CHEMICAL HERITAGE FOUNDATION

# LESLIE L. VADASZ

Transcript of Interviews
Conducted by

David C. Brock and Christophe Lécuyer

at

Los Altos, California and Sonoma, California

on

15 March, 19 April, and 7 June 2005

(With Subsequent Corrections and Additions)

ACKNOWLEDGEMENT

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Chemical Heritage Foundation
Oral History Program
315 Chestnut Street
Philadelphia, Pennsylvania 19106

**LESLIE L. VADASZ**

| | |
|---|---|
| 1936 | Born in Budapest, Hungary on 12 September |

## Education

| | |
|---|---|
| 1961 | B.S.E.E., electrical engineering, McGill University |
| 1990 | AMP, Harvard Business School |

## Professional Experience

| | |
|---|---|
| | Transitron Corporation, Wakefield, Massachusetts |
| 1961-1964 | Technical Staff, Research and Development |
| | |
| | Fairchild Semiconductor, Palo Alto, California |
| 1964-1968 | Technical Staff, Research and Development |
| | |
| | Intel Corporation, Santa Clara, California |
| 1968-1972 | Technical Staff, Research and Development |
| 1972-1975 | Director, Engineering |
| 1975-1979 | Vice President |
| 1976-1977 | Assistant General Manager, Microcomputer Components Division |
| 1977-1979 | General Manager, Microcomputer Components Division |
| 1979-1991 | Senior Vice President |
| 1979-1991 | Director, Corporate Strategic Staff |
| 1986-2002 | General Manager, Systems Group |
| 1988-2002 | Member, Board of Directors |
| 1991-2003 | Executive Vice President |
| 2002-present | Director Emeritus, Board of Directors |
| | |
| | Intel Capital, Santa Clara, California |
| 1991-2003 | President |
| | |
| | Harvard Business School, Cambridge, Massachusetts |
| 1991 | Lecturer, System Group |
| 2003 | Lecturer, Internet Law Program |
| | |
| | ZettaCore Inc., Englewood, Colorado |
| 2003-present | Member, Board of Directors |

## Honors

| | |
|---|---|
| 1977 | Elected Fellow, Institute of Electrical and Electronics Engineers |
| 1991-1996 | Member, National Research Council Computer Science and Telecommunications Board |
| 1997-2002 | Member, Presidential Advisory Committee for Information Technology |

## ABSTRACT

**Leslie L. Vadasz** begins the first interview by describing his childhood in Budapest during World War II. Vadasz developed an early interest in mathematics and literature, and began an undergraduate mechanical engineering program before continuing in solid state physics at McGill University in Montreal. Vadasz worked on metal oxide semiconductor transistors at Transitron Corporation before joining Fairchild Semiconductor, where he helped develop the silicon gate process. In the second interview, Vadasz details the early efforts to produce memory devices at Intel Corporation, including erasable programmable read-only memory. Vadasz continues with the transition of Intel Corporation into a divisionalized structure and international extensions, at which time he became Vice President. Vadasz recounts his role as general manager of the microcomputer components division and its interactions with the semiconductor industry in the third interview. Vadasz began serving on the Board of Directors in 1988 and describes its place in assisting Intel management. He also explains the foundation of Intel Capital. Vadasz concludes the interview with remarks on the importance of technical knowledge in both developmental and managerial work.

## INTERVIEWERS

**David C. Brock** is a senior research fellow with the Center for Contemporary History and Policy of the Chemical Heritage Foundation. As an historian of science and technology, he specializes in oral history, the history of instrumentation, and the history of semiconductor science, technology, and industry. Brock has studied the philosophy, sociology, and history of science at Brown University, the University of Edinburgh, and Princeton University (respectively and chronologically). His most recent publication is *Understanding Moore's Law: Four Decades of Innovation* (Philadelphia: Chemical Heritage Press), 2006, which he edited and to which he contributed.

**Christophe Lécuyer** is research historian at the Chemical Heritage Foundation. He holds a Ph.D. in history from Stanford University. He has published extensively on manufacturing districts, university-industry relations, and the history of electronics and scientific instrumentation. He was a fellow of the Dibner Institute for the History of Science and Technology and taught at MIT, Stanford University, and the University of Virginia.

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**INTERVIEWEE:** Leslie L. Vadasz

**INTERVIEWERS:** David C. Brock and Christophe Lécuyer

**LOCATION:** Los Altos, California

**DATE:** 15 March 2005 [Interview 1]

**BROCK**: This is an oral history interview with Les [Leslie L.] Vadasz, taking place in Los Altos, on 15 March 2005, with David Brock and Christophe Lécuyer as the interviewers.

If my research is serving me well, Les, I understand that you were born in Budapest in 1936, and I was wondering if you could describe for us your family background and your early years in Hungary.

**VADASZ**: Okay. I was born in September 1936, a Virgo, which means that we adjust pictures on the wall, because we don't like crooked pictures, and the like. I was an only child. It was in Budapest that I spent the first twenty years of my life. My parents were not highly educated people. They, in fact, did not have a high school education. They only had elementary school education. My mother was a seamstress, and my father, while his learned profession was a carpenter apprentice; his actual work was as a painter, a house painter.

