Oral History of Geoff Tate

Interviewed by:
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Laws: Good morning. Today is July 26th, 2017. My name is David Laws, I'm the Semiconductor Curator here at the Computer History Museum in Mountain View, California. This morning, I'm going to interview Geoff Tate about his career in the semiconductor industry. I am particularly interested in talking to Geoff about the challenges of managing a semiconductor company based on intellectual property. Welcome, Geoff!

Tate: Great!

Laws: Glad to have you with us!

Tate: Yeah, I'm glad to be here! Thanks, Dave!

Laws: Let's start with your childhood, Geoff. Where were you born? Tell us a little about your family and what were your interests as a child?

Tate: I was born in Winnipeg, Manitoba, Canada, in the middle of the country. My father was a land surveyor, my mother was a homemaker, both from Canada. And I grew up, oh, five, six, seven years it was in Winnipeg, and then we moved to Edmonton, which was a booming town at that point. It was 100,000 people, the center of the oil business. So my dad got transferred, and I spent the rest of my childhood in Edmonton, in Northern Alberta. So my interests as a child? I always liked sciences, math, that was the stuff I liked the most. I hated English, but I managed to get good grades. And I always wanted to do something different every year. A paleontologist, astronomer. It changed.

Laws: Where did the interest in the sciences come from? Was it from friends, mentors, reading?

Tate: Well, I think my dad stimulated a lot of interest in the sciences. My mom was always supportive of school and doing well in school. Neither of my parents had completed a college degree. My dad dropped out during the war, my mom never got around to starting. But they both wanted us to get a good education. And they were happy just for us to do whatever, but my dad had a strong math bent, there was a lot of trigonometry and stuff in land surveying, as it turns out, and I think encouraged my interest in that field. So when I finally finished high school, I went into university studying physics. I thought I wanted to be a theoretical physicist, and study atomic particles. But you need a lot of calculus, and I had a terrible calculus professor, so he turned me off.

Laws: That sounds familiar. But I can't blame my professor.

Tate: He turned me off. I still remember his name. Funny how you remember certain people's names, and to him everything was obvious but it wasn't so obvious to me. I needed a little more help, I guess. But I was taking a computer science elective class. And found that to be very interesting, so I switched into that, and off I was, and that eventually led into semiconductors.

Laws: This was at the University of Alberta in Edmonton?

Tate: Yes, yes, yes. Up in Canada everybody just went to their hometown university. I don't remember anybody who went anywhere other than the local university.

Laws: Uh huh. You had siblings? Brothers? Sisters?

Tate: Three. Two brothers around my age, and then a sister who was 11 years younger.

Laws: Did they have similar interests?

Tate: I think sometimes whatever your older-- I was the oldest-- so whatever the oldest is good at, a lot of times the younger ones channel away from that.

Laws: <laughs> That's an interesting phenomenon, isn't it?

Tate: So I think they might have done well in those fields, but especially my brother one year younger than me, hated to be compared, so he focused on other things, and became an English major and then eventually a lawyer. My brother, a couple years younger, never did well in school. Dropped out and moved around, and eventually became an English teacher, now living in China. And my sister studied nursing. So we all ended up doing very different things.

Laws: Was there a school teacher or other mentor that encouraged your interest in science? You said your parents did. But were there other influences that helped you in that direction?

Tate: Oh, yeah, but I can't say I remember all of them vividly. I do remember a math teacher in junior high school who actually got me involved in an afterschool program where we could use computers at the university? Which was really a good deal. I forget his name, but I remember when I was studying, he was very good. There was a science teacher in junior high school, his name I forget-- I can remember what he looks like-- who similarly, I liked a lot. And then in high school, there was a teacher, Mr. Radomsky [ph?], who has really got me interested in sciences and especially physics. Which is probably why I went into physics originally.

Laws: Okay. And in physics at college, did you study semiconductor technology?

Tate: Oh, no. I dropped out of physics and moved into computer science like in the first half a year.

Laws: Why did you do that?

Tate: Oh, because of my calculus professor.

Laws: Of course, the calculus.

Tate: And the computer science. I'd actually been learning the computers through this university program where we could do programming on our own. But I just found the computer stuff to be much more interesting. And perhaps the thing that I liked about computers was that it was easier to do things and get stuff done quickly.

Laws: Sure. It's much more tangible. You can touch something and get a result.

Tate: Yeah, atomic particles you need some gigantic reactor, bureaucracies are involved, takes time. You know, computers, back then you had to do punched cards, it wasn't instant, but it was way faster turnaround time than a lot of other things, and I liked that.

Laws: What kind of machine were you working on?

Tate: I did the program that involved me going down to university in high school, it was an IBM 1130 that had APL, among other languages. But APL was the really cool one that we loved to use. In university it was an IBM 360 mainframe. And I think we programmed primarily in Fortran, if I remember right.

Laws: Probably.

Tate: At the start anyways. Wat-4 from the University of Waterloo. And but then pretty quickly I got involved, somehow, with the PDP-11 running UNIX, and learned how to program in C. And I think that was just kind of open and available and sitting there, and I just started to do it and used it as my programming tool of preference, because it was instantaneously responsive, and I liked the C language.

Laws: And then so you graduated in 1974?

Tate: I did.

Laws: And your next move was to where?

Tate: I went to Harvard Business School.

Laws: Okay.

Tate: I don't know why I didn't follow on in graduate stuff. I don't recall anybody ever encouraging me to do a PhD or a master's program. So I sort of think back and I wonder, "Well, how come I was so focused on going to business school?" But I'd always been interested in the business side of things as well, or maybe not "always," but somewhere along the line, that interest developed. And I applied to two business schools, my local university and Harvard. I didn't know about any others. And I got into Harvard, so off I went.

Laws: Was there any particular direction you pursued at Harvard in business?

Tate: No, Harvard has a general program, and there are very few electives. So as I recall, there was a few electives in the second year. The first year is all prescribed. And it's only a two-year routine. And I didn't actually know anything about business. As it turned out, I may have been in the last year where they actually let people go into Harvard without work experience. Because not having work experience made a lot of the classes somewhat [abstract], you know, especially I remember Organizational Behavior classes, and they talk about dysfunctional behavior in organizations, which is, you come to realize how these things work, but when you've never worked in an organization, it's like, "No, people wouldn't really do this kind of stuff would they?" So a lot of it wasn't that-- it would have been better if I'd had work experience.

Laws: For sure.

Tate: But on the other hand, I'm not sure I ever would have bothered going back in school, if I'd had work experience.

Laws: True, true. How did you find Boston after Edmonton? It must have been quite a change of scene for you.

Tate: Well, not a lot of people go to Edmonton as tourists. Boston's a much more fun place, and the weather's a lot better. And compared to where I'd spent all my life, other than one trip to Disneyland as

kids, where we got to see Western U.S., which was a lot of fun, I'd never really been outside of Western Canada. So Boston just seemed like a really old place, 400-year-old graveyards and old buildings. Just lots of people. It's really a college town on a large scale. And so it was a lot of fun. It was very eye-opening and very interesting. I had a great time.

Laws: Did you get to use computers at all in the business curriculum.

Tate: Hm, I don't recall that we ever used a computer in the business curriculum. At Harvard, some of the mentality was that they were focusing and developing General Managers. And you could hire people to do accounting, finance, computers, you know? The program was really focused for general management.

Laws: And then when you graduated from there in '76, I believe, you started to look what could you do with these skills? How did you make a choice?

Tate: Well, it was easy because nobody wanted to hire me in the United States. Being Canadian, I didn't have a visa. There was one company that interviewed me and made me an offer, and it would have been consulting in the IT space. Somewhere in Alexandria, Virginia. So I seriously considered that, but in the end decided it was much more of an IT job than it was a business job. So I ended up going up to Canada and working at Imperial Oil, which was, and still is, the U.S. subsidiary of Exxon in Canada. They gave me a job in marketing, which was more along the lines of what I was interested in doing.

Laws: OK

Tate: I wasn't interested in working in the oil business, but in Canada there wasn't a whole lot of things to pick from. So that seemed like the best choice at the time.

Laws: And where were the offices? Where were you located?

Tate: I was at their headquarters in Toronto, Canada.

Laws: Toronto. So another big city.

Tate: Another big city. Toronto's a nice place, too.

Laws: Yes, it is.

Tate: I'd rather live in Boston than Toronto-- but Toronto was diverse, good food, a lot of interesting neighborhoods, a lot of immigrants. So it was a pleasant place to be.

Laws: And what did you learn about marketing?

Tate: At the time, I'm not sure I learned that much. In retrospect, I'm sure I could have been a lot better. That's why at my startups, I try not to hire people out of school. They really haven't learned what they need to learn yet, for the most part. But it was a training ground, and what they were really doing in this program was to identify talent for future promotions. And so I remember a couple of marketing programs that were being explored at the time. One was like a talking [gas] pump, you know, a pump that would have audio-visual feedback. It seemed like kind of a silly idea at the time. Probably still was. Another one was convenience stores. And in retrospect, that was an obvious idea, but at the time it seemed like a really dumb idea to have a convenience store at a gas station. And what did I really know about cars? I didn't even own a car. I wasn't a car person. My friends were car nuts. So it was really kind of an opportunistic place to go to learn more about the business world. And it clearly from the start wasn't likely to be where I was going to spend my career.

Laws: Did you ever get to see any ideas that you had come up with put into action?

Tate: Yeah, I had to implement marketing programs, and these were retail, point-of-sale programs for promoting certain things. And I had to fly around the country and train people, and work with real service station dealers. So it was hands-on.

Laws: This was your first real experience of business.

Tate: Me and some friends had done some business stuff as hobbies, you know, buying and selling things, janitorial services, but this was the first time it was a full-time job.

Laws: These were when you lived in Edmonton?

Tate: Yeah, yeah. So this was the first full-time job with any real exposure to business. You were in meetings where they were talking about long-term plans, and strategic decisions and the financial forecast, and capital allocations and all those kind of things. So it was actually a well-run company with a lot of good systems and procedures and processes. So I think I learned a lot more than they got back in return at the time.

Laws: And did you get a chance to observe organizational dysfunction at all in that role?

Tate: Oh, yeah. Yeah, well, all organizations have dysfunction. You know, once you're past two people, you know, usually it starts to develop.

Laws: Sure.

Tate: And this was a gigantic company. It was an eight billion dollar business back then as a part of a hundred billion dollar business. So there were just layers and layers of bureaucracy. For its size, it probably was fairly well-run. It was probably less dysfunctional than average for a company its size. But I remember at one point I got promoted to a senior marketing level or something, so I got an office. But the guy on the other side of the wall was in an office, and he was more senior than me, and he complained that his office was smaller than my office. So they actually came in one day and took down the hard wall and moved it, so that the offices would be regulation size. <laughter> Which seemed like a really stupid idea. The stupidest thing was at the time, the phone jack was mounted on the floor. So now my phone jack for my phone, and I was in marketing talking to people across the country, was located on his side of the wall. <laughter> So I didn't have a phone for however long it took it to install a new phone jack.

Laws: Fascinating.

Tate: So that was an example of a really stupid thing.

Laws: Yeah.

Tate: I remembered deciding that big companies weren't really my thing even then, and that a lot of silly stuff just-- there was a lot of things that companies waste time and energy on. Style was more important than getting results in big companies.

Laws: Any use of computers in that job?

Tate: Nope. I do not remember any computers. Or any use of computers. There were computer programs. There was an IT department. We'd get reports.

Laws: Accounting/financial stuff?

Tate: Yeah, but they'd show up like in the daily summaries or things like that. There were no terminals, there was no programming that was done. Whatever the computer was, it was probably some big mainframe somewhere else in the building spitting out reports and those would get distributed around.

Laws: And how long did you spend at Imperial?

Tate: I spent a little over-- around two years. I did my marketing stint then I got promoted to what they call a financial and operation's coordinator, supporting the Regional Sales people in Western Canada, back in Edmonton, as it turned out. And they were going to promote me again to an Area Sales Manager. But at that time I'd already taken three weeks' vacation and toured around the U.S. - it was time to find a job in high tech.

Laws: And who did you target for your visits?

Tate: I don't remember all the names, and probably half of them are gone. Probably more than half of them are gone. I took three weeks' vacation. I know I went to Southern California. I talked to aboard company there. I talked to a printer company in the Valley, north of Los Angeles. Because I remember being very surprised that you could drive for so long and just see nothing but people in buildings.

Laws: <laughs> Right.

