, may have gone to work for Komag. We had these, we looked at the tribo-chemical, wear of lubricants and using these UHV systems, and that was good work, I thought. We also-- so I think the most satisfying work we have done has been in our-- oh. Let me say this though. That our, one of the real things that a whole series of my students did, all the way for the last 30 years, was writing code for air-bearing design and slider dynamics under various situations, including all the way up to ramp load systems and shock, you know, taking into consideration all of the air-bearings as well as the vibrations of all the structures and how they would get excited and do all that. So, we had students that-- so I think that code, our members always had access to that code, and someone to kind of talk to them about it when they needed and so I think that was what really kept us in business, because there were certain companies that relied on that code. I mean, did you know--

Yamashita: I think they joined the lab just to have your code.

Bogy: Yeah, to get the code.

Yamashita: <laughs>

Bogy: But they were, yeah, the main companies. It's interesting. See, IBM did not rely on that code for their ABS design group, but everybody else at IBM relied on that code, <laughs> because the ABS design group didn't share their code with the rest of IBM.

Yamashita: Oh, right.

Bogy: So, guys that were there, especially my former students who had gone there, they all used our codes and insisted on using our code.

Yamashita: So that was a major contribution.

Bogy: Yeah, yeah.

Yamashita: I mean, to the whole storage industry.

Bogy: So, I think that was our, that was our biggest product in terms of keeping members and getting them to pay.

Yamashita: Right.

<laughter>

Bogy: Because they had access to our code. We learned early on to write our code so it would expire with someone's membership, and so that's what we did.

Yamashita: I see.

Bogy: Yeah, and so…

Yamashita: Yeah. That was very smart.

<laughter>

Bogy: So, I think those, you know, that, I would say, the LDV work, the code work, and then some carbon overcoat and, you know, tribo-chemical wear type work and then our other work. We did lot of work in ramp load systems that people liked, and we did lot of work in nano-indentation of ultra-thin films. As you know, when you get a film that's two or three nanometers thick, carbon overcoat on there, magnetic media, to characterize that mechanically is quite challenging. I mean, typically the way to do it is, well, to measure its hardness, okay. What's its hardness? Well, you poke something in it <laughs> and see what kind of hole you get for how hard you poked on it, and it's plastic deformation, and doing that for few nanometers is pretty challenging, so we did a lot of work in that, early work, and worked with this company, Hysitron, and helped them actually develop their nanoindentation system.

Yamashita: You worked with these companies that, you know, measurement company that, you know, you helped to develop the science and code and everything else. That was probably the very, very fruitful work as well, I imagine.

Bogy: Yeah. Yeah.

Yamashita: Yeah, a number of them, right?

Bogy: Right, yeah.

Yamashita: Hysitron and…

Bogy: We-- yeah. Right.

Yamashita: I forgot. It was-- there were couple other ones that you work with very closely.

Bogy: Yeah. The Digital Instruments. We worked closely with Digital Instruments, the guy who started that one, down at UC Santa Barbara, and we worked with him on that and also up, you know, LBL, they were doing a lot of work on that, some guys up there. But that was all very, very interesting work, yeah.

Yamashita: Also, key contribution that lot of companies that wouldn't have been able to develop something like that, you know, on your own.

Bogy: Oh, I--

Yamashita: Could go and purchase these equipment and _____ it.

Bogy: That's-- also we worked closely with Wyco with…

Yamashita: Wyco.

Bogy: --Jim Wyatt and we had Wyco System. We had Zygo Systems too. We worked with the guys from Zygo. A lot of-- I think we helped those companies get into the-- data storage companies.

Yamashita: Yeah, right.

Bogy: I mean, to sell their stuff to companies.

Yamashita: Right.

Bogy: Because we did work on that and we would display it at our meetings and stuff.

Yamashita: So, I want to cover one topic. I remember experiencing your ground rules, you know, for grad students and so I remember still very clearly you had very firm rules about, you know, expectation and so on. So, when you pick grad students, do you have some ideas in mind how you pick them?

Bogy: Well, that's interesting. I mean, yeah, I do. I have definite ideas how I pick them and my ideas don't agree with a lot of others, but first of all, I say that there are three kinds of graduate students. <laughs> Just like every… There are those graduate students, you give them a broad picture of what it is you're working on, and roughly what kind of area you think they should be working on, and there are those graduate students that can then figure out what to do and they can figure out how to do it and they can do it.