We were not well off, but we had a reasonable existence. Our family religion was Jewish, and I spent the latter part of the World War II years in the Budapest ghetto. Through a number of lucky circumstances, we survived. I believe at that time I was in the second grade. After the war, I continued with my elementary school years, and there's nothing really very memorable about those times, other than I was a kid going to elementary school.

**BROCK**: Did your family have an apartment in the center of Budapest?

**VADASZ**: We were living in, I would say, a working-class neighborhood, in what we called the Eighth District. Budapest is divided into a number of districts. In fact, after the war, in addition to the work that my parents did in the areas that I mentioned, they were also the superintendents of the apartment house that we lived in. We had an apartment there, a two-bedroom apartment.

**BROCK**: In the period of time when your family lived in the ghetto, was that a move to a different part of the city?

**VADASZ**: Yes, that was a move. We were basically uprooted from the apartment that we lived in, and were taken to a special district which was fenced away, and we lived there. Then after the war we went back to the apartment where we came from, and so it was as simple as that. [laughter] There's probably a hundred or five hundred pages behind it, but it's as simple as that.

**BROCK**: Did you have extended family in the city, or grandparents?

**VADASZ**: Well, my father was an orphan from an early age, so I don't remember any family on my father's side. On my mother's side, there was family: her parents, and her siblings. She was one of six brothers and sisters. Now, some were lost in the war, but even when things settled down, my family on my mother's side had a sister and two brothers. So there were two sisters and two brothers who made it through, and my mother's mother lived with us. So that was our existence between 1945 to 1956, when I left Hungary.

**BROCK**: So you were going to elementary school before the move to the ghetto.

**VADASZ**: That is correct. First year, and I think the beginning of the second year. Actually, since I was born on 12 September, and the qualification to start the first year is 1 September, I was delayed a year. So I finished my first year in 1944, and started the second year in the fall of 1944.

**BROCK**: Was that a public school or a private school?

**VADASZ**: It was a public school, and for all my early life I went to various public schools.

**BROCK**: Could you describe what your school experience was like, your pre-high school school experience?

**VADASZ**: There's nothing that memorable. First of all, I don't remember very much of it. Whether it's not memorable, or I just don't remember, I don't know which of the two. There's a difference. Frankly, one of my fond memories are the foreign-aid packages that came to the school, and the very good-tasting chocolate drinks that we had in school. But as far as the early years, it's hard for me to recall anything significant.

I could recall a little more in the middle school times than in early elementary school, and there I recall that there was a definite time when math really started to click and I'm very conscious of that memory. Suddenly I understood, and I cannot tell you what year it was, but I know that there was a very dramatic shift. You know, if you have three red apples and two yellow bananas—all these different math problems suddenly clicked. After that, I looked at the world of math and science in a different way.

**BROCK**: Would you say that that began to become your primary interest at school, math and science?

**VADASZ**: Certainly. I was more interested in the physical sciences, than in subjects like history. Literary subjects bored me more, significantly more. In fact, I went to a technical high school, and that was a very enjoyable experience because not only did you learn how things work, but also you had a machine shop where you could make things. You could work with wood, with metal, and you can work the machines like lathe and milling machines. That was a very good primer for the rest of my career.

**BROCK**: Before you went to the technical high school, just thinking about your father's experience in carpentry and in painting, had you, as a hobby, done any work with him in woodworking, or working with your hands, building things, that sort of thing?

**VADASZ**: I tended to gravitate toward building little toys for myself. I mean, if I saw a toy, I wanted to see how it worked, and cut it out of wood or plywood with this little saw, tiny little saw that you were able to cut very precisely, put things together with nails and—there was no Scotch tape at that time—strings. I liked to do that. I was reasonably good with my hands, to do things, to create things; nothing sophisticated, but just things that interested me.

**LÉCUYER**: Were you also playing with chemical sets?

**VADASZ**: No. In fact, I have to tell you, chemistry was one of my worst subjects. I never really liked chemistry, because, you had to remember too many things. I have to admit that I liked much more subjects where you could think through and arrive at the result by just thinking through, and I never could do that with chemistry. I was lost in the formulas, and lost in having to remember just too many details. I was kind of impatient with subjects where you had to remember rather than think through. I liked the cognitive part of learning rather than the memorizing part of learning.

**BROCK**: Did reading figure as a big activity of yours?

**VADASZ**:  There are various parts in my life where I went through, in my early life, a lot of reading.  They were very irreverent or irrelevant readings, because they were often books that were funny, or adventures, or detective stories.  I mean, I remember having old, translated English mysteries available for us to read, and they were not published very much after the war, but they were—

[BREAK IN RECORDING]

**BROCK**:  We were talking about reading these English mysteries in translation.

**VADASZ**:  Yes, that's right.  I still remember some of them.  Certainly, I remember books by Zane Grey, okay?  I remember mysteries by Wallace.  There were some mystery series that I seem to remember.  There were these mysteries which were sort of a matchstick character with a halo over the head.