Tate: In the Bay Area. I talked to Advanced Micro Devices [AMD]. I talked to TI. I talked to somebody out in Boston, I can't remember who. I was, I think in Atlanta. So I was all over the place in three weeks. And I cold-called a bunch of companies. I remember talking on the phone to Bill Davidow, who later was the chairman of my board.

Laws: Right.

Tate: Who said, "No, we don't need anybody like you." <laughs> He was at Intel at the time.

Laws: Right.

Tate: So I cold-called a whole bunch of people. I got three weeks' worth of interviews set up. And the interviews would usually go like, "Wow, this is great, we could really use somebody like you." And I'd say, "Well, by the way, I'm from Canada. I'll need a visa." And it was like, "Oh, well, there's the door. Don't waste our time." There's only one company that ended up needing somebody bad enough to consider getting me a visa.

Laws: And that was?

Tate: And that was Advanced Micro Devices.

Laws: Interesting. Were you married by now?

Tate: No, I met Colleen who would become my wife, but we were just dating at the time.

Laws: She was in Toronto where you were?

Tate: She was in Edmonton.

Laws: Oh, okay.

Tate: Colleen came down [to the US] after I did get a job offer. Fortunately, it took six months for them to get me my visa. Because my job was for a Product Marketing Engineer and my actual degree was Computer Science. AMD at the time needed somebody who understood computer architecture. In my Computer Science program I didn't study semiconductor devices, I studied digital logic. But I understood computer architecture and could draw multipliers and adders and state machines and all that kind of good stuff. I couldn't draw a transistor or explain how it worked, because I'd never taken any courses in that. So the U.S. government got a little hung up on the fact that I was getting a job as a Product Marketing Engineer, and I didn't have an engineering degree, and that made the visa process take six months, instead of one month. But what AMD should have done is called the job a Product Marketing Computer Scientist and I would have gotten the visa in a month, but then maybe our relationship wouldn't have developed enough. So it was probably good that it took six months.

Laws: Interesting.

Tate: So she came down later, and ended up getting a job at AMD also. AMD was growing very fast at the time, and she had IT skills, and got hired into the IT group. Only took her one month to get her visa.

Laws: So this was, I believe, 1979 when you joined AMD in Sunnyvale?

Tate: Yes. 1979.

Laws: And who did you work for?

Tate: I worked for John Springer.

Laws: What was your role working for John? John was Product Marketing Manager for bipolar microprocessor, right?

Tate: Correct, yeah. And John had been marketing the AMD 2900 bit-slice family for some period of time before I got there. I think I was his first Product Marketing Engineer. He had been looking specifically for somebody with some computer architecture skills to talk to customers about architectural stuff, and also perhaps talk to the internal group that was working on new products. So I worked for John for about a year, and then John moved on to the Z-8000 MOS microprocessor that AMD was doing in competition with the 8086 and the 68000. And then I ended up reporting to you, Dave!

Laws: That's right. That was about 1980 I would guess.

Tate: I think it was 1980, although an ability to remember dates is not what I'm good at.

Laws: I had a cheat sheet in front of me that you prepared for me.

Tate: I don't remember working for John for that long. So I think it was around a year into the job that John moved on and I started reporting to you.

Laws: Now it must have been quite a change of culture coming from a multibillion dollar company in Canada to Advanced Micro Devices in Sunnyvale. Were there surprises in the way the company worked, and the way you got things done?

Tate: That's so long ago, it's hard to remember. But you know, compared to Imperial Oil it was a small company. Headquarters was a two-story building. You know, my job was in one of the smaller buildings that was two stories. It was a relatively small campus. Just the Canadian Operations of Exxon was probably ten times bigger than AMD at the time. But AMD had already gone public, and probably had a thousand employees. Although a lot of those employees were manufacturing folks. The actual professional staff of degreed people probably was just in the hundreds. So it was a company that you could sort of get your arms around. You could end up meeting and knowing most of the management team in a fairly short period of time. And I liked that. I liked the ability to get a bigger picture of what was going on. You know, the managing director who ran the group, you know, the engineers who reported to him. The fab operations, I'm not sure that we had our own fab, probably not. But the fab were very close-by. So everything was close. Everything was touchable. You know, if you needed to find people, you just had to go down the hall, or maybe a couple of blocks and everybody you needed to work with and make decisions with was very readily available and approachable.

Laws: Who was the Managing Director you were reporting to at that time?

Tate: When it was John Springer, I don't remember who the Managing Director was.

Laws: Would it have been Phil Downing?

Tate: I think it was, yeah, now that you mention it. Yeah.

Laws: And then Bob McConnell came in later?

Tate: Yeah, and John East..

Laws: And then John East. Right.

Tate: Was McConnell the Managing Director? I think he was the Design Manager reporting to John, if I remember right. And then later he became Managing Director.

Laws: What was the job of Product Marketing Manager in the bit-slice microprocessor business? What did you do? How did you spend your time?

Tate: That was after John moved on. I forget when I became Product Marketing Manager. Maybe it was when I started reporting to you. Maybe it was after. But at that point, mostly what I recall doing was supporting the sales guys in the field. There was a lot of pricing, delivery issues. The order's late, needs to get expedited. Allocation of parts if there was overdemand. Scheduling of backlog. There was a lot of that stuff. There was a lot of stuff on pricing. What prices should we quote? We were the majority supplier, but there was some competitive versions of some of the devices that we made. So sales guys would be calling. In the morning, it'd be Europe. In the evening, it'd be Asia, and the day it'd be all over the U.S. So there was a lot of talking and supporting customers on pricing decisions. So that was the tactical aspect of the marketing. In terms of market development, there was writing datasheets. I remember the first datasheet I wrote was for the 2960, which was an error correction device.

Laws: True.

Tate: Which I'm not sure why that was in the Bipoloar Microprocessor Group. But could have been anywhere, but anyways, I got to write a long datasheet there using the help of the applications people to figure out how this stuff worked. And back in those days, datasheets were very detailed. Customers basically wanted to know how everything worked inside, and what the critical paths were, and what the timing paths were, etcetera. So that was my first datasheet. We did more datasheets than later, because there was a lot of new product development. There was a DSP family, there was the 29116. And then

there was the marketing. I remember getting the cover of one of the major magazines for the 29116 was a big deal. Writing articles, getting articles placed, talking to press and editors about new products and announcements. And then we did a lot of seminars. You know, these days, there isn't this kind of stuff. But back in the old days the way a lot of people learned things was to go to seminars that companies would hold. The company would hold the seminar in two or three hours on some new product line, and the sales guys would pack them with interested customers. And we did, I think, like a couple of different seminar series, and we'd hit like 30 different spots around the world. Me and the Product Marketing Engineers that worked for me. And that was one of the best ways we had to stimulate new design activity.

Laws: The 2900 was interesting for AMD in that it was one of the first real proprietary products where you had to actually go out and create a market, rather than just try to defeat a competitor's price, or sell on quality or something. Did you find salespeople needed a lot of training in order to change their style of selling, and even the people they would call on to sell the product?

Tate: I think the original 2901 family market had already been developed by the time I got there.

Laws: Okay.

Tate: So I what I remember was the follow-on products. The 29116 and the 29500, which ultimately weren't as big a deal, because CMOS was starting to make inroads into the processor arena. So I was involved in the marketing development of those products. But I think John Mick and however else had worked with him, had developed the market for the original bit slice devices.

Laws: So the groundwork had already been laid, and the sales force was pretty supportive, as I remember. By that time they realized that there was some real benefit to having proprietary products. .

Tate: Yeah. So I wasn't there during the transition from commodities to having the first proprietary product. But the salespeople for the most part spent their time selling commodities. And sometimes one of the challenges was to get the salespeople to pay attention to the proprietary products. They were paid on a commission scheme, and proprietary products require [a long] design cycle, as you know, and during that design cycle you don't get any money for it upfront. You have to do the work now, and you get commissions a year or tw [later]. And in a lot of cases, it's easier for them just to try to go get commodity business in the short term. So that's why we would do things like seminars, and articles and advertising, because then you're not solely dependent on the salespeople to win the designs.

Laws: Right. And this was the time when I think AMD invested a lot of money in Field Applications Engineering force as well. Were you involved with them?

Tate: Oh, yes! Extensively. Yeah, they were probably the most fun people to deal with. Because they usually had a lot of interesting technical challenges and issues and you know, listening to them and their customers and trying to figure out how to help solve the customers' problems was one of the most interesting parts of the job.

Laws: Wasn't one of the differences in the kinds of products that were coming out when you were there was that customers expected a lot of support in terms of software? Compilers and other tools. Were you involved in helping to identify those and promote them?

Tate: There was no software in the products I was involved in.

Laws: Wasn't there a development system for the 2901?

Tate: There was a development system. That had already been largely developed. Got it. So it was something that I hadn't been involved with and there was an applications engineering team under John Mick, who handled a lot of that stuff. So there was like a parallel organization inside the company run by Sven Simonsen and John Mick. They provided application support at the central level for various product lines, including ours. So the applications people who developed things like the development systems didn't work for the business unit, the way it was setup. So I don't recall being involved in the development systems issues or decisions. I think it was either all done at that point, or it was done in the Applications Group.

[Editors note: For more information on the AMD 2900 Family history, see the "AMD 2900 Microprocessor Family Oral History Panel." Recorded: February 11, 2009]

Laws: What was your next move within AMD, Geoff?

Tate: At some point, I got promoted to run the Multi-Bus Board Group, which had been a separate subsidiary company, AMC [Advanced Micro Computers], and was absorbed [into AMD] because AMC was partly owned by Siemens.

Laws: Siemens, yes.

Tate: And at some point, that fell apart. And the company owned now all of this AMC group. It had another name, which I can't remember right now. And somehow, I don't remember the details, I ended up becoming the Managing Director of this Multi-Bus Board group which was not doing very well. But it was my first chance to be a General Manager.

Laws: And how did that work out?

Tate: It was a learning experience. <laughs> It was the first of many, you know, turnaround opportunities in my career.

Laws: <laughs> Right.

Tate: So the group had more than a hundred people and up until that point, the most people I'd managed directly was five? So now all of a sudden, I had a hundred people reporting to me. And these hundred people weren't all very happy to see me show up to be the Managing Director. It's hard to believe with all this gray hair, but back then I was a young whippersnapper.

Laws: <laughs> Right.

Tate: I was like 29 or something?

Laws: Uh huh.

Tate: And I think they were all hoping that somebody would come in who was like some Greek god of business with a proven track record. Not somebody who'd never run anything before. So I remember a lot of envelopes under my door. In the old days, people would resign by putting an envelope under the boss' door when the boss wasn't around. You'd come in and open your door, and you see a white envelope, and somebody else was quitting, going somewhere else. The business was multi-bus boards. Which was something Intel had started as a business line. And the thinking is being, I guess, that, "Hey, we make semiconductors and we make processors, why don't we make boards, as well?" Sort of an extension downstream. But the board business was very different. And the customer base was very different. And I think that was the biggest issue. You know, I remember going to places like mills that made fabrics in South Carolina. You know, these were people who'd never buy semiconductors. So strategically it probably had been a bad idea from the start. And the company was losing a lot of money on the products. We had a manufacturing line in the building in which the offices were. We were building and shipping a lot of stuff. The revenue wasn't bad, but the losses were, I think, as big as the revenue was at the time. So we worked on promoting certain products, cost reducing others, introducing new stuff. And we ended up getting the business to a breakeven point, as I recall. But it became pretty clear it was never going to make a lot of strategic sense. It wasn't synergistic with the rest of the company. What became very clear to me after about a year was if the synergy's not there, why bother doing it?

Laws: Right.

Tate: And I didn't want to waste my time doing something that didn't make a lot of strategic sense. So I recall recommending that we sell the business unit. Shut it down or sell it. But I figured, if we got to breakeven, we could probably sell it. And we ended up selling it to some company that was in the board business in Champagne-Urbana, Illinois. So they bought it, so we got something for it. We got rid of all the people, and the businesses. And at that time, I expected to leave the company and go do something different, but I ended up staying because they moved me into another job.

Laws: And what was that?

Tate: I think since it all happened fairly quickly, as I recall, I had the choice of two jobs. There was a business unit doing bipolar PALs, and there was a business unit doing ECL gate arrays. And maybe those were the same business unit at one point. But they had made a decision to move the ECL Gate Array Business Unit to Austin. So I think I temporarily ran the PAL Group. But for a very short period of time, not long enough to really figure out exactly what a PAL was or how it worked. And I ended up taking the ECL gate array job more, because at that point, our family was growing, and we needed to move from a townhouse to a house, and the cost of houses was, even then, steep in the Bay Area. And after going down and looking at Austin, it was like, "Wow, you know, we could buy like a mansion in Austin." So we went with the Austin location, which meant [going with] the ECL Business Unit.