Yamashita: Right.

Bogy: Then there are those graduate students who really can't figure out what to do, but if you tell them what to do, they can do it.

Yamashita: Mm-hm.

Bogy: And then there's the other ones that you don't really wish you had and that is they can't figure out what to do and if you kind of tell them what to do, they can't really do it <laughs> and so, you know, they-- not going to. So, I want to have that first batch of graduate students, so you say, "Well, how do you get those students?" Well, I get them by going by their history, their training, and their performance, where they've been, and looking at various things, and so what has happened, what has happened then, for me, over the years, is that almost all of my graduate students have been foreign students. <laughs> They, in other words, we get a lot of applicants to our department each year for graduate study and from the top universities in the world, so in, say, in China. So what? So Tsinghua University in China. It's kind of recognized as a top university, right? In this technical areas that we-- or in India. Well, these certain of these IITs in India. They turn out top people, and so they apply here. They can't come generally unless they're supported completely, right? So, I look at those top students, you take a top student out of a place like, you take a place like Tsinghua University, their graduating class may have hundred fifty students in it and the top one or two guys who have applied, you know. Very interesting. So, you look at those students and you say, "Gee, those guys are really well prepared to do stuff." I mean, they know the physics, they know mathematics, they know laboratory work, mechanics. They know electronics <laughs> and they know programming. They know all these things, right, and you say, "These guys are

really prepared." There's one drawback. They're expensive, because you have to support them and that includes non-resident tuition, so…

Yamashita: Oh, I see. Wow.

Bogy: <laughs> So a lot of professors look at the incoming graduate student pool and they say, "I don't want that guy. He's too expensive." So, I say, <laughs> "I'll go for this guy. He's expensive but I believe he's worth the money," and so I typically end up getting these top students from China or India and they're just outstanding students.

Yamashita: I see.

Bogy: And so, they come here, we have these requirements that they perform academically, that they-- of course they have to do well in their courses, they have to pass a preliminary exam, they have to pass these qualifying exams, all that stuff. These students that I get, they're two or three years ahead <laughs> in these performance criteria, you know.

Yamashita: I see.

Bogy: And they're really able to go. So, these students, that's how I choose the students and so that's why when you come to my laboratory you see Chinese students, you see Indian students, maybe a European or two or something like that, but I remember, of course, Silicon Valley is made with, I mean, I remember one time at Komag you almost had to speak Chinese in order to operate there.

<laughter>

Bogy: It was something like that, but anyway, then when I get these students, then what? How do I deal with them? I say, "Okay. In our lab, we do experiments. We do modeling. We do program development, and we do various other things," and I say, "I have this range of problems," so I tell my students, "The first year all you have to do is try to learn what it is we do. I don't care, you don't expect to do any research, accomplishment, the first year, just learn what we do, and make the best grades in your courses and take these prelims early and get ready for your academic stuff," and they do that, and then I say, "And then you probably prefer to either be an experimentalist or to be a modeler or to be a program developer or whatever, and I said, "I like to honor that preference that you have," and so then I just kind of… Every now and then I got to have an experimentalist, and I tell this guy, "Look. You've just got to be an experimentalist."

<laughter>

Bogy: Or something like that, but that's kind of the way I do. I get what I think are the best guys and then let them kind of go their way and help define their …..

Yamashita: Lot of times you have to, if they're a foreign student, you may not necessarily be able to meet them, you know, before you get them, right?

Bogy: I have for a long time--

Yamashita: Or do you?

Bogy: --Skyped them or WeChat them or something.

Yamashita: Oh, okay. Okay.

Bogy: You know--

Yamashita: So, you do--

Bogy: --interview them. I interview them.

Yamashita: You do interview them.

Bogy: Yeah.

Yamashita: Uh-huh.

Bogy: And I have visited in China. I've visited students who we're going to take as <inaudible>.

Yamashita: Scope them out first or…

Bogy: Yeah, right. Yeah.

Yamashita: Okay.

Bogy: And yeah, so it's important that they be able to have good English. Almost all of them do now, but I can recall students that I took who had what a-- these TOEFL scores, test of English as a foreign language. They had great scores in the TOEFL from China, <laughs> and they would come here and these guys could't speak English, you know.

Yamashita: I see. I see.

Bogy: And so, I remember, I asked one, I said, "How did you make such a good <laughs> score on the TOEFL?" He says, "Oh, that was easy. You just had to memorize 7,000 words."