**BROCK**:  *The Saint*?

**VADASZ**:  *The Saint*, yes, a series of books like that.  Now, that wasn't exactly high-quality reading, but those were the kind of things that I liked.

**BROCK**:  Was Zane Grey your introduction to an image of California?

**VADASZ**:  Well, Zane Grey was an introduction to early America, and I found it quite fascinating.  Yet when I left Hungary, the U.S. wasn't my first choice.  I really wanted to go to Australia, and I never made it.

**BROCK**:  Why Australia?

**VADASZ**:  I don't know.  I just had an image of Australia: a lot of land, few people, so the opportunities must be great.  It was not very scientifically researched. [laughter]

**BROCK**:  Could you describe the emphasis that your parents put on education in your household?

**VADASZ**: I don't remember one time that my parents really helped me with my homework, yet it was understood that they very much wanted me to have an education, very much supportive of me having an education. I was never pressured into it. I was never told, "You have to sit down for two hours and study." But somehow there was an atmosphere of, "Yeah, he's going to go to college."

It came through, probably more than anything else, in my parents' having a very high appreciation for the professions—people who were lawyers, people who were doctors, people who were engineers. "He's an engineer." "He's a doctor." It was a big deal. And so it kind of rubs off. You feel that, yes, it's something to strive for. So that was the atmosphere. And so it was never really a question that you grew up with this mentality that, "Yes, I'm going to be somebody." And since I felt pretty comfortable with my hands and drawings and the like, mechanical engineering was something that I felt was an obvious calling. The fact that I didn't become a mechanical engineer is another story, but it was—

**BROCK**: Was religion an important element in the household?

**VADASZ**: Actually, it wasn't. It wasn't at all. I mean, obviously, my early life was significantly impacted by religion, but the spiritual aspect of religion was never an important part of our life.

**BROCK**: You mentioned drawing. Was that another big hobby of yours, or activity of yours, as a young man?

**VADASZ**: Well, in school I was really fascinated with things like descriptive geometry, or perspectives—being able to draw three-dimensional elements. That was a very, very comfortable subject. I mean, those are really topics I thrived on as a student. In fact, later on in life, my first real job that I got in Montreal was very heavily dependent on the fact that I learned descriptive geometry, which is a story on its own. Maybe we'll get to it.

**BROCK**: Okay.

**LÉCUYER**: It is my understanding that in Hungary there is a very strong value given to math. Is that right?

**VADASZ**: Yes, math and physics, and I guess chemistry, too, if you like. [laughter] The Hungarian education system gave me a good foundation, a pretty good foundation.

**LÉCUYER**:  Because, at least in France, Hungarians are famous for mathematics and physics.

**VADASZ**:  That's right.

**BROCK**:  Could you tell us a little bit about the decision to attend the technical high school? Was there a series of exams that you were sitting for?

**VADASZ**:  No.  It was that the first year of high school was a gymnasium, and I found it boring, and I transferred to a technical high school.  It's as simple as that.  In fact, I had to take an extra summer course in machine shop, which obviously I'd missed during the first year. It doesn't mean that we did not have humanities.  We did, but the emphasis wasn't there.  The emphasis was much more on technical and shop subjects.

**BROCK**:  Was it at that time that you really started to think about mechanical engineering?

**VADASZ**:  It was solidifying, yes, solidifying.

**BROCK**:  What would you pick out as some of your most important experiences while at the technical high school?

**VADASZ**:  I don't know if I can really talk about most important experiences.  I remember some experiences.  I don't remember most experiences, so maybe the ones I remember are important for being stuck in my mind.  I mean, I can tell you a couple of my favorite projects that impressed me.  I remember that we basically had to tie—we had a steel rod of about an inch and a half in diameter, in cross-section diameter, and we basically had to tie a knot, which meant that you had to heat it up, hammer it, heat it up, hammer it, heat it, and basically tie a knot of this piece of iron.  This was quite a project.

Another one I remember is that we had to make a perfect cube out of the rod.  We had to use the lathe, and a planer to make a cube.  Those projects were fascinating, as some of the experiences where we were actually working in mechanical shops of companies as interns for a few weeks.  Those machines were very sophisticated, so we could only look at them.  They never would let us operate them. [laughter]  Those are the kind of little fragments that I remember.

I also remember some of the professors, but none really stands out as, gee, I had a favorite professor. In a way, I sometimes think, "What's wrong with me?" I mean, most people have a favorite professor, and most people remember these people, and I don't.

**BROCK**: Do you think that it would have been fair to characterize you as being a good student? Do you think you stood out as a good student?

**VADASZ**: I was among the top-level students. In fact, I think I ended up graduating up in the top of the class, but I didn't feel that I was the smartest student in the class. There were people in the class that I looked at and thought, "Gee, these people are really smart, and really smarter than I am." I can't say that I was a very hard-working student, either.