Laws: About when was that?

Tate: Oh, I think I took over the board group in '83. So I think it was '84.

Laws: '84. Okay.

Tate: I think it was like within a little over a year after I took the board group on that we ended up selling it. Because I remember we moved down to Texas in early '86, just before our second child was born. So I think I ran the ECL Gate Array group in the Bay Area for about a year before we ended up moving. So it was late '84, maybe early '85, something like that. And I was paired up with an engineering guy, Dave Pederson, you know, who I ended up having a great time working with. And all of a sudden I found myself managing the business unit doing bipolar, high-speed gate arrays for minicomputer companies. Which was kind of fun, because I remember working on minicomputers like PDP-11 and PDP-8 and now all of a sudden we had a chance to sell chips to people like Data General. I think the work had already been done by Dave to establish the first customer and maybe it was Tandem Computers, but we ended up going on to win business at Data General, Honeywell, Tandem, HP, maybe DEC. But Data General was the program I remember most.

Laws: Right, so a relatively narrow market, but if you can get into it there's some good revenue to be generated? Again, a different kind of market than most of what AMD was serving. Essentially a custom product to built for a specific application.

Tate: Yes, this was back when ASICs [Application Specific Integrated Circuits] were starting to become a hot item, LSI Logic in the CMOS space was a hot company. So this was ASICs, but in the bipolar area, which would end up being not a long-term good business, but at the time, you know, the company was strong and bipolar, and so this was an area that we had an opportunity. I think we did sell a lot of other AMD products - [MOS] memory devices, bipolar memories and so forth - to these companies. So there was already a strong business relationship and a belief that the company, AMD, was a good supplier, and this gave us an entrée to do business with them in gate arrays. They were looking to have somebody other than Motorola, who was the giant in this space, to give competition both in performance and cost.

Laws: Now, you were in Austin. You didn't have your own fabrication area, did you? You were basically subcontracting that out to another party.

Tate: Yeah, I never ran a fab. We started off [using the fabrication operation] in Sunnyvale, but I knew from the start we would move to Texas. Actually, initially they said "We're going to move you to San Antonio," because that's where the fab was moving to. But I quickly reached the conclusion that Austin would be a much better place in terms of recruiting engineers, in terms of just personal wanting to live in Texas, I'd rather be in Austin. And I thought it'd be way easier to hire engineers to move to Austin, and that turned out to be the case. Eventually, we moved all our engineers from San Antonio to Austin later on. But I said, "If I'm going to move, it's going to be in Austin." We were the only bipolar group up in Austin. All the others were down in San Antonio. And the cities weren't that far apart, so it was a 90-minute drive. So never had a fab that reported to me and I never managed to fab in my career. The number of times I've been in a fab -- I can probably count on my fingers.

Laws: . How long did you stay in Austin?

Tate: We were there around four years, so a lot happened. We had our first child in Sunnyvale, but we had our second child shortly after we moved to Austin, and our third and last child was born in Austin. And I went through several more career changes while in Austin. So it was an interesting time. We liked our time there, but we ended up moving back to the Bay area, as you know.

Laws: What were the changes, career changes while you were in Austin?

Tate: When we moved down with the ECL gate array group, I remember a very tough year after we moved, because only half the engineers wanted to move. But we were in the middle of programs with customers. We had something like 80 different gate arrays that we were contracted to do, so I remember

being down on the test floor myself, you know, debugging stuff, working issues, working super-long hours because we just had a shortage of people until we could hire the talent and train them, which we eventually did to get back up to speed. So somewhere about a year after we got down there, I ended up also getting responsibility for the AM29000 microprocessor, which was my first MOS product in the RISC processor space. Back in the late 80s, RISC processors had become hot and interesting and everybody was doing one, Just like in the early 80s everybody was doing a 16-bit processor. Intel won that race for the most part. So now, there was a race for RISC processors and would RISC processors dethrone the x86? And if so, who would have the best RISC processor?

So the 29000 operation had been going for some time, but I don't even remember who had been running it before, but for some reason they asked me to take over running the 29000 group while continuing with the gate array. We promoted Dave to be the managing director of the gate array group, and he continued to run that while I spent most of my time on the 29000 products. And somewhere along the line, I ended up with all of the bipolar products as well - what was left of the bit-slice efforts. I think things were already starting to go down in terms of demand. We were doing a 29CO1, a CMOS version of the 2901, but integration is the way to go with CMOS, so lots of little pieces just wasn't the way to build anything anymore. So that business was slowly phasing out and I spent most of the effort on the 29000 because it seemed like that was the area that could have substantial upside. I remember meeting Chuck Geschke at the time, of Adobe. We won a big design win for laser printers. They didn't build laser printers, but they did the reference designs that most of their customers use. So winning the reference design meant you were going to be designed into most of their customers' laser printers. We ended up winning a lot of designs for the 29000 in products like that. Not computers so much as things that needed computing resources embedded in them. Like an embedded processor. The 29000 over time,didn't end up becoming the big winner. There wasn't, you know, [sufficient demand], but then SPARC and other things ended up not being the big winner either, because the x86 never got dethroned. The x86 stayed with the PC, which was the big win, and things like SPARC got into certain workstations and so forth. So all of the RISC processors ended up as niche products in certain areas. Maybe good-sized niches, but the x86 never was taken over by RISC at that period of time.

And then at some point in time, I also got responsibility for [AMDs] x86 business unit and a whole bunch of MOS miscellaneous products back in Sunnyvale. Graphics and so forth. So now I had all the bipolar logic, what was left of it, and at that time I basically took all the people off the bipolar, and that was when we moved [them] from San Antonio. I made a decision that we should bet big on cloning the [Intel] 386. When I took over the x86 business unit, I sort of had a history of getting business units with problems, you know, losing tons of money or whatever the issues were. But there were challenges because the x86 business unit's problem was we were making huge profits on the 286, but the 286 was going away because the 386 was coming out, and Intel had refused to honor a licensing agreement to send us the mask set for the 386; a minor problem. And there was a whole big litigation that was going on, but I wasn't involved in the litigation, thank God. But I had to figure out what to do with the x86 business unit. My predecessor was about to sign a deal with Chips and Technology where we would pay them over $100 million. I remember meeting Dado [Diosdado P. Banatao] at the time, a smart dude I kept running into over the years, and Dato was a smart guy, but the deal he had was very unattractive. It was 100 million

bucks, we'd get to be a second source for a product which was not plug-compatible with the x86, and we would have no derivative rights.

Laws: So they had their own processor?

Tate: They had to develop their own processor.

Laws: I knew they had all of those x86 support chips that they were selling.

Tate: Yeah, well they were trying to figure out what to do because Chips and Technologies could see they were going to get integrated out, so they were going to compete in the processor [space], but as long as the 386 was the sole source, there was a willingness to consider a non-plug-compatible product. But the business terms were so unattractive I said, "Well, for 100 million bucks, there must be something better we can do." Hopefully, there's a something better we can do. So, one of my team members, Ben Oliver, came up with the idea of, "Hey, why don't we clone the 386?" We have the patent rights, unlike anybody else." The reason Chips and Technologies couldn't do a plug compatible product was something about the cache.

Laws: And there was something about microcode, as well, wasn't there?

Tate: Microcode or cache or there was some issue why you couldn't do it. So Ben said, "Well, we have patent rights. Nobody else does." And he said, "I think we could reverse engineer it." So I didn't hear any better ideas and the profitability of the 286 was so high compared to everything else that we did, and the potential-- if we could make the 386, it would be so much more profit for us than anything else that I was responsible for. So we shut down everything else that we were doing in San Antonio on bipolar CMOS, 29C01, 29C116, canceled all of that stuff, moved all the engineers up to Austin and set up a team under Ben of about 60 engineers in a locked room with a special key entry so they would be-- what's the term? You want to have the people not exposed to other trade secrets. So we took people who had never worked on the x86.

Laws: Clean room?

Tate: Clean room, that was it. So, we took all of these bipolar guys who had never worked on an x86, so it was clear that they weren't bringing in anything that had been learned from Intel, but really Intel never sent anything other than mask sets as far as I knew, so I'm not sure there was a big issue anyway. We set up a room and basically they delaminated 386 devices and took photos and went down to the local Walmart and got them developed and slowly pasted up on the wall all of the 386 metal layers, and started tracing and building up a model of a 386 and then got code to run through it.

Laws: By develop a model, this was a computer simulation?

Tate: Right. You needed the netlist. So they figured out the netlist for the 386. It wasn't me. I never did any of the engineering in any of these projects, but the board team figured out how to put in some special modes for laptops, for sleep mode and so forth, which turned out to give us a competitive advantage over the Intel 386 in laptops, later. They ended up building a 386, which was completely compatible.

Laws: Was there a name for this product?

Tate: We had two projects going on. One was Longhorn and one was Lonestar. I can't remember which was which now. The other one was a 286 with all the peripherals integrated, which we ended up building, but you know, the market moved to 386 at that point in time. The 386 actually came out after I'd left AMD, but it worked the first time or pretty close to first time and got AMD back in the x86 business. And part of the reason that the RISC processor business never took off was that we cloned the 386. I should say Microsoft had plans for Windows, importing it to some RISC processor. But once there was a 386 second source it's just like, "Hey, it's way easier to support one processor and have multiple sources." So that was a big turning point in the processor business, but we were doing it at the time because it seemed like the best next step.

What I wanted to do after that was do the same thing with the 486, but I remember going to a meeting with Jerry and the management team and presenting a plan. Now, this was before we had the 386 out. We didn't have it out yet, but I believed it was going to come out and it was time to start working on the next step if we were going to do it. And it's just like, well, just having the 386 isn't going to get us anywhere. We need to be moving ahead. And what I was convinced was it that we had to develop value-added versions of the 386, otherwise it's just a straight second source. We'd have no strategic relationship with customers that would give us any stickiness. If we could develop things like modes for laptops, maybe certain customer groups would come to view us as a strategically important supplier, not just somebody who would knock 30 percent off the price. So, we wanted to do the same thing with the 486, but my mental recollection of that meeting at this time was half the management team said, "What's the 486?" And the other half said, "That's just for mainframes. That doesn't bother us." At this point, AMD really didn't even have microprocessors as one of its three key areas. I remember in the late 80s, the strategic thrusts were Telecom, and there's two others, but processors wasn't one of them. Flash [memory] maybe. Because there wasn't a clear path in the processor business, processors wasn't really listed as one of the strategic focus areas and we hadn't built the 386. There was a lot of skepticism whether this idea that I was working on would ever work. Not just a lot, there was a huge amount of skepticism about this among certain quarters. So the willingness to do 486 wasn't there at the time. Eventually, the company did get into doing processors by buying NexGen and other things.

Laws: And that was for Pentium?

Tate: So, the light bulbs came on at some point that, hey, there's a lot of money here and let's go on it, but they hadn't come on at that point. And frankly, after 10 years I was starting to go, "Hey, you know, I'm not going to be CEO here ever because Jerry's not going to go away."

Laws: What was your position?

Tate: Senior VP. I reported to Tony Holbrook, who is a great guy and I enjoyed, actually, my time talking with Jerry as well. Jerry, one-on-one, was a great guy to deal with, and because the processor group made so much money, I had a lot of one-on-ones. You know, pricing and all of this kind of stuff was important to the company's revenue stream. But I reported to Tony and spent most of my time talking with him. I enjoyed that but I always-- I like being a general manager and I was at a point of, "Okay, well, now I'd like to run the whole thing, not just a third of the company." I'd like to figure out how to run the whole thing and I didn't see it likely that Jerry was going to retire any time in a reasonable timeframe. For me, as a young guy, five years seemed forever and I figured Jerry would be there a lot longer, and he was. So I figured, "Well, if he's there, what am I going to do for the next five or 10 years?" So I was already thinking, "Time to do something different," and frankly I was always more of an entrepreneurial person. The reason I didn't do entrepreneurial stuff [earlier] is because I didn't have a green card until the mid-80s but I envisioned that at some point I'd be my own boss. I'd be a CEO.

Laws: So what were you working on at AMD if you didn't have a green card?

Tate: Oh, well, the process then was the same as it is now. You come in under-- I forget what you start as, but then you go to an H1B visa and once you get your H1B visa, it's fairly mechanical to get to a green card.

Laws: Okay. I came straight in on a green card, so I somehow missed all that.