<laughter>

Bogy: I said, "Okay. Well, that--" I learned from that, that I couldn't go by the TOEFL scores, so I had to have some interview with them one way or the other.

Yamashita: Do you suppose that, you know, you said in the U.S., is it, is the education system not producing enough of good students or it's just the competition worldwide is very, very keen?

Bogy: Here the-- there's a changed emphasis in what students want now. It's changed from wanting to really learn fundamentals to being an entrepreneur or to being an environmentalist or to do socially useful work and not so much on getting in the laboratory and grinding out stuff that's hard, you know, and… But these foreign students still do that.

Yamashita: Still do that.

Bogy: Yeah. <laughs> They're still trained in that way, you know, and I think it will change there also, but probably is still okay. I mean, I still get really good-- I have, as I said, I have a new student who came last week from Tsinghua University. The guy is great.

Yamashita: I see.

Bogy: Mm-hm.

Yamashita: Are you still, do you still do work on other areas besides HDD? Or are you migrating to new fields or…

Bogy: Well--

Yamashita: What is happening?

Bogy: --I'm having some thoughts in that direction but I'm not sure. In other words, the HDD companies have sort of decided that a substantial part of their future is also in solid-state, right, and to the extent that they're reducing their university support for HDD work in favor of solid-state work. This MRAM has kind of become a popular thing. There're problems we could do there. There are mechanics problems there. There's heat transfer problems there, nanoscale type. We could find work to do, I think, in that area, and I've been thinking about it but haven't yet decided if I want to do that or not. But I think I'll keep my eyes open in that regard and if the opportunity arises where I think we have the expertise that would lend itself to productive activities in those areas, I think we would possibly look at it, yeah.

Yamashita: I see.

Bogy: I mean, as you know, CMRR changed their name, so they're no longer Center for Magnetic Recording Research.

Yamashita: That's right. The "magnetic" came out.

Bogy: Yeah.

<laughter>

Yamashita: Just noticed that recently,

Bogy: Yeah, and so--

Yamashita: Sign of times. <laughs>

Bogy: Yeah. So, I think they have-- they've made that move to go into some MRAM type work.

Yamashita: And your grad student, I mean, even with a storage type of thesis and work, they probably could go work anywhere.

Bogy: My students-- you had written a question about where do my grad students go?

Yamashita: Mm-hm.

Bogy: So, I would say I, and I mean, I have supervised 66 Ph.D. students and about a hundred master's students.

Yamashita: So far, uh-huh.

Bogy: Yeah. I don't keep up with the master's students but the Ph.D. students, about a third of them have gone to academia and about the other two-thirds <laughs> have gone to industry and of those, almost all into the hard drive industry, business. A few in other industries, but presently, in my recent students, I would say more of them are going to Apple and Google and <laughs> places like that. The requirements on them there are really not as stringent as they are in a hard drive company in the sense that they want people who can basically run commercial, write commercial, finite element codes and analyze stuff that my students, you know, students can basically do without a Ph.D., but that's where they're going, and a lot of our students, as you know, there's been a lot of downsizing in the hard drive business, a lot of our students have left and gone to Apple. I probably have six former Ph.D. students at Apple in their reliability group.

Yamashita: Oh, really. Oh.

Bogy: Yeah. <laughs> And--

Yamashita: I remember Brian Strom was one of the early ones to go there --

Bogy: Yeah. Yeah.

Yamashita: --wants to go there.

Bogy: He was an early one. He's a manager of a group there in Reliability and he hired, he hired three or four other guys. They were at Samsung when they kind of, he hired them from there. Yeah, Brian

Thornton and Walt Fong and two or three other guys. They have a group there and same in Google. Google hires these guys.

Yamashita: I see.

Bogy: And the people in our CML who are doing servo automatic controls and servo stuff, they're going to these companies for autonomous vehicle--

Yamashita: Ah, right, right.

Bogy: --stuff. Yeah, <laughs> you know, so…

Yamashita: There's a huge expanding field in this kind of thing, so…

Bogy: Yeah. Right. So, our students are just really well grounded and prepared and have great capabilities and they don't have to go to hard drive companies. They have a, they know the technology more when they go to those companies, but they're able to go elsewhere.

Yamashita: And even become a university president.