**BROCK**: You can't?

**VADASZ**: No. No, I didn't work very hard. Then again, it fits with the fact that I liked the cognitive part of subjects, and I wasn't very much into the cramming part. So all in all, I was a very ordinary high school student.

**BROCK**: What were your hobbies during high school? Did you do athletics?

**VADASZ**: My most athletic activity was that I liked to play Ping Pong. In fact, there were a number of times we played hooky from school to play Ping Pong. Ping Pong was a sport that was quite popular in Hungary then, and I was reasonably good at it.

**BROCK**: Where did you play, when you played hooky?

**VADASZ**: There were always some big rooms where they had a table, and during off hours you could get in there and play. I never played it professionally, or seriously enough that I was on a team or anything like that. Of course, people on the street, they always kicked the ball. Soccer is something that you play at in Europe, just like here kids play at baseball. But I never really engaged in any organized way in sports.

**BROCK**: Did you work during the school year, or just in the summer?

**VADASZ**: No. Even during the summer I didn't work. I was working as part of my school assignment, so from that point of view, I had a pretty cushy life. I didn't have to work to make a living. I was basically living at home, and my parents spoiled me rotten.

**LÉCUYER**: Did you plan, by that time, of going to college?

**VADASZ**: Well, as my studies at the high school were coming to an end, yes, I wanted to go to college. I ended up at an agricultural university—mechanical engineering in agricultural machinery. It wasn't my first choice, but at least it was a university. It was mechanical engineering of a sort, and I remember finishing the first year before the Hungarian Revolution, and leaving in 1956, just around the time that the second year started. In fact, the second year had started. Then the revolution, and then I left.

**BROCK**: Was that university in Budapest, for mechanical engineering?

**VADASZ**: Yes, yes, yes. It was on the Buda side. It was a newer university. Of course, it was pretty far from where I lived, and that's the first time I remember getting exposed to traveling every day, long distances. I mean, here it's routine. How many people go to work, and travel an hour and a half a day back and forth? I mean, before that, when I went to high school, I just took the streetcar for three, four blocks, and I was there. When I went to the university, it was really, really far, because I lived more toward the outskirts on the Pest side, and then there is the Danube [River]. I had to go over the river, and then go north quite a bit on the Buda side.

**LÉCUYER**: What kind of courses did you take when you were at this college?

**VADASZ**: Well, again, they were math, physics. I don't remember chemistry. I keep blocking out chemistry from my head. [laughter] Gee, I really am sorry, guys. Probably you'll pick up and walk out on me. And engineering, mechanical engineering. Some of the elemental stuff, like how does a plow work? Things like the angle of the plow, the speed of the plow, the rate at which you turned the earth. There's actually a science behind all that. I'm not sure that people who had a wooden plow ever knew what the hell they were doing, but they could plow the earth. And then topics like combines, how combines work. We were learning about machinery.

Of course, everybody had to take Russian. But again, to me the most important courses were always in math. It came easy. It was always something that you could use in every other subject you studied. It was a good foundation.

**BROCK**: And the most conceptual of the conceptual things.

**VADASZ**: Yes.

**BROCK**: What was your experience like of the revolution? And could you tell us about leaving Hungary?

**VADASZ**: I think by now you probably get the feeling that I wasn't a kid who was very heavily involved really in anything. I did stuff that was interesting, and the school material interested me. I was a very apolitical individual. I wasn't interested in or knowledgeable about politics. In retrospect, there are certain things that I understand better than I understood at that time.

Between the first year and the second year of college, during the summer, we were on an ROTC-like assignment, as part of our military training. If I would have known what was happening, which I know now, I would have seen signs that something was coming. But I didn't, so I went through the summer kind of clueless. Then the university year started, and I continued to be clueless about what is likely to come, even though, in retrospect, I have a feeling that there were more people organizing than I assumed.

I kind of went along with going to the demonstrations, and going to the front of the Parliament. Our group never made it to the Parliament, because there was so much of a crowd that we ended up in one of the feeder streets, way, way, way away from where the speaker was, and I didn't hear one thing that any speaker said. We were just dangling by. And then we heard shots, and eventually the group started dispersing, but not in a panic. People were pretty deliberately going home, and then you began to see more and more evidence of people with guns, people showing flags from the window with the Russian hammer and sickle cut out of it, and more and more evidence that there is something—there is an uprising here.

Frankly, one of the most disturbing sights that I remember from that night was when we came to a corner and there was a bunch of people sort of dangling about a bonfire. Then you got closer and you could see that they were burning books. And, frankly, that bothered me. It didn't matter, almost, what books, but that made me feel uncomfortable.

The pendulum swung, and it was obvious that after the death of [Joseph] Stalin, the regime got more and more open, and finally it got into a runaway situation that nobody could stop. The people wanted a complete overhaul. Things felt good initially. But it was obvious after a few days that it was not going to last, because Russians were coming in. I left in November, late November, which was pretty much after the whole thing was kind of over, and I had a pretty easy time leaving.