Tate: You must have had better lawyers. So no, I had to go through a lot more stuff than that and so did Colleen. It wasn't until the mid-80s that we got a green card. With the green card it would be easy to move around to other companies. And actually, I had quit AMD twice before, once with the board group. I just figured, "Hey, we should sell this and I'm going to go do something different," and they promoted me instead. There was another time when I quit and they promoted me instead.

Laws: Did you have alternatives to go to when you quit or were you going to go out..

Tate: No.

Laws: Okay, you just needed a change?

Tate: No, I never worried about short-term security issues and my wife is always very supportive. In Silicon Valley, security comes from, you know, being good at something, and there are so many opportunities it's like you're not going to starve on the streets. I had a strong sense of company loyalty. I was not somebody who was going to go spend a whole lot of time working on something else rather than putting my efforts into the company. I worked hard and when I did and I didn't have time to do a whole lot of other stuff besides family and work.

Laws: Did Colleen continue to work in IT while you were in Austin?

Tate: The IT group was centralized so there wasn't really anything in Austin. Before we moved to Austin, she had already gotten a job looking for Don McIntosh [in Sunnyvale]. In fact, she ended up being the product engineer for the 2960, one of the products I'd written the datasheet for at some point. She really liked that kind of stuff, and so when we moved down to Austin, she ended up in the telecom group, and actually she got to use a lot of her software background because they did have software things. There were ISDN chips they were working on. She ended up working for George Menassian, who she really liked. George is now off to his own startup, Crossbar Memories. But back then, he was in telecom. So she worked all of that time and then when we moved back to the Bay Area she actually interviewed for several jobs. AMD, for some reason, didn't have an opening. I don't know why that was the case, or she wasn't interested in what they had available. But I remember she had a job interview at Cisco. She talked to one of the big guys there, I wish I could remember his name offhand, and decided the salary was too low, daycare costs are so high “I'll just stay home.” But we probably could have retired a lot earlier if she'd taken the Cisco job.

Laws: You quit when you were living in Austin or had you moved back to the Bay Area?

Tate: We were in Austin and at the time I decided to quit, it was late 1989. The 386 was in fab or close to going into fab, so I figured I'd done my work. There wasn't any interest to do a 486, so it was kind of like, "Well.."

Laws: Right.

Tate: And waiting until the 386 came out, you know, and trying [to generate support for] the 486 just seemed too far away, too long. AMD had been a good company, I enjoyed working there, but it was time to do something different. If I was ever going to do it, now was the time. I was a corporate officer at that point, so I had some fiduciary duties to the company and I took those seriously, so I wasn't off interviewing at other companies. I just said, "I'm going to quit." We picked a date, it was in January, so

they could get somebody else in and have an orderly transition. I remember walking out the door in the middle of January and it was like, "Okay, now what am I going to do?"

Laws: And this was in January 1990?

Tate: 1990. I told Colleen, "Well, we have some savings.."

Laws: You had moved back to the Bay Area by that point?

Tate: No, we were still in Austin.

Laws: You were still in Austin, okay.

Tate: I quit, we were in Austin. We thought we'd stay in Austin and so I said, "You know, I want to do a startup, so give me six months. We've got some savings. We can get by on savings for six months. If at the end of six months I can't figure out what to do, then I'll get a real job. I'll crawl back to AMD or I'll get a job at TI or Motorola or something like that. You know, six months. Give me six months." And I had some ideas. My main idea was a Windows graphics accelerator. I remember talking to Michael Dell about it and so forth, but there was just no venture capital in Texas. There was one company in Dallas and I drove up and talked with them at times, but you could tell they had a waiting room full of people. This was a monopoly, so getting money out of them and sitting in the waiting room, I talked to them.

Laws: Were those the guys out of Mostek?

Tate: Yeah. What was the name? Sevin Rosen.

Laws: Sevin Rosen.

Tate: Yeah, they were very successful. I can't remember who I talked to, but it was pretty clear just talking to people in the waiting room that they had been there multiple times and that this process was not tilted in the favor of the startup person. And I had six months, that was my time limit. So, I told Colleen, "Hmm, you know, I'm going to talk to people in Silicon Valley. Maybe they'll fund us in Texas." Well, of course no one in the Silicon Valley back then wanted to ever get on an airplane to go anywhere, although the trend had just started. There were one or two exceptions. But there was a lot of interest in my background, having run all of these business units and being [involved with] micrpprocessors, so I ended up talking to a processor company in Plano. A lot of these VCs wanted me to run existing companies, so I went and talked to a bunch of them in the Bay Area and in Texas just to sort of see what they're like and

why did you put money into this company and why are you excited about this company? To get a idea what made a good startup from the point of view of a venture capitalist. What does a venture capitalist want to see? Because I'd never dealt with these venture capitalists, so that was very enlightening. What I found was almost all companies were me-too's, right? We're going to do processors because there's a lot of money in the processor business. We're going to do this because a lot of other people are doing that. And I never liked the me-too thing, you know? I was more interested in developing new stuff for new markets, although it could be harder. If it worked, it could be much more rewarding in a lot of dimensions, including monetarily.

So after a few months of talking to VCs, I ended up running into the guys at Rambus, [Paul Michael "Mike"] Farmwald and [Mark A.] Horowitz, and of all the people I talked with, they had the wildest idea technically, but it was like, "Well, if they can make it work, this could be really good." I'd done enough processors to realize that there was going to be a continual, rapid improvement in processor performance, and graphics performance, and that these things needed memory and that memory was not on the same trajectory in terms of performance improvement rates, so processors are going up like that and memory speeds are going up like that. Processors are no good without memory. So at some point, there is going to be a big problem in the memory bottleneck. Mike and Mark had an idea for a 500 megahertz memory interface which was, to put it in perspective, around 20 times faster than existing memories at the time. VCs would always talk about you need 10X, 10X better, so those were 20X better. And it required doing stuff that was passed my technical abilities, but one thing I'd learned was to ask a lot of questions. I had managed a lot of people, being successful, and a sort of getting a sense of which engineers can do stuff and which can't. You're really making bets on people in any business, so although I couldn't do it myself, I was pretty good at asking a lot of questions. People like Tony Holbrook, especially, or Phil Downing before him sort of showed me how to ask lots of questions. Drill down. I think Tony was the guy who made the analogy. You know, he drilled down. If every time you drilled down, you'd find that there's substance you don't have to drill a lot of times. But if you drill and you just find a whole lot of funny answers, it probably means that there's nothing anywhere. It's like exploring for oil. So what I found with Mike and Mark is they really seemed to know what they were talking about. They clearly had a strong experience in doing architectures. Mark had done the MIPS-SAC [ph?] program at Stanford. Mike had worked on the MIPS processors at a previous startup and really understood the physics required to do very high-speed signaling. The predecessors are really CERTIs [ph?], and the phase lock loops and stuff that would be required. So I came back telling Colleen, you know, "Wow, I found this company. It's only like.."

Laws: How did you meet them? Was it through a VC?

Tate: Yeah. I was talking to a bunch of VC's and the VC's would always listen to my proposals and then say, very politely, "Well, maybe you should consider this. Maybe you should consider that." And when I talked to Mike and Mark -- I had actually talked to two different groups; Bill Davidow at Mohr Davidow, and Bruce Dunleavy who at the time was at Merrill Pickard, but later Benchmark Capital, which is still in existence. And those two had already invested in these guys, because these guys had this idea, but more

importantly Intel had verbally agreed to use the technology in a 486 processor and put a Rambus memory in a 486 processor. So interestingly, a whole bunch of threads came together. Intel was doing this because they were concerned about the performance threat of RISC architectures. So if the RISC architectures presented a performance threat and Intel couldn't shift from X86 because of all the code base, why give up the code base advantage? But to stay ahead in performance, they were thinking, "Okay, well, if we break the memory bottleneck, maybe they can keep his ahead in performance compared to these RISC guys." So, I think that was their general thinking.

Laws: So, that was an incredible coup to get Intel to buy into that.

Tate: Well, it was a handshake at that point in time. And it wasn't necessarily committed product and it ended up falling apart.

Laws: But it gave you some confidence, perhaps.

Laws: It fell apart because my old group got the 386 working, and when the 386 was working and people saw there was a second source to the 386, the interest in RISC evaporated. Intel called us one day, we'd ended up signing a contract with Intel in my first six months, but at the time we signed the contract was around when the 386 came out of fab and was working and then later on in 1990, AMD was marketing it and all of the PC guys are going, "Great, now there's a second source, so we can can all of these RISC architectures we're working on." So I think what I had done before was to put the kibosh on what we were doing with Intel. If the 386 had never come out, who knows what would've happened with Intel. So the whole premise with Rambus was we can make this high-speed memory interface work and that Intel would quickly use it. Well, we ended up making it work, although it took more people and more time and more money than was projected.

Laws: Now, you went in as a CEO?

Tate: I went in a CEO, yeah.

Laws: And this was in 1990?

Tate: 1990.

Laws: Six months after the January when you quit, basically?

Tate: Yeah, I think it was May of 1990 that I ended up going.

Laws: Okay, five months.

Tate: Yeah, it was about five months. So again, close to the end of my window with Colleen. And it was like a month before that I decided emotionally I wanted to join. It was a matter of figuring out how we could afford to live in the Bay Area. So I just said "I can't afford to live in the Bay Area on that," so I said, "I guess I'll have to forget this and go back to Texas and work on something there," and they came running back and said, "Oh, no, we can work something out."

Laws: Okay, good.

Tate: So eventually we got to a salary where I could figure out we could afford to rent something and then eventually buy something that was nowhere near like the house we owned in Austin, but would be acceptable. So, I started directly as a CEO. The co-founders had no interest in being-- even managing people, much less being CEO. So there was none of this-- some people become CEO and the co-founders wanted to be CEO and they have their own set of issues. I didn't have any of those kind of issues, fortunately. I was CEO because the venture capitalists wanted somebody who had proven management experience and had run a much larger teams. So when I left AMD, I think I had four or five hundred people reporting to me. Now I had three. So, there was a belief that I could scale up for quite a while with this organization.

Laws: And where were you located? Where was the office?

Tate: When I joined, there wasn't an office. We were using one of the conference rooms at Mohr Davidow. There were just three of them. Now, I was a fourth, and we hired another person, fifth, before wind up getting some space. F Horowitz, was a Stanford professor, and although he was taking a leave of absence, he wanted to stay. His agreement with the VCs was that the office would be within five miles of Stanford at all times. So the cost of real estate goes down linearly from Stanford, and going north didn't make sense because there were no engineers to the north. Going south was where you'd want to go to attract engineers, so El Camino Real and San Antonio Road was five miles. So we looked around there and we found something, very modest, a small office with room for maybe 15, 20 people at most. And we rented that and moved into it with a short-term lease. It was behind a pub.

Laws: On El Camino?

Tate: Yeah, the office building is still there. It looks the same. It doesn't look like anything's changed. So we were there for about a year, and the whole time I was at Rambus, we were within a block, two blocks of El Camino and San Antonio.

Laws: So what was the first thing you had to do when you walked into Rambus? There's this bright idea, there's three people, you're a new CEO.

Tate: Well, they needed a plan and they needed a contract signed with Intel. But more to the point, they needed a plan. So the plan was, "Hmm, we'll do a high-speed memory interface. Somehow, we'll get a bunch of DRAM companies to use it and Intel will put it on their chip, and then somehow we'll make some money." But nobody had ever done a semiconductor IP business model before.

Laws: Right. That's a totally new area. Well, the ARM RISC processor was around.

Tate: ARM, I'm sure was around, but they weren't on our radar. ARM, like Rambus, took years to percolate along. When Rambus later went public, most people assumed that, we had just started in '95, went public in '97. So it takes a lot of time. So, ARM was out there bubbling away in Cambridge [England] somewhere, but we weren't aware of them. So they were doing a similar thing. They originally started building chips for computers, and because that failed, they sort of were forced to try to do something with IP. In our case, the company didn't really have a clear plan when I came on board. So I remember drawing up a strawman plan as part of the whole interview process, partly to help me think things through, partly to get on the same wavelength as the rest of the team. The big question was would we do our own chips or what? So the presumption would be that we would do our own chips and that's how we would make money. But the presumption failed in several dimensions. Well, first off, the Intel deal fell through, and Intel didn't want to pay us any money, being Intel. So Intel's thing was, "Okay, well, we'll create a market, but we're not going to pay anything. We're not going to pay a nickel, but we'll have the rights to use your IP on processors. And you can make money from the DRAM guys."

Laws: How did they get the rights, if they weren't' giving you any money?

Tate: That had been the handshake deal before my time.

Laws: I see.