<laughter>

Bogy: Yeah, right. Yeah. Well, that person who's a university president, he went there, he had been dean of Virginia Tech and he had gone to be dean. He, prior to that, he'd been a professor at I think another university, but he had gone there to be their dean, and about two months after he got there, they had that huge shootout at Virginia Tech and…

Yamashita: Ah, ah, ah, was horrible.

Bogy: In the building that his dean's office was in.

Yamashita: I see.

Bogy: And they had to evacuate that and everything but he was a very successful dean there and he got this job as chancellor.

Yamashita: It's a big system too.

Bogy: Yeah.

Yamashita: Texas….

Bogy: Well, he's not of the whole system. He's of this university, it's not the Austin campus, it's the University of Texas in Dallas, which is--

Yamashita: Oh, okay.

Bogy: --an upcoming--

Yamashita: One of the--

Bogy: Yeah.

Yamashita: --branch university,

Bogy: Yeah, yeah, right, yeah.

Yamashita: Okay. Mm-hm. Yeah.

Bogy: Yeah.

Yamashita: Maybe few other questions left. I forgot to mention. You won some awards like the Reynold Johnson Award and is there some other ones that, you know, you care to talk about?

Bogy: I won some ASME awards related to, you know, tribology was a big part of-- they have a Tribology Division of ASME and they have, their type of award, is called a Mayo D. Hersey Award.

Yamashita: I see.

Bogy: I won that award back maybe 20 years ago. I won an award, yes, a Reynold B. Johnson.

Yamashita: It's 2011--

Bogy: Reynold Johnson had--

Yamashita: --I think it was. Yeah.

Bogy: Yeah, they had two awards. One still exists but--

Yamashita: 2010.

Bogy: --the one I won doesn't exist anymore.

Yamashita: Yeah, unfortunately.

<laughter>

Yamashita: 2010, I have it here.

Bogy: Yeah, right, and I won some Seagate Award for some kind of contribution in data storage stuff.

Yamashita: I see.

Bogy: And some NSIC awards for just doing the stuff that we were doing at the time that was-- after we finally got over the hurdle of being admitted into the NSIC.

<laughter>

Yamashita: I see. I see.

Bogy: I was-- and I've earned some university awards. University of California has a-- they don't give honorary degrees. They give what they call a, Berkeley gives something called a Berkeley Citation.

Yamashita: I see.

Bogy: Instead of that, and I won that award at Berkeley.

Yamashita: Was that recently or some time ago?

Bogy: Oh, that was-- it should be in there. Probably 2011 or something maybe.

Yamashita: Oh, okay.

Bogy: Maybe-- no, 2000-- probably '9 or '10, yeah. Berkeley Citation.

Yamashita: So that's quite an honor to get this.

Bogy: Yeah. I was-- yeah, it was honor to receive.

Yamashita: You've been there 50 years.

<laughter>

Bogy: Yeah, I mean, after 50 years.

Yamashita: They need to give you something.

Bogy: They're going to have to do something for me.

Yamashita: So, the last thing, you know, I wanted to hear what you say about your hobbies and your skiing at your age, which is remarkable.

<laughter>

Bogy: Well, I was, as I told you, raised in a rural setting.

Yamashita: Yes.

Bogy: And when I was growing up, my father and other people around would take me hunting and fishing, so we did a lot of hunting and fishing. I haven't continued so much with hunting, but I continue some fishing. So, I would say my favorite activities, outdoor activities, I would say, has been skiing and just mountaineering, hiking in the mountains and climbing. Frank and I did a lot of rock climbing together. We did that, so that was a great thing for us and skiing I used to do quite a bit. I had a place up at Donner Lake there and when my children were young we'd go skiing all the time. When they left, we didn't go so much, so I started sailing.

Yamashita: Sailing, oh, okay.

Bogy: I have had for the last probably 30 years boats in the bay, sailboats, and also had a powerboat, fishing boat that I'd take out in the ocean, fishing for salmon and stuff like that, so that, they closed salmon fishing here and I gave that boat to my daughter and son-in-law who live in Connecticut and I--

Yamashita: This is Susan or…

Bogy: Huh? No, that's Rebecca.

Yamashita: Rebecca. Oh, okay.

Bogy: No. She's a doctor in New Haven and--

Yamashita: Oh, okay.

Bogy: And her husband's an organic chemist there and-- but he's a big fisherman and so they fish in Long Island Sound, and so I go there two, three times a year and fish with him in Long Island Sound. It's great fishing there.

Yamashita: What do they fish for?