**BROCK**: Could you tell us a little bit more about how you made the decision to leave, or what you thought you were going to do?

**VADASZ**: Well, I thought I was going to go to Australia. [laughter] It wasn't to be, and I ended up going to Canada at the first opportunity that I had. I ended up in Montreal, and I had a wonderful experience in Montreal.

**BROCK**: What made you feel that you needed to leave?

**VADASZ**: First of all, they were very uncertain times. I still remembered the experiences of the Second World War, and that did affect my thinking. But the other thing was that I began to learn, well before the revolution, that the opportunities in that country weren't very great, as you grow up and become an engineer. You do have an inflated view sometimes—in this case it wasn't an inflated view—that the grass is greener on the other side, and, you know, we kind of idolized the West. In the West there were opportunities to make something out of your life. There was an increasing desire to be there. There were many immigrants in the West, and they had made good. They created a life for themselves. So there was a constant draw, a cultural draw, if you will. But, not having been outside of the country ever, you didn't really know. It was really based on just gut feeling, on imagination.

**BROCK**: Right. And you said your experience getting out was not too terribly difficult?

**VADASZ**: I left early in the morning, like nine-ish, got to the border; by six o'clock I was out. Many people had difficult experiences, what a horrible trial they had to go through. Sometimes I feel that they were watching for me and wanting to get me out of there, it was so easy.

**LÉCUYER**: How did your parents feel about you leaving?

**VADASZ**: Well, my parents were hoping that eventually we'd reunite, but my grandmother lived with us, who was over eighty, and you don't subject an eighty-two-year-old person to such an adventure. But it was emotional.

**BROCK**: So as you left and you were setting out for Australia, how did you get diverted in a quite different direction to Canada?

**VADASZ**:  Well, as part of the story, I left with my aunt and her family, and I was hanging around, hoping that we'd all go to Australia.  My uncle had a problem.  He was quite sick with what later turned out to be a kidney problem.  As the permit to go to Australia didn't come, and the opportunity to go to Canada became available, I, alone, went to Canada.  That's how I ended up in Canada.

They were asking for university students and I signed up for Canada.  By that time it was February 1957.  Remember, I left Hungary in November.  It was February, and in fact it was late February that we ended up going to Montreal.

**BROCK**:  Where were you waiting at that time?

**VADASZ**:  Partly in Vienna and partly in Linz, outside of Linz in a camp where there were old U.S. army barracks.  By the way, we were there together with some people from Yugoslavia whom the world had forgotten for a long time.  That was not a very comfortable experience, because they knew that the Hungarian refugees were treated specially by the world, and the Yugoslavians were kind of languishing there, and so they didn't particularly love us.  Some people did get beaten up. That was not a very happy camp.  But eventually I was out of there and was in Vienna and from there on to my very first airplane flight, to Montreal.

**BROCK**:  Did you have much English at that point?

**VADASZ**:  None.  None.

**BROCK**:  And you went by yourself.

**VADASZ**:  Yes.

**BROCK**:  So what did you do when you arrived?

**VADASZ**:  Well, we were first in a jailhouse outside of Montreal at a little place called Saint Paul l'Ermite, and there was one prisoner.  We were very curious: "What does a prisoner look like?"  I'd never seen a prisoner in my life, so we visited him from time to time.

But it was damn cold there, and then soon after we arrived, McGill University put us up, a number of us, in a little house right next to the campus in Montreal.  They gave us an accelerated course in English, and our teacher was an English lady who didn't speak a word of

Hungarian. We interacted with her for four hours a day for, I think, six weeks. We had an English language book, and a phonetic language book, so that you could sound out the words. That's what got us started.

The next thing I did to practice my English was to read a book, which was kind of impossible because I didn't know most of the words. I had to stop, look in the dictionary, and then go on, and I just wasn't progressing. Finally, after about twenty-five, thirty pages, I just started reading, not understanding many of the words. But what's wonderful is that as you start doing that, your mind starts filling in.

**BROCK**: From the context?

**VADASZ**: You understand enough that, after a while, you start understanding what you're reading. And I think that was a very important element of my learning English.

**BROCK**: So were you with a group, then, of other Hungarian university students?

**VADASZ**: That's right.

**BROCK**: And you were all headed to McGill.

**VADASZ**: That's right. There were others who went to other towns. McGill wasn't the only place, but McGill was a part of this system of bringing in students.

**BROCK**: And was the Canadian government somehow supporting this work with your group?

**VADASZ**: I would assume so. I would assume so. But basically, McGill provided us with room and board, and we were there until early summer; so from the end of February to probably June. May, June, I don't exactly remember. I should have written it down, but I don't have a very good sense of history.

**BROCK**: Did you know that you were going to be enrolling in courses there, in the fall?

**VADASZ**:  Not at that time.  I was kind of on the fence.  First of all, I didn't know whether I could pass an exam.  Second, I frankly didn't know whether I wanted to.  Then I had a couple of summer jobs, which convinced me that I wanted to enroll.