Tate: The venture capitalists had negotiated with people at Intel, Bill Davidow had come from Intel, and the basic elements of the idea was, "You guys make money some other way" Because Intel's premise was, "We never pay royalties to anybody." That was a non-negotiable point in all of our dealings with Intel. Intel's view was just that. And they were big, and they were the gorilla, so if you wanted to work with them you had to do things. You could do it their way or you could not work with them. At that point in time, if you were going to do a high-speed memory interface, it was very clear. It was like, "Okay, where do DRAM memories go? It was something like 90 percent went into PCs. What percent market share does Intel have in PCs? Ninety-five percent. So it's like, okay, if you're not going to work with Intel, somehow you have to build a high-speed memory interface with the other 5 percent of the market. Good luck. Now

maybe you're focused on graphics chips or something. Now it's a way niche-ier play. Way easier if you can get Intel on board.

Laws: Got it.

Tate: Because of that dynamic, it's sort of forced us to do a deal with Intel and then forced us to do whatever deal you can get by with, and then as a startup you don't have any leverage and Intel had gigantic leverage and strong positions in thinking about things. But even then, there hadn't really been a clear plan put together about how this company would make money. The hope had been, I think, that we'd write up a bunch of slides. We'd file a bunch of patents and then we'd just license them on the patents and they could figure out how to make the rest of it work. To convince people to use our technology, we had to design and build stuff and make it work and prove it up. The working assumption was that people would see that this was such a good idea that they go off and invest all the effort to make it work themselves.

Laws: Let me understand something here. So if this interface was put onto the memory chip, it didn't matter whether that same interface existed on the microprocessor, you could still get the benefit of much higher performance memory? Because you said Intel didn't go ahead with it.

Tate: Right, right, right. So Intel ultimately didn't go ahead. The whole Intel thing confuses the telling of the story, but it's an inconvenient fact.

Laws: No, but it's an important starting seed.

Tate: Because we had the handshake with Intel and because Intel was willing to tell about to the memory guys, that got us deals with the memory guys.

Laws: Got it, okay.

Tate: And what became apparent was that we were going to have to show the memory guys exactly how to implement our technology. We weren't going to get away with it just, "Here's a license to our patent. Here's a copy of our slides, you can figure it out." Intel wanted every memory to be completely interchangeable with every other memory, and the devices that were coming out in the memory business at that point using JEDEC standards were not compatible with each other. It's hard to write a document and think of everything that has to be compatible. To ensure compatibility, you have to have test suites, you have to have net lists, you have to have a whole bunch more than just a written document. So, Intel was insistent that we implement the memory interface before the memory guys [did] and work with them to implement it and teach Intel how to do it as well. So, before the deal fell apart, which was about a year

into my time there, we were able to sign deals with two memory guys; Toshiba and Fujitsu. Good thing, too, because otherwise we would've had a real hard time surviving once Intel dropped off. Because of Intel's involvement, they were excited to work [with us], and assigned some of their better people, Their people were very interested in this high-speed memory interface technology and working together we were able to eventually build DRAMs and implemented this high-speed 500 megahertz technology working pretty much exactly as originally planned. It took way longer and more..

Laws: And you did not need that interface on the microprocessor?

Tate: Well, you did. You did, and that's what made our business model so difficult compared to ARM. In the case of ARM, ARM just has to convince their one customer, and ARM's processor is inside that chip, and any chip that it touches it doesn't need to know that there's an ARM processor inside. What we needed to do was to do all of the technology work, but also we had to convince DRAM companies and companies [with chips] that DRAMs hooked up to, processors or graphics chips or other devices, to simultaneously adopt a new interface which was useless for connecting to any other kind of memory.

Laws: Yes, right.

Tate: So we had to get all these companies to jump at the same time, and the whole dynamics of the pricing in the DRAM business worked against us. In the D-RAM business back at that time, there were 20 suppliers, and the reason you got [low] commodity prices is because if you didn't like the prices from once a player, there's 19 others to go to. As soon as you're talking about two suppliers of DRAMs, well, the dynamics are different. They know that the customer wants two suppliers, so you're going to get at least one third of the business, so you don't have to be as aggressive. They would always blame it on our royalties. They said, "Well, our prices are high because of those royalties. We've got to pay Rambus," but that was baloney. It was because they had the leverage to get a better price.

Laws: What sort of royalty would it be?

Tate: The DRAM guys paid basically one percent royalty.

Laws: Okay.

Tate: There was variations on the theme and some of them started a little higher, especially with the later guys, but basically it was one percent. One percent royalties. Which, for the value we were delivering, 20 times higher performance seemed like a good deal. But the DRAM guys were used to paying zero percent royalties, so they never it saw the same way. Today, semiconductor IP licensing is kind of a given. People are used to building chips out of blocks and having to license IP, sometimes for license

fees, sometimes including a royalty. Like ARM still gets royalties, but back in 1990, there was a huge emotional resistance to paying any royalties, because at that point in time, people were used to doing everything themselves. There was a lot of NIH and when they paid royalties, it was because some big guy like TI had a big war-chest of patents and they came along and said, "You know, you are infringing on our stuff. We invented all of this DRAM stuff. Now you owe us money." So emotionally, they put us in that bucket as opposed to in a bucket of, "Hey, we're showing you how to do something that makes your chip run 20 times faster, that gives you a more valuable product that gives you some pricing leverage." Of course, Intel really didn't want to pay more for it either, so that worked against us. Intel was like, "We don't want to pay any price premium, even if it does run 20 times faster." That was a bit of a challenge, so we had a lot of challenges in getting this off the ground because we had to make it all work technically, then we had to convince enough DRAM people and at least one big logic company to all jump at the same time and hope everything worked, technically and pricing and all that kind of stuff. So it was very challenging.

Laws: Incredible sales job, Geoff. How did you pull this off?

Tate: Persistence and the memory bottleneck. What was clear to everybody, including Intel, was that at some point they'd need to use something like what Rambus was doing. We'd talked to Intel every year after they broke off talks with us and they say, "Hey, well it's clear we were going to have to do something," because it was the same thing every year. The trajectory of what the DRAM guys are doing on their own is not going to keep up with our trajectory. And you can get higher bandwidth by going to wider buses, but wider buses meant buying more memory and more memory meant a more expensive PC, and there was a limit to how wide a bus could be within the economics of the PC business. Workstations, they could afford to have much more memory because they were doing bigger tasks. But PCs were where most DRAMs were going. Especially with laptops, there was also a size and weight constraint; 64 bits wide was about as wide as they would go. And you could put more pins on the DRAM package, but there was an economic limit to that before they started becoming expensive and the package became more expensive than the dye. So eight bits wide, 64-bit buses, eight DRAMs, that was kind of the upper limit. If you can get the bandwidth that you wanted out of the eight D-RAMs, then you needed to go to higher-speed signaling to break the bottleneck. That was pretty clear for the mainstream PC, and it was just a matter of time before we'd get there. So we eventually got there, but unfortunately for us, other applications got there first. Once we got everything working and the Japanese company stuck with us and ther ASIC guys developed and the capability to put us on the device, we got a few low-volume design wins with people like Silicon Graphics that had a need, but very low-volume But at least it was something, it gave us some credibility and gave the Japanese companies we were dealing with more confidence in our technology.

Laws: So when did you start to get these first real designs?

Tate: I think it was, like, 84/83 timeframe.

Laws: So three or four years after you started?

Tate: Yeah. Silicon Graphics, Brocade..

Laws: No, no, 93/94.

Tate: Sorry, yeah. Yeah. See, I told you I wasn't good at dates, 93/94, that kind of timeframe. So the big opportunity for us that turned us around was Nintendo. So we had focused, originally, on, "Okay, there's PCs and there's graphics chips," and we were never very successful in graphics chips. We got Cirrus to use us, but the rest of their chip was a very competitive with what somebody like Nvidia was doing at the time. The Nvidia's were using more specialized memories for various reasons and we didn't get traction, but a chip that combined graphics and processing was a game chip. So the video games were taking off in performance, needed aggressive price points and Nintendo wanted to do a 3-D game. Up until that point, all of the games were2-D; Pac-Man and Pong and so forth. There were better and better 2-D games, but Nintendo wanted more lifelike 3-D rendering and images. Their work with Silicon Graphics showed them the hardware and software engines required to get the kind of images that they wanted, but they couldn't afford the $20,000 Silicon Graphics workstation. They needed to build the game for a few hundred bucks, which meant the semiconductors needed to cost dozens of dollars. Their main partner and supplier was NEC, and NEC was the company that had licensed us and done ASICs for, I think, Silicon Graphics. So there was a relationship with NEC, with Silicon Graphics, NEC with Nintendo. NEC, so that Silicon Graphics could build, successfully, a chip. NEC, basically said, "Hey, well, if you can use Rambus technology, we're willing to do the chips for you, and we can supply the DRAMs." In Japan, multi-sourcing is less of a concern. You do things based on relationships and they believed that NEC would take care of them and give them competitive pricing. It's a very different dynamic over there, fortunately for us. Because without that, it might not have worked. I remember being in the meeting with the Nintendo big boss. He is a smart guy, but not a technical guy. He's more a business guy and we were there with the engineering VP for Nintendo and a couple of my key technical people. The big Nintendo boss kept going, "Do I have to use this Rambus memory? Why can't I just use standard memory?" The VP of engineering said, "Well, you want 3-D graphics performance, so we need this kind of bandwidth. You want a $300 price point, so we need this kind of cost. I can either meet your cost budget with standard memories but we'll have a low bandwidth, or I can meet your performance target, but we'll have a wide bus and we can't meet the cost target. The only way to do both is to have a memory where we can get 500 megabytes per second out of a single DRAM." Because their minimum configuration would be to have one DRAM.. They wanted to have an option to install a second D-RAM for an expansion module, which was technically challenging. And so and that meeting, we went around for an hour and we're sitting there listening to these guys, basically debate, "Why should I use this stuff from this little risky company?" And NEC was there as well and was saying, "Hey, and technically we'll vouch for it. You know, we've done enough work with these guys. We'll make it work." So the big boss said, "Well, NEC tells me your royalties are too high, so you have to cut your royalties." We were getting, like, one percent royalties, so we said, "Okay, we'll cut them in half." And in return, I said, "Well, you'll have to give us a free game for every employee." So we did get a free game, so we were the first on our blocks to get games. All the

software was in the Japanese when it first came out, but my son figured out how to make it work anyway, and the other kids. And then the other issue is they said, "Okay, we were doing all this 500 megahertz on a four-layer printed circuit board," which at the time was considered pretty good. So Nintendo's big boss said, "Well, I want to build it in China to keep costs under control, so you need to make it work on a two layer printed circuit board, 500 megahertz." Worst-case signaling. And we had a connector with an expansion. So this was not, trivial. So my guys, when I got back to the office, said "Oh, no way, we can never make it work on two layers." So I said, "Okay, well, we had to exchange some emails." The guy said, "Well, okay, then we won't use you." I don't know what else they would've done, so I said, "They won't use us. So we've lost them." So they said, "Well, give us the weekend," you know? So they went away and they dummied up something and we went back a week later to Japan and showed a two layer printed circuit board running at 500 megahertz, much to everybody's surprise.

Laws: And when was this, Jeff?

Tate: It was about 84/85. Sorry, 94/95..

Laws: 94/95.

Tate: ... Timeframe.

Laws: And were the VCs watching what was going on? Were they concerned? How much money was in the company by then?

Tate: Oh, I remember Bill Davidow saying at some point later, "You know, if I'd known what would've happened with Intel, I never would've invested in this company." You know, it was too much of a science experiment for their liking. You know, we struggled to keep things going, but we were able to do more rounds and we had up rounds, but we started with quite a low valuation. The company was only valued at $4 million when we got started. That was in the A round. You know, these days, that wouldn't even be a seed round, and we only raised, like, a million bucks. Fortunately, I was able to negotiate big licensing dollars from the memory guys. So Toshiba and Fujitsu, the first two guys, they paid us $5 million each. I remember the Fujitsu guy came over and they negotiated with us. They had more lawyers than we had engineers at the time. In fact, they were looking around going, "Where is everybody? Why are we paying you all this money? Where's all your engineers?" And we were able to continue to get those license fees from the DRAM guys. There were 20 DRAM guys [in the business] , so even though we didn't have an Intel, there was enough potential that we were able to..

Laws: So the company was funded by the licensing fees then, rather than by venture capitalists?

Tate: For the most part. I think by the time we went public, we had raised three quarters of our capital consumed from licensing fees. And because of licensing fees, we were able to do continuing rounds with the VCs as well.

Laws: Right, so you weren't heavily diluted, then?