Bogy: Oh, they fish for-- depends on the time of the year but they fish for striped bass, they fish for bluefish, they fish for blackfish and for black bass, is a different one, and that's pretty much it.

Yamashita: You join them for fishing, with him?

Bogy: Yeah. Yeah. I go there and fish with him often. We used to-- but I used to fish, I would take my own boat out. That same boat, I'd take it out into the Farallon and fishing out in there and--

Yamashita: Well, that's way out there.

Bogy: Yeah, that's out there, yeah.

Yamashita: <laughs> Awesome.

Bogy: And on my sailboat, we used to go out. I had my sailboat in Mexico and brought it up from there.

Yamashita: Wow, awesome.

Bogy: <laughs> And sail. Used to sail out often down in Monterey and up to Point Reyes and stuff, but then my wife didn't like the ocean waves so much. Get seasick. So, we kind of stay mostly in the bay now. We still sail it in the bay.

Yamashita: I remember you telling me a story, this long time ago, but you told me you hooked up a sturgeon, big one, and it kind of dragged you around for little while and… <laughs>

Bogy: Well, I don't know.

Yamashita: There were some good ones.

Bogy: I hooked up, once--

Yamashita: Something.

Bogy: I don't quite remember that, but I had a--

Yamashita: Something big. <laughs>

Bogy: See, well, I, in Texas when I-- I have a, my sister, has a big ranch in Texas that has a lake on it that's got great fish, but it also has alligators.

<laughter>

Yamashita: Oh.

Bogy: And I hooked up with an alligator and that was-- and the boat was small and so I got dragged around quite a bit until we got rid of the alligator.

Yamashita: I see. Oh.

Bogy: But yeah, so we… So boating and skiing, and then I like-- oh, I remember Tu Chen was a big boater.

Yamashita: Yeah, he loves fishing. Yeah.

Bogy: Where is Tu Chen now?

Yamashita: He's retired and he doesn't fish anymore, but…

Bogy: Yeah. Where's John Chen? He was my student in Berkeley.

Yamashita: He works for this TRENDFOCUS.

Bogy: Oh, yeah?

Yamashita: It's… They did most of the SSD business analysis.

Bogy: Yeah? Okay.

Yamashita: That type of thing.

Bogy: Yeah.

Yamashita: But you know, I went fishing many times with Tu Chen, so I--

Bogy: Yeah. I never went with him, but he and I used to talk about fishing stories because, yeah, I knew he had this boat and he would go out fishing. He went out in the ocean too, right?

Yamashita: Yes.

Bogy: Yeah.

Yamashita: Or I went to Farallons with him one time.

Bogy: Yeah. Right. Yeah, we ….

Yamashita: Just caught just one tiny little fish.

<laughter>

Yamashita: After about, I don't know, several hundred dollars in gas.

<laughter>

Yamashita: But it was ridiculous.

Bogy: I went out there once with one of my students, actually. He was my programmer analyst and we went out there and we were fishing and we saw this huge, really weird fish and it was a-- it was up-- it's called a sunfish, and he came up to the top of the water--

Yamashita: Oh, right, right.

Bogy: --and he was-- he looked like he had been cut half in two. Only his head half was existing <laughs> and he was around there and we--

Yamashita: They can become very, very large.

Bogy: Yeah, he was very big and I saw that. That's the only time I've ever seen one. We saw that one, and we also saw some great white sharks out there once. They breed out there, but…

Yamashita: So, you don't look like you're ready to slow down any time soon or maybe--

Bogy: Well, I figure if you slow down, what do you do?

Yamashita: <laughs> Uh-huh.

Bogy: You just-- you can't afford to slow down, right?

Yamashita: Yeah.

Bogy: And--

Yamashita: And you got grad student to support.

Bogy: I, well, I have a grad student. I have a five-year commitment to the one I just took, right.

Yamashita: <laughs>

Bogy: So, what am I going to do? But sooner or later I have to-- the thing that will go is the laboratory first, because it's the hardest to keep going. You can keep modelers going <laughs> without a whole lot of effort, you know, but to keep guys in equipment. We just bought the-- Seagate had a big, a big auction sale this last week and we bought new, some new oscilloscopes <laughs> from them that have great, great capabilities.

Yamashita: I see.

Bogy: Yeah. And got to figure out how to get that down, but it's something we need for our work right now.

Yamashita: I see.

Bogy: Yeah.

END OF THE INTERVIEW