**BROCK**:  Could you tell us more about that?

**VADASZ**:  The first job I had was working in a photo lab.  I didn't mention that one of my hobbies was photography, to the point that I did my own film development.  That's a hobby that started in high school, picture development, and I liked doing that.  I and one of my high school friends were very much into photography.  That was one of my prized possessions, my camera.  So I went to work in a small photo lab, developing pictures.  I remember the very first job, a dollar-an-hour job.  As it turned out, I was sweeping the floor more than developing film, and it got a little bit tedious, so I was looking for another job.

I found one in the outskirts of Montreal, outside of the downtown area, in a heavy sheet metal business.  That's where I had the opportunity to use my high school geometry.  I went there, applied for the job, with very broken English, and they put some drawings in front of me and asked me how would you do what you needed to do.

The work that they were doing was very interesting, you know.  If you make a big barrel from sheet metal maybe of half-an-inch thick, and you have to fit a pipe into that barrel, which is also made of sheet metal, let's say, a quarter-inch thick, and with a smaller diameter, now, you have to basically cut out the right holes and the right shapes while they are both flat, and then roll them, and the two have to fit together once rolled.  Now, you basically have to take a drawing, which is a finished drawing of a barrel with a pipe going into it, and project it out to see how it would look if it was flat, which is descriptive geometry.  I just couldn't believe that I was using something that I learned in school. [laughter]  That is wonderful, and suddenly I increased my hourly earning power by eighty cents.  I went from one dollar to one dollar and eighty cents per hour.

But I also learned that there's something beyond that rainbow, and that I'd better continue with my education if I wanted to do something with my life.  So I applied to McGill, and I had to take a math test, but I didn't have to take an English test, and that really saved me.  That was McGill's way of giving some allowance to the fact that we were foreigners who did not have a good command of the language.  The math was easy, not an issue, so I started in the fall of 1957, as a second year student.

**BROCK**:  When did the shift from mechanical to electrical happen?

**VADASZ**:  Well, at that point I was studying engineering physics, which included electrical engineering.

**BROCK**: Oh, so from—

**VADASZ**: Right from the beginning.

**BROCK**: What was behind that switch away from the mechanical?

**VADASZ**: I think it's more understanding and getting fascinated with the electronic world around you. It's more environmental. Especially the subject of solid-state physics and creating these electronic blocks very much captured my imagination, and I was interested in that subject at an early phase of the solid state electronics business. Now, I didn't realize how early early was. I mean, some of our studies of transistor theory were from the notes of the professor who was writing a book on it. It was really early. I still remember Professor [Gerald W.] Farnell, who was going to publish a book, and he was probably a couple of chapters ahead of where our class was.

**LÉCUYER**: So had you been exposed to transistors in Hungary?

**VADASZ**: Oh no, no, no.

**LÉCUYER**: No, it was in Canada that you discovered the field.

**VADASZ**: That's right. That's right.

You mind here if I stop for a second?

[PAUSE IN RECORDING]

**BROCK**: We were talking about how you were introduced to electronics, the transistor, your professor's notes, and the solid state, and you were saying that it seemed to you that this was particularly exciting because it was early days in the field.

**VADASZ**: Early days, and, again, I found the subject very challenging and it captured my imagination. It really helped a lot that I was fortunate enough to be a lab assistant in a physics lab, You have to build the lab gear, have to learn all the lab experiments so you can help the students. This also gave me a much deeper understanding of physical phenomena and the whole subject area. That helped a great deal.

**BROCK**: Was that helping you to finance your McGill education?

**VADASZ**: It was part of my earnings—I mean, I didn't have money. It was partly that, partly summer jobs, partly scholarships from the university. You know, in retrospect I have to say that when I was working in that lab, some of the stuff that I did was kind of make-work. It was the professor's way of helping me to earn some money. I don't know whether he realized that he helped me much more than just earning some money. It made me more desirous to learn the subject area.

**BROCK**: Did you have lab experience, then, with electronics during this time period?

**VADASZ**: Some. Some. Not very much. It was very early times, remember. This was in the late fifties, early sixties, and the kind of lab experience that we had were operational amplifiers and the like. The computer programming that we learned was in assembly-level programming, and we were programming an IBM 650, which was a vacuum-tube machine. That was a different definition of "windows environment." I mean, you took a bunch of cards to a window, and the next day you picked up your results. [laughter]

**LÉCUYER**: That is, when the machine wanted to work. I mean, the machine was very unreliable.

**VADASZ**: Yes, but that wasn't my problem. That was somebody else's problem. When you get back your plot, and realize that the program was not working, you had to figure out what went wrong in your program. But again, that's learning. You understand through assembly-level programming better how the machine works, and so it was all about learning—that's what universities are for, to learn. It's not about you getting the most sophisticated plots.

**BROCK**: What were your main activities outside of the classroom or the laboratory? Working? Did you have any hobbies that you took up in Canada?