Tate: Right, right. So it was a bit of smoke and mirrors to make that work. I wasn't misleading anyone, but we were having to sell these guys that there will be a market. We didn't have an Intel anymore, like the first couple of guys, but it was a competitive space and fortunately for us, there was 20 DRAM companies, so we were able to find a third and fourth and fifth. We figured, "Hey, there's enough." For them, 5 million bucks wasn't that big of a deal. They're used to building billion-dollar fabs, and having a value-added memory sounded like something of potential interest, even though there were no sockets yet that existed for them. But we were able to convince them that there will be a market and it takes time to develop these things. So slowly but surely, we got things that slowly built momentum and go forward. But it was tough and there was times when it was obvious it was all going to hold together. The VCs were supportive, you know. They sunk money in. You know, like Bill said, they wouldn't have done it if they'd known. Of course, I should have told Bill, "Well, I wouldn't have taken the job if you had told me that Intel was going to fall apart, either." Two-way street, here. But it ended up working out.

Laws: So, when did you start generating revenue?

Tate: Oh, well we had revenue in the form of licensing fees from the start.

Laws: I guess you'd consider that revenue .

Tate: The first deal we signed, we got the first check right around Christmas in the first year that I joined. So we had revenue all along, but we weren't profitable. We became profitable or cash-flow positive shortly after Nintendo.

Laws: About 95?

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Tate: It was more like 96, I think, because with Nintendo, you know, it was a lot of work to convince them. Once we had convinced them, the actual engineering to get their ASIC device working went pretty smooth and part of it was pretty straightforward. We'd already incremented other ASICs and so forth. So it was more mechanical at that point. We'd done it before, multiple times. So we weren't in the critical path.

In fact, all the hardware, all the chips were working and they built up a board. We figured, "Okay, well, production will start soon." We had another meeting with them and they said, "Well, the software guys said they needed another year to get the software where they wanted it to be." So, we were sitting there for a year. But when it came out, the Nintendo 64 was a huge hit. It was a huge hit. Our customers had wondered if we could ever get the 500 megahertz memory interface to work and figured it was only for supercomputers. So when the first really big hit was a game, a kids game that sold for a few hundred bucks, whatever the exact price was I don't remember, it was like, "Wow." And, it was a two layer printed circuit board. That gave us instant credibility. All of the rest of our customers at least had four layer printed circuit boards. So if we could make it work there, we could make it work anywhere. So now, all the people who had shown interest but wanted to avoid risk started piling in, including Intel.

Laws: Did you have a standard design that each of the DRAM companies could use or it did you have to create something different for [each of] their process technologies?

Tate: You know, there was no real foundries back in the day. So there was no concept of the standard design. We had a standard. There was a Rambus memory interface standard, so to be compatible you had to meet all of the detailed specifications at the interface, and then they gave us their process design rules and we implemented the interface for them. For the first five years, we did everything. And then we would work with them on the core because the interface they were used to delivered data at a 30 megahertz data rate at over eight bits. Now, we had a 500 megahertz interface over eight bits, so the interface had to change and we basically designed the interface for them. The pins are turning 500 megahertz, but it would fan out internally into, like, a 64-bit wide bus running at whatever it was, 62 megahertz. Some lower data rate where things became more digital, and that's where our customers would hook up. But then we had to work with them on a lot of stuff about the DRAM core, so we ended up learning all sorts of stuff about how DRAMs worked internally and different customers would implement stuff differently, but we had to make it all look like one DRAM. So there was an issue about how to pipeline things to get high performance, but keep the die size area low, and so forth and so on. So we were learning and consulting at the same time. The first couple of guys, we were more learning and then later we were more consulting and showing people, "Okay, we'll do the interface, we'll bring in a bus that's X wide and then here's the core changes you need to make in order to keep your die size low, but be able to deliver 10 times the bandwidth."

Laws: And this is all analog here, essentially, right?

Tate: Oh yeah, tons of analog stuff. You know, everything was handcrafted, hand custom. There's no standard cell libraries, any of that kind of stuff. These are full custom chips.

Laws: What kind of design tools were you using?

Tate: Back in those days, you got tools from the Daisies or the Mentors, they were, like, work stations. They were proprietary. Over time , things became more based on servers and the graphics interface became more standardized, less company-specific, but remember I didn't do any of the real design, so I would see what the people were working on when I to come by their layout stations and so forth. I remember writing checks for CAD tools and CAD equipment. It was a big part of our outlay, besides salary. It was salary and stuff to CAD people and stuff to server people. That was the three big bucks that we had to spend money on.

Laws: About how many employees did you have by this 95/96 timeframe?

Tate: Let's see, I think at the time that we signed the first agreements we had, like, 10 people. At the time we were convincing Nintendo to work with us and to do that we had gotten some low-volume customers and got ASICs working and we'd build reference designs and reference systems. We were in the 30-people range. And by the time we went public, we were in the 100-person range.

Laws: And what year was that?

Tate: We went public in 97. And the shift that happened was we were doing all of the designs for the DRAM companies. When we shook hands with Intel in 96, Intel wanted, not what we'd developed, but a much faster version of what we'd developed. So we had to do a second version pushing performance even more and Intel wanted us to license every DRAM company, even though the DRAM companies didn't really want to license us in many cases. Business-wise, you know, I tried to get Intel to take an approach of, "Let's license half the DRAM companies. That will give you 10 suppliers. With 10 suppliers, you're getting towards commodity pricing." But Intel would be like, "Well, no, no. We're so big and we're going to use it so much Rambus DRAM, we have to have everybody." The reality was that eventually they had to have everybody, and my pitch to them was, "Look, there's a certain set of people who are willing participants, and there's a certain set of people who are unwilling participants. It's a lot easier to work with willing participants. Plus, we're a small company. Getting 20 DRAM companies on a new memory technology simultaneously is a huge engineering effort." So as usual, I lost the debate with Intel. I lost every debate with Intel. In fact, Intel is a good company, but as somebody would say, they don't dance well with others. They're used to doing things their way and it's pretty hard to move them off their thinking. And, you know, they've been successful, so that's fine. So they insisted, "No, we have to get everybody going." So that forced us to hire a lot of people. We had to do a lot of work to develop this new memory technology, but we also had to have a number of people to support 20 DRAM companies, which forced us to have to teach the DRAM companies how our interface worked. We couldn't possibly design 20 different total custom memory interfaces in parallel and then do it again every year and a half as you move to higher density memories. That wasn't a feasible approach, so it forced us to teach the DRAM guys, which was unfortunate because that's when they started to really learn how our technology worked

and lightbulbs started to come on and they started using our ideas in some of their other memory technologies.

Laws: And you could not get a license fee in those other applications?

Tate: Oh, yeah. When we started the co, there was page-mode DRAMs, but by the time we were in production with Nintendo, things had moved to synchronous DRAM, which was kind of playing off of one of the ideas of a Rambus DRAM to clock the DRAM , rather than having everything be asynchronous. But its performance was way below Rambus DRAM. And then there was double data rate synchronous D-RAM, which was when things were starting to become potentially competitive, although what they were able to do was to way below what we were able to do. It took them years and years to catch up, but they caught up by using more and more of our technology, which they figured out because we were forced to teach them how our stuff worked. Phase lock loops in a DRAM was not something any of these guys were comfortable with or used to. They couldn't see any reason why they needed to use it. I remember being in a meeting with Samsung where we were teaching them how it worked and why we needed it, and you could see the light bulbs going on. All of a sudden, "Ah, well that's why you use it. That's how you do it." And because of our requirement to teach them, it laid the groundwork for later problems where they took our ideas and stuck them in other memory devices. The philosophy at all of these memory companies was, patents are for the lawyers to worry about. Our job is to build what we need to build to keep the factories full. And because of the concerns about paying us royalties, they continue to work on other kinds of memory devices which didn't pay us royalties, but of course they used our inventions, so eventually, they did pay us royalties, but not at the time.

Laws: The IPO in 97, again, this was a different kind of company you were trying to take public. Was there a challenge in selling the idea of a public company working on this kind of basis?

Tate: No, I don't recall there being a challenge. There was an issue of educating people, because before every chip company buildt chips, so we were a semiconductor company. So it's like, "Well, what chips do you build?" You know, people had already gone through the fab versus fab-less evolution. So some people started calling us a chip-less chip company. I never would've used that term, but just like a fab-less company had to do everything that a fab company did, we had to do pretty much everything a chip-producing company would have to do. We had the testers, we had a product engineers, but our relative focus was different. We didn't have to have hundreds of manufacturing people because we didn't have fabs and we just had to have enough test engineering to show our customers, "Here's how to do production tests," but we didn't have to do production tests on a regular basis. So we had all the same elements of a chip company, but instead we would license the critical portions.

Laws: And you didn't need a big sales force outselling your proprietary design?

Tate: We needed a salesforce, but it wouldn't have been nearly as big as if we were selling some sort of chip. Yeah. It was a matter of sort of taking the fabless approach that had already worked and sort of using that as an analogy. Okay, well, chip companies used to do all this stuff, and then you carve out the fab, so we're like a chip company. But now we carve out some other steps. But we're doing all the design work, so we're not a patent-licensing company. Yes, we have patents, which we license. Intel has patents, too, but what we're doing is transferring design know-how. What we're giving the customers is it the ability to design the chips, setting up standards, giving them the actual physical designs or we're teaching them how to do the physical designs and setting up an ecosystem in which they can build chips that are compatible and make money. So, the patents are just one part. This is a total solution. What we showed them was-- and at that point, there wasn't this concept, but what happens today is when you build up a logic chip, you have blocks all around the chip you've licensed from different players. Some of the really big companies do all of their own blocks, but most chip companies get this block, you know, they get the DSP from Tensilica. They get a processor from ARM. They get SRAM memory, usually from the foundry. They get to the IO pads from the foundry. They get standard cells to do their own random logic from the foundry. There's all these people who provide them the different blocks, and people were used to that. But we are the first provider of a block of IP which was licensed. And we were making the argument that this would be a trend in the future. And sure enough, people like ARM and stuff popped up as semiconductor IP. Today most companies couldn't ship chips if they can't get IP blocks from companies. So the analogy that we used was that this was going to be like a PC board. On the PC board in the old days, there's all these chips, you buy them from different companies, you wire them together and make your PC board. That's how chips are going to be developed, and we are one of the first of these kinds of blocks. So we were able to tell the story pretty clearly, but more importantly, we had a huge success with Nintendo and we signed a contract with Intel and that was more convincing to the customers. The Nintendo stuff had already made us profitable and the Intel business had the prospect, if they were to adopt this as fully as they said, and Intel was out there saying, "Hey, we're going to make everything Rambus [compatible] over time. It'll take five years. With that-- and the projections of the company's profitability were huge, so it was an easy sell. Especially compared to all the selling I had to do in the previous seven years in much more difficult circumstances.

Laws: And what was your revenue when you went public? And I presume you were profitable?

Tate: Yeah. You know, profits and cash flow are different things, and so I always tend to think more about cash. We were profitable, because you had to be-- in the old days, you have to be profitable to go public. You had to have X number of quarters of profits with steady growth and you had to convince the bankers that you were going to be able to keep it up for at least X more quarters or else they wouldn't touch you. Of course, today, companies that go public on a totally different set of metrics. Back in the old days, it was this old-fashioned approach, so you had to be profitable in order to go public.

Laws: And do you remember roughly what the revenue was at that time?

Tate: I don't. But it's all in the public record. It was tens of millions of dollars, which generally was considered too little, but we were more like a software company than a chip company, so the profitability of the business was more like a $100 million chip company, and it's profitability in the end that people care about.

Laws: Sure. So from 97 on, where did the company go? What did you do?

Tate: From 97, for the next several years, we were consumed with making the Intel stuff work. When we went public, we had a handshake-- well, we didn't have a handshake. We had an agreement with Intel and we were working on developing the kind of memory and technology that Intel wanted. It was much faster and it had [to have] the capability to serve big memory systems, whereas what we'd done with the 500 megahertz was really for small memory subsystems, smaller amounts of memory. But PCs had to have the ability to have at least 16, and preferably 32 DRAMs with a modular expansion capability. So their real preference would be you could have one row of DRAMs and you could add up to three more rows of DRAMs, so you could start with 25 percent capacity and go to 100 percent capacity in chunks of twenty-five percent. And when push comes to shove, at a minimum, you needed to have the ability to populate half the memory and upgrade another half of the memory. And the more granularity you can give the better. That upgradeability was a big issue because sockets introduced huge signal integrity challenges. And building a memory system where everything was soldered down is way easier than building a memory system where there's one socket, much less three sockets. So, the number of sockets was the biggest challenge. And that was the technical issue that took us the longest to work out. We had some packaging concepts early on which didn't pan out. Fortunately, Intel helped us out and showed us some ideas, and-- maybe not so much ideas but sort of coaxed us in a better direction. And then we ended up going to something that looked more like a traditional memory module. And we were able to get that to work. But he whole socketing thing was still the biggest challenge we faced the whole way through. And ultimately, we had one glitch with Intel at the end. And it had to do with some narrow aspect of the socketing where-- I don't even remember right now, where there was glitches and occasional situations in maximum memory configurations. Anyways, we figured it out and solved it. But it came at an awkward and uncomfortable time. So, it was a big deal.

Laws: How was the company organized at this time? You had a VP of engineering, and--

Tate: The company was organized pretty much the same way as it had been for a while. I think we changed it later, but Dave Mooring was my VP of sales. Subodh Toprani was the VP of marketing, Allen Roberts, the VP of engineering. Ed Larsen was the HR director or VP. Finance was Gary Harmon at that time. This was all when we went public.

Laws: Right.

Tate: Oh, I'm probably forgetting other key names. But that's been a while now since we went-- Well, how long has it been? We went public in '97--

Laws: Well, that says twenty years.

Tate: And it's 2017, so twenty years, a long time. So, we were functionally organized. Later on, we organized more by divisions. And we made Dave president of the company. Laura Stark and Kevin Donnelly got executive roles later on. They'd been with the company when we went public as well. But they became VPs later. So, we had a lot of smart people, a lot of good talent. We changed the details a lot. But basically, it was functional for a long time. Then we went to a business unit set up for the rest of the time was the basic organizational direction.

Laws: What was it like trying to hire people into a strange company like this? Did it take a lot of convincing?

Tate: Hiring before we went public was always a lot of work. You know I learned over the years not to convince people. Instead what I learned, and what I have done subsequently at other startups is life is like a menu. People want to do certain things. People have certain personality types. And there's certain objectives that they have. And what you really want to look to do is to find people who what they love to do is what you need to have done. Where they want to go in their career aligns with where the company needs to go to be successful. You're looking for people where there's goal congruence and alignment. If you're convincing them, that means you're trying to get them to do something other than what they really want to do. And when people get out of bed in the morning and want to go to work, it's because they're having fun. They're doing something they like. The people they work with is a critical part of it, too. So, I learned long ago through hiring-- some hiring mistakes that the best thing to do is find people where there's this gigantic goal congruence. And the right people are people where fairly quickly you go, "Wow, this person is really great and could really help us out." And that person is going, "I don't need to go talk to any more companies. This is where I want to be." So, you look for that resonance where it's just like-- but you only find those people occasionally. So, we would interview a lot of people. We'd interview a lot of people. And most people didn't want to go to a risky startup. Going to startups was more popular back then. But people were looking for low-risk startups. And there aren't many of those. A lot of people want to join startups and don't really know what startups are like. So, they'd see long hours, risk, all those kind of things. I would just be very open with them and say, "Here's the good stuff. Here's the bad stuff. You've got to like all of it because you're going to figure it out. After you join, you'll find it all out. So, we may as well tell you now." And what happened was we were able to hire the people we needed. And our turnover was extremely low because we only hired people where there was a huge goal congruence. And when we had a bump in the road, it didn't cause them all to want to quit because they were doing what they liked to do. And we built a team of people who really liked working together with each other. So, that team stayed together with very low turnover for a very long time. We would let people go if they couldn't cut it for some reason. But we didn't even have to do that very often. So, hiring the right people at the start was

always critical. And I had the benefit of having run businesses for ten years before doing Rambus. So, most of this thinking had happened before. So, hiring is a huge thing. And you want it to be. You've got to put a lot of effort into hiring to be successful.

Laws: Were you having to give much stock away?

Tate: Oh, you know the VCs never wanted to give away stock. But too much is sort of a relative thing. So, I don't really know compared to other companies that-- how much we gave away. I suspect we gave away less than most companies. But on the other hand, we were more successful than most companies. So, all of the executives are-- none of them have to work. Most of them are retired.

Laws: Sure.

Tate: Lots of the engineers, same thing. So, everybody did well. And if they didn't own a nice house, now they own a nice house.

Laws: I'm sure.

Tate: So, I think it was good risk reward for everyone.

Laws: Didn't you get into some kind of issue with stock pricing at one point.

Tate: Oh yeah, yeah, like a lot of companies did.

Laws: Anything you can tell us about that?

Tate: Oh, it's well documented. At Harvard business school they didn't teach us about stock option pricing. So, there was a transition where I think accounting rules-- Gary Harmon always would complain that accounting rules used to be based on good judgment. And then it became based on strict adherence to slavishly following a bunch of extremely complex rules. And the option pricing has to be done in very precise ways. And I we got caught up in that transition. I always follow the advice from my experts. And as far as I knew, what we were doing was what we were supposed to be doing.

Laws: Sure.

Tate: And I have this feeling that we were doing what our experts told us to do. But when-- everybody runs for cover when these issues occur. And everybody lawyers up. And there was years of litigation, a lot of money, time, effort spent. In the end, we weren't gaming any systems. We were doing what we thought was fair, and reasonable, and logical, and I think was the right thing for the shareholders. It was all about retaining people and doing the right thing is to retain people and stuff. There were some companies that may have been gaming systems through slush funds. I read about some companies that did very different stuff. We didn't do any of those things.

Laws: It was a trying time for you when you're focusing on that rather than running a business.

Tate: Oh, the option pricing occurred after. I was no longer running the business. I was chairman of the company. Which also meant the company wasn't very invested in me, perhaps didn't see the need to protect and circle me like some other CEOs who were involved in stock option pricing, their companies handled it very differently. But I wasn't running the company at the time. The option pricing issues that came up had occurred while I was running the company. And it all occurred after we went public.

Laws: So, you left Rambus in 2005?

Tate: Well, I have a hard time getting my dates right, like I said earlier. But I think I was CEO until 2005. And I think I left Rambus as a board member in 2006 if I remember right, as part of the whole option pricing thing. It came up. It was becoming a big mess. So, we agreed that I just get off the board, and emotionally I was disconnecting from the company anyways for various reasons. The new CEO and I weren't on the same wavelength. He was happier not to have me on the board, I'm sure. That's probably true of most CEOs, don't really want their prior CEO on the board.

Laws: They don't-- yes, sure.

Tate: It's probably unusual that that works out.

Laws: So, what did you do with yourself after you left?

Tate: After I left, I spent a few years tied up in a lot of litigation. It was the patent litigation as well. I had in my-- I think I was called for depositions-- I've lost track, thirty times, fifty times? Maybe it was fifty days of depositions. You can imagine this but for ten hours with stacks of documents with lawyers. And so there was a ton of litigation unfortunately in the patent litigation side. And my involvement in the patent litigation didn't go away. And my obligation to be a witness didn't go away just because I was no longer involved with the company.

Laws: I presume you were compensated for this.

Tate: No.

Laws: Wow.

Tate: Nope. There was no compensation. Under U.S. law, if you're involved in these things, and you're subpoenaed, you have to show up. And if you're within the jurisdiction of the court, you have to show up to testify at trial if subpoenaed as well. So, I had a bunch of stuff where the patent litigation tied me up. And then there was the litigation on the option side. So, for the first couple of years, I tried to relax. But I spent a lot of time in litigation. The litigation started to tail off. And so, I started to get involved in some Angel investing. I thought that would be fun. Bill Davidow sort of warned me that it might be fun, but it might not be lucrative or profitable. And he was right. So, then I got involved with some venture-backed boards, Benchmark Capital and others. Some of the VCs I knew invited me onto some boards. And I found couple other boards. So, I found that a lot more interesting. They are higher quality companies and better management teams and so forth. And Benchmark and MDV asked me to consider joining the board of Nanosolar and said, "And you know we're thinking about changing CEOs. Maybe you could be the temporary CEO, as well." So, I fell for the old temporary CEO trick. And when I took over Nanosolar, the board knew there was problems. That's why they wanted to change CEOs. But the problems were so much worse than the board realized that it was very hard to get out of being temporary CEO when things are a big mess.

Laws: What was Nanosolar doing? What was their product?

Tate: Nanosolar had developed a technology for making flexible, thin film, solar panels using something called CIGS, a certain metal stack up, and depositing it on a flexible substrate although they ended up putting it in between solid pieces of glass. So, the fact that it was flexible was a curiosity but didn't have any value in the end product. And the whole solar space back at that time around 2010 was hot and interesting. A lot of money was going into green and clean of all sorts and kinds of things. So, it seemed like an exciting area. A lot of semiconductor people were getting into it because there are certain elements of manufacturing which are similar.

Laws: Right.

Tate: Although, I'm not a manufacturing expert. So, I said hey, it would be interesting. I was really not planning to be CEO. But I ended up running it for almost two years. And we ended up selling off the business to a Swiss firm. And then the solar business got into a gigantic oversupply basis. So, all the startups in Silicon Valley got wiped out.

Laws: Yeah including a famous one on the other side of the bay.

Tate: Yeah.

Laws: Solyndra.

Tate: Solyndra, right, right, right. So, it was interesting. In the end, what I realized is that if you think DRAMs are a commodity, you haven't been in the solar business. All you're producing with solar panels is electrons. And electrons are all exactly the same. So, there's no differentiation. It's just return on investment. And you're selling ultimately to utilities. So, if you think the customers that you sell DRAMs to are large and bureaucratic, try selling solar panels. And they want stuff to work for thirty years in the sun, and the rain, and the snow, and the ice storms. So, the reliability challenges are gigantic. And when I took over the Nanosolar, there was a shortage of solar. But once the shortage ended, the customers were like, "Well, this is a new technology. So, we'd be willing to buy it after you have five years of reliability data." It was really, really, really hard for a startup to be able to afford to do. So, it was a tough business.

Laws: Were the issues technical, or were they much more market driven?

Tate: The issues that Nanosolar had were primarily organizational.

Laws: Ah.

Tate: There was a whole bunch of PhDs with no organization structure. And they'd raised four hundred million dollars. And they were in the process of pissing it away at a rapid rate. Underneath that, there was technical issues as well. But the biggest issue was organizational. So, it reconfirmed why I do startups from scratch, where it's easier to get it right at the start.

Laws: You create your own disorganization.

Tate: Trying to fix problems takes way more energy than doing it right in the first place.

Laws: Yeah. I've seen that too. So, you did that for a couple of years. And then I understand you're now involved with a programmable logic company. Tell me about it.

Tate: Yeah, once I escaped from Nanosolar, I went back to doing venture-backed boards. And being on a board's a good alternative to being CEO, but it's not the same. You give advice and people are free to

ignore it. You know, and I was on the other side. So, I know how that works, and I'm okay with that. But I hadn't planned to go back and be a full time CEO, though I'd get calls repeatedly from people who wanted somebody to do this, or to do that, or to do those. But nothing that was ever exciting enough because there's a lot of companies that need management. But there's not very many companies that are worth putting all that effort into. You need a special alignment of things to-- and everyone likes different stuff. So, I like a certain type of company as well. So-- and I was having a good time. Finally, all of the litigation had been done. That was all behind me. We were learning Spanish. We were traveling the world, started to have grandkids. And so, I noticed four years ago that my wife was starting to shoot down my ideas about travel because why would we travel when we have a grandkid. And Colleen will say, "No, no, no, it wasn't like that." But that's my recollection of it. And at about that time, one of the VCs I know from Everspin-- I'm on the board of a company called Everspin that does magnetic memories. Like a lot of VCs, I get calls from time to time from them. They'd say, "Hey, I was talking to XYZ. Why don't you go meet with them? See what you think. Let me know is this worth spending any time on?" And usually, I'd have a lunch or a breakfast, and I'd come back and tell them the ten reasons why it won't work. But in this case, the young guy that I met and the professor who was working with him-- this was a UCLA PhD who'd finished up and was doing post grad work up at Stanford. But really, he was trying to start a company based on some technology he had developed with his professor at UCLA.

Laws: And the name of the person is?

Tate: Chen Wang [ph?].

Laws: Chen, okay.