**VADASZ**: Not really. I mean, my camera was stolen, so after that, I didn't do much of that. Again, I can't say that I had many hobbies, and I certainly couldn't afford to do things like traveling. Entertainment was maybe going to a movie or watching TV. Things like winter sports or anything like that I took up when I was in California, not when I was in Canada, which is kind of odd. [laughter]

**BROCK**: Did you find, then, over time that the electrical engineering course work and practical work, if you will, was coming to you as easily as the mechanical had come to you before?

**VADASZ**: Reasonably so, but not to the same level, not to the same level. I mean, you have to deal with a different level of abstraction, and I never was that interested in things like ham radio or constructing electronic things. I was interested in my mechanical toys. So electronics never became a hobby for mine. But I think that I found that, just like in the mechanical areas, being able to visualize the physical phenomena and that was a very important part of understanding. And I always felt it was more important—this may sound ridiculous—more important to understand how a device worked than how the circuit worked.

**BROCK**: What do you mean by that? I'm not sure that I—

**VADASZ**: More important to understand how the vacuum tube worked than the amplifier, because from the vacuum tube you can understand relatively easily the amplifier. But if you didn't understand the vacuum tube, it's very hard to understand how the amplifier worked.

**BROCK**: I see.

**VADASZ**: It's more important to understand how the basic physical phenomena in a transistor works than how a flip-flop works, because I can derive from a transistor how a flip-flop would work.

**BROCK**: I see. So if you paid particular attention to understanding how all the components or devices—

**VADASZ**: If the physics works, then the circuit follows.

**BROCK**: Interesting. And that was sort of an approach or a viewpoint that you were developing then, do you think?

**VADASZ**:  I'm not sure that I ever consciously developed it, but as I look back, I mean, I naturally gravitated toward that kind of conclusion.  Maybe it's like the chemical formulas.  I didn't understand enough of how you derive that formula, so I found it not that challenging.  If I would have understood it better at the atomic level, maybe, maybe I would have been more enthused about the subject.  But in the electronics area, I definitely wanted to understand the underlying physics of the devices, and then the circuitry kind of followed.  That's been a very consistent phenomenon as I look back all through my career.

**BROCK**:  Did you have a question, Christophe?

**LÉCUYER**:  Yes.  I was thinking about the course work that you did.  So does that mean the department was oriented towards electronics?

**VADASZ**:  Electronics.

**LÉCUYER**:  So there were not really many electrical machinery courses, for example?

**VADASZ**:  Well, there was some electrical machinery, because, you know, at least at that time, engineering as a specialization was still quite broad.  And electrical engineering was still quite broad, I mean, even though you favored one or the other area.  I think it's probably true today, too.  I remember courses in statics, dynamics, thermodynamics—generally physics courses.  We probably studied it somewhat differently than the physics department did.  And by the way, that kind of argument is still going on in engineering education, just how much of the fundamental courses should you be teaching.  Frankly, I would probably vote for a heck of a lot of it.

**BROCK**:  As your interest in electronics deepened, and your undergraduate years are going by at McGill, how did your thinking develop about your career, or what you were going to do after you graduated?

**VADASZ**:  You know, first of all, you have to understand that I did not have a clue about how a corporation works, so I wasn't a guy very savvy in understanding business or business environments.  I worked at companies where I had a certain job, and I did not necessarily understand how the company worked just because I had a certain job.  I had that hazy feeling—"I will work in engineering.  I will probably work in a research and development lab."

When I started to interview for a job, that's when my first shock came.  I did not find any research and development department that wanted to hire me in Canada.  I'm not sure I even found any R&D labs, in Canada I mean.  American companies had their sales engineering organizations, not R&D.  The job I was offered from Northern Electric, which is the predecessor of Nortel, was a sales engineering job.  There is one thing I knew, that I didn't want to be a sales engineer.

**BROCK**:  Why is that?

**VADASZ**:  There are probably two major reasons.  One is that it's not what I was interested in, but I also think that it was my insecurity about my language skills.

**BROCK**:  Oh yes, that makes sense.

**VADASZ**:  I didn't know any French, and my English wasn't that good.  I felt that whatever sales engineering is, it means interacting with a lot of people on the outside, and I really wanted to use my knowledge and learning to create something.  I felt more comfortable doing that, rather than having to engage others selling them something, and depending on my lousy English and nonexistent French.  As I said, *je ne parle pas français*, which I regret, because I had all the opportunity in Montreal to learn, and I kept making excuses to myself that, well, I'm learning English. This didn't endear me to the local French population at all.  I could have learned French; it wouldn't have been that difficult.  I should have.

Anyway, I interviewed with some American firms, and eventually I got a job offer from Transitron.

**BROCK**:  Were these American firms coming to McGill to do interviews with the graduates?

**VADASZ**:  Yes.

**BROCK**:  And was that Pierre [R.] Lamond who came to McGill?

**VADASZ**:  No.  I have no idea who came, but a number of us were then invited to Boston, to Wakefield, Massachusetts, and that's where I first met Pierre Lamond.  Actually, he's the one who hired me.  But it wasn't an easy decision to leave Canada, because I felt that I got something very valuable from that country, and that I was not really behaving in the most proper manner by just leaving.  I didn't feel that I was giving back, and that was something I felt bad about and I still have some discomfort about.