Tate: And the professor is Dejan Markovic. And after-- I can't say that it was after the first meeting. But after a few meetings, I started to go you know this kind of feels like Rambus. His idea was I can make a better FPGA. I can make an FPGA that's half the size die area compared to a Xilinx and Altera. And asking lots of questions, I started to become convinced that he was probably right. Maybe he did know how to do that. But I told him the problem is that I'm not an FPGA expert. But I said, "Based on what I do know is those companies are six billion dollars a year revenue. You have nothing. Nobody wants to put money into semiconductors these days." Like semiconductors are getting some interest now. But four years ago, totally dead. Nobody wanted to put any money in. So, I said, "Even if this was a good business idea, I don't know if we can raise the money. But if we could raise the money, and we build something that's half the area-- die size, the problem is-- the biggest-- the first problem is the TSMCs wafer price to Xilinx is going to be half or less of the wafer price you pay. So, all of your economic advantage is gone. There'd only be an advantage if it's all other things being equal. But it's not being equal. Little companies have huge headwinds they have to sail into. And you're not going to get around them. Plus, you need all these high speed I/Os. And there's packaging. And there's software." And I said, "If you want to do FPGA chips, goodbye and good luck. It's not going to work." But it seemed like he actually had some technical advantages. And he seemed like a really sharp guy, and, as PhDs go, easy to work with. And I was

starting to feel like maybe I need a new hobby because traveling and stuff was maybe not going to stay on the horizon as much. And I always had a nagging feeling with Rambus that-- of unfinished business. Things didn't work out the way we wanted with all the DDR litigation, and the option litigation, and all that stuff. The company should have been worth twenty billion dollars. Two billion's not bad. That's better than most people do. But it's like maybe we try this again. And so, we brainstormed. And we figured out well why not an IP block. Why not do an FPGA IP block? And it seemed like an awful idea. Of course, as it turned out, that people had done it for-- people had tried for twenty years. In fact, John East, one of my early bosses at AMD, he ran Actel. I took him out to pick his brains about FPGA, and he laughed when I said we're going to do FPGAs and IP block. He said they tried to do that in the '90s when Rambus was--

Laws: Right.

Tate: Starting to do semiconductor IP. But anyways, I got this sense that hey, maybe there's something there. We talked to some customers. We saw some interest. And because Chen had done all this work before-- he'd done five different FPGA chips, for a small amount of money, we were able to fund the company and get to a point where we had working silicon, working software, and sign up the first customer. Something we could never have done if we were doing a chip approach. We would have needed twenty times more money to do chips. So, as a semiconductor IP play, it was able to be financed. And the VC who'd introduced me ended up coming in, and we did the first round of investment. And then once we signed a customer, we were able to more investment. And now, we've raised about thirteen million dollars in an A round and a B round. And we're signing up more customers. And it looks like we'll be able to make this market work.

Laws: What is unique about the function? You said size, chip area.

Tate: Well, there's nothing unique. What ARM does isn't unique, for example. This isn't like Rambus where nobody has ever done it before. People have done FPGA for a long time. People have tried embedded FPGAs since Actel. And as it turns out, we probably ran into a dozen different examples of people who've tried over the years. What I think is different his time is that, with Chen's invention, which is a better interconnect, and an FPGA is mostly not- programmable logic [but] is mostly the programmable interconnect. We can make the interconnect denser so we have less area compared to competitive alternatives. But more importantly, we also use fewer layers of metal. So, at twenty-eight nanometers, we use six layers of metal. The chips that use us may have ten layers of metal. But what's important is that you have to be compatible with all the metal stack ups. If our solution was ten layers of metal, we wouldn't be compatible with all the different metal thicknesses and widths that people use. The first five, six layers of metal are common. And then things change. So, you have to be able to implement IP in the bottom five, six layers of metal if you want to be compatible. If you're not compatible, your market starts to shrink.

Laws: Is it a static RAM based cell?

Tate: It's a sixty-configuration memory bit.

Laws: Okay.

Tate: And remember, I'm not the engineer. So, it's not a static RAM. And it's logic design rules. But anyways, our real competitive advantage is that we had higher density and less metal layers, and then if somebody else was to try to do it, because of Chen's inventions-- he ended up with an ISSCC outstanding paper award, he and the professor and another UCLA engineer. So, it turns out, he did come up with something pretty impressive. So, but the timing is also right because the cost of masks is accelerating. So, the ability to make chips be more flexible to get a better return on investment is attractive to people, whereas at 180 nanometers, mask costs were relatively small. So, there was less pressure there. So, I'm not quite sure what's different about us from what other people have done. But it's not very clear what the other people did. So, it's hard to know how different we are. But the concept of FPGA, it's just like ARM. ARM didn't have a new concept. It was just we can put it inside your chip. And other people have processors that go on chips. But ARM was able to provide a better processor at better economics than their competitors. And I think the idea of an embedded FPGA is not new. But with our interconnect density advantages, our metal advantages, the timing, and perhaps our execution, we're able to deliver a solution that checks off all the boxes people need. Whereas, other people apparently weren't able.

Laws: Is there a particular kind of customer or a particular application? Or is it general purpose?

Tate: It turns out it's probably-- it's very general purpose. There are applications where we see a lot of activity, networking. The networking business is shifting from enterprise networks to data center networks. And people like Microsoft have written about how the data center protocols for security, for packets, for storage all need to become programmable. They want to build data centers where they can change the protocols the data center is run on programmably, rather than have to change hard-wired chips whenever they want to add new packet formats. And I think within the data centers, they are going to optimize things differently than outside the data centers. Standards are good. But the data centers are getting so big, the data center is a whole ecosystem unto itself. So, I think with programmable protocols, they can optimize to make things work better within the data center as opposed to hard-wired stuff based on worldwide standards.

Laws: Sure.

Tate: So, that's forcing the networking people to look at ways to do this program. Building a processor is just too slow to handle programmability at line speeds in switches, and in NIC chips, and so forth. Another sector is defense electronics. The aerospace defense people buy something like ten percent of all FPGAs. They love them. But when you're putting stuff up in airplanes, or in missiles, size, weight, power,

all are very important. FPGA chips, if you can integrate them, the size goes down. The weight goes down. The power goes down. The performance goes up. Plus, we can implement for things to go into space, rad-hard FPGA, which you can't buy today. Plus, if you're a defense guy, and you're worried about security of supply, we can implement our stuff in U.S. based fabs, whereas all FPGAs today are built in fabs in Asia. Well, most chips are built in fabs in Asia. It's not just FPGAs. So, that's giving us a lot of traction in the defense aerospace arena. There's other segments, microcontrollers, deep learning. But it looks to me like this technology potentially could become pervasive. If it becomes pervasive, then this will be bigger than Rambus was.

Laws: What stage is the company at now?

Tate: Oh, we're still early stage. We're not at the stage where we have the breakout, high-volume Nintendo 64. On the other hand, everything works technically. Everything's worked technically since one year into the company. The nice thing about this is that we're more like an ARM and not like a Rambus. At Rambus, we had to get all those chip companies to agree to jump at the same time. And there was all sorts of price competition issues and so forth. This is more like ARM. We go in their chip. We make their chip more flexible. But it doesn't affect any other chip that they buy. So, we convince the chip company or the systems company that designs their own chip. And there's no other-- so, it's like ARM. We don't-- the sell is easier. We have to convince one person. But we don't have to convince five people. And technically, it's all digital. So, it's not all this hard high-speed analog stuff with signal integrity issues like Rambus. The main challenge is, just like at Rambus, is risk aversion. People love the idea. And ninety percent of our meetings end with, just like at Rambus, when somebody else is in high-volume production let us know. We'd love to use this technology. But they don't want to take the risk themselves.

Laws: How do you police something like that, where it's buried in the chip, to make sure that you get paid the royalties you should? Do you just have to trust them?

Tate: Well, that's an interesting question. That sort of goes back to so, why'd we have the problems at Rambus. The difference between Rambus and ARM is that at Rambus we were forced to teach our-- we had customers who were giant compared to ARM's customers. And the memory interface was-- they only had two things to do, the core and the interface. So, it was another strategic list, whereas if you're using an ARM processor, there's a dozen other things that you care about more. So, ARM doesn't make so much money from any one customer that that customer wants to go the effort of displacing ARM with their own engineering team. So, the way that you get people to pay your royalties is because they need more stuff from you in the future. They'll honor it. Once customers reach a conclusion that they've learned everything that they need to know, they don't need anything more, and this is just a matter of paying for a patent, then they turn it over to the legal department to figure out how to minimize those costs. If the customer needs something from you to make the next generation chip work, and they don't know how to do it themselves, then that means they need you. And so, they'll keep paying you what they agreed to pay you on a previous deal. So, it's a matter of staying relevant, staying important, having what they need

for the next generation, not just what you did for the last generation. I think it's as simple as that. ARM I don't think even has any patents.

Laws: Probably not.

Tate: It's just a matter of okay the next chip is going to use ARM. And you need a bigger, faster ARM. So, you better not piss off ARM. So, you better pay them what you agreed to pay. So, I think it's as simple as that.

Laws: So, how much of your time are you spending on--

Tate: Oh, I'm working--

Laws: Full-time?

Tate: Pretty much as hard as at Rambus. The one difference is I try to bicycle to work. Every day.

Laws: So, it's outgrown a hobby then.

Tate: Oh yeah, yeah, it's a full-time job.

Laws: And where is the office where you're located? If you can bike to work, it must Palo Alto somewhere.

Tate: We're actually located, again, within a couple of blocks of San Antonio and El Camino.

Laws: Okay.

Tate: So, real estate is too expensive in Palo Alto. I could bicycle there, but too expensive. And it's getting further away from where most engineers live in Silicon Valley.

Laws: Yeah, they can't afford to live in that area.

Tate: And going south of El Camino and San Antonio would take me all day to bicycle to. So, the handshake deal with Chen, my co-founder, was okay, if I'm going to be CEO-- because he had to convince me to do this and stop doing all this fun stuff and working full-time. And I'm going to need to bicycle to and from work because, without bicycling, I'll gain like thirty pounds. That happened at Nanosolar where I had to drive to work.

Laws: Right.

Tate: And life's too short to gain that much weight. So, it's going to have to be Mountain View. It's going to have to probably be El Camino and San Antonio, maybe Castro Street. Castro's too expensive, so San Antonio and El Camino. And actually, we started off in a six hundred square foot office. And then when we needed more space, we were looking-- there wasn't a lot of space back a year and a half ago. The A list space in Mountain View was a very short list. But one of the addresses was like well, that's-- that address sounds familiar. And sure enough, it was the Rambus building that we were in for the longest period of time.

Laws: Okay.

Tate: From like '91 until 2000 we were in a building across from the old DMV. It's still there. So now, we've got half of the first floor, and this great location, very nice office. And it's my lucky building.

Laws: Yeah, okay. Well good. Good luck to you, Geoff. You've come full circle for sure.

Tate: Yeah. Doing it again.

Laws: Any thoughts on somebody wanting to start-- a young person wanting to get into industry, or start a business today? What advice would you give them?

Tate: Wow.

Laws: Technology presumably.

Tate: Yeah, well the most important thing is to figure out what you like to do and do it. If the money is in technology, but you don't like doing technology, then you probably shouldn't do technology. I know a lot of people in a lot of walks of life. And you don't have to make a lot of money to be happy. But if you're not happy, it doesn't matter how much money you have. So, the most important thing is to have a great family life and do something for work that makes you feel good about yourself and where you want to go do it

every day. And if it happens to make money, that would be good too. So, if you happen to be lucky enough where what you like to do is technology oriented, then that's a great space to be in. I'd say computer science is still the right place to be. EE, Horowitz complains that he just doesn't see the talent he used to see, that all the sex appeal has moved over to programming and biotech and all this kind of stuff. So, the talent isn't going in. But of course, that doesn't mean you can't make money and do well if you're good at what you're doing. So, I know the semiconductor space, I know in the computer science space, there's huge opportunities for people. And what you probably want to do is go to a place like Silicon Valley where there's a ton of companies that are growing fast that are willing to give young people a chance and, like at AMD, have a lack of-- it's not like AMD had a lack of management. I'm phrasing that wrong. But at a fast-growing company there's like a big suction.

Laws: Just a lot of opportunities to find some--

Tate: You just can't get enough good people fast enough. So, if there's opportunity, it's easy to work hard and be given it or take it by just assuming more work. And I remember back at AMD, when I joined, it seemed like management was all pretty old. But in retrospect, they were all very young.

Laws: Kids.

Tate: I go to semiconductor companies now, and I think about it, and I go, these guys are all like twenty years older than the same management functions at AMD back in the day. So, you want to be in a place where there's a lot of fast growing companies. And you want more than one fast growing company because you have to have some competitive capability. Any one company may not be the right thing for you. So, Silicon Valley I think's a perfect place. But there's other places in the world, Israel, China, where the situations exist probably as well.

Laws: Sure. Geoff, thank you for spending time with us today.

END OF THE INTERVIEW