**BROCK**: Were you weighing the Transitron offer or their interest against interest from other American firms?

**VADASZ**: Well, you know, once I got an offer from Transitron—I mean, I interviewed with a number of companies, but that came in first. I may have gotten some other offer, but it was not significant or it was not interesting. Transitron really interested me. It was R& D, solid state, in a young, aggressive company. That just had all the makings of a good arrangement.

**BROCK**: And at the time, Transitron was really growing very quickly, is that right?

**VADASZ**: It grew quickly. A number of stories were written about their activities. The company was formed by two brothers, the [David and Leo] Bakalar brothers. One of them was an ex-Bell Labs scientist, did some good work, and so it was just exciting from the outside.

**BROCK**: Could you tell us a little bit more about that initial visit?

**VADASZ**: It wasn't a "wow." It was, you know, interesting walking around the halls and looking into the lab and talking to people, but, I mean, I didn't come away thinking, "I'm in Nirvana." It was a pretty reasonable trip. An offer came very soon after that, a very nice offer at that. I remember that the offer from the Canadian company was in the mid-four hundred dollars a month, and here I am getting this offer from this American company for the mid-six hundred dollars a month. That's a lot of money for somebody who pays several hundred dollars a quarter for tuition. "God, I'm getting six hundred dollars plus a month." It was a great offer in a field that I was interested in. There was not much to think on the offer.

**BROCK**: In the offer, whose group were you joining, and what was going to be the nature of your work?

**VADASZ**: I was joining a research department, which was a very tiny department. This department used to report to Pierre Lamond, but then Pierre left for Fairchild, and then I don't remember how the various reporting structures changed. Again, I was kind of clueless about the organizational structures. But it was a small department, working on some government contracts and on some research related to that. They were basically solid-state physics-related problems.

**BROCK**: Were these silicon devices that you were working on?

**VADASZ**: Well, initially on germanium, then silicon. But again, this was before planar silicon. Initially it was zone-refined. Probably the first silicon structure I worked with was the size of my thumb in diameter, which was probably three-quarter-of-an-inch in diameter. Considering that today we're talking about a pizza-size wafer, that was really tiny. As in most early-phase companies, you have to do experiments from soup to nuts; everything. You had to grow your crystal. You had to build your furnace. You had to build your vacuum-deposition equipment. You had to do the physical experiment; maybe you had a technician. It is not the most productive way of getting results, but it's wonderful learning. It's a wonderful way to really get a feel for the materials processing, the cause and effect between processing and how electrical results happen. In retrospect, I couldn't have gotten a better education for the semiconductor industry than I got during the first couple of years at Transitron.

**BROCK**: So you did all those sorts of activities yourself.

**VADASZ**: Yes, that's right.

**BROCK**: And you were responsible for trying to develop a new device, then? Was that it?

**VADASZ**: Well, I had various tasks. I was slotted into various projects. I can tell you some of the projects I remember. One project I remember was looking at the electrical characteristics of silicon with gold doping. This meant, really, that you tried to get gold into the silicon, and increase the recombination-generation rate in the silicon, and then looked at the AC performance of diodes. How quickly can it switch? Clearly, gold doping affects the characteristics of the silicon. You can create the kind of relationships and process parameters which will influence your diode manufacturing.

Later on, my project was looking at transistor structure with two emitters, which is a chopper. That structure had its own unique electrical characteristics. The problem was, unfortunately, not only that planar technology was at an early phase of development, but Transitron never really mastered planar technology. I mean, it turned out to be one of the companies that was a one-trick pony. As technology moved on, and Fairchild was the originator of the planar technology, many companies couldn't really master it in a timely enough manner. That was really the undoing of Transitron; it never really mastered planar technology. So my work on double-emitter choppers didn't go very far.

Then I got increasingly interested in metal-oxide-semiconductor transistors, MOS transistors, and so we started some laboratory experiments—

[BREAK IN RECORDING]

**BROCK**: We were talking about the MOS transistor work.

**VADASZ**: Yes, I ended up publishing a paper with one of my research associates there, and that, I think, was my last technical work there. Along the way I also worked on a Sandia project where we had these big high-voltage diode packs, more than one diode in a pack, for—I think it was for the Minuteman Program.

There's a funny story associated with that work. I needed to make a presentation at Sandia, and we had these five-packs and ten-packs. I was giving my presentation about these five-packs and ten-packs, and for some reason people started laughing, and I couldn't figure out what the hell was funny. Later on they told me that, well, Tampax was a feminine hygiene product. [laughter] I was not pronouncing "ten-packs" right.

But these were the kind of projects that I was working on. It was in late 1963, early 1964, that I was getting restless. I was getting restless for a very simple reason. I was in a very small department, with very few researchers, and I felt that I was not really learning from my environment. That really bothered me because I started to be pretty conscious of the fact that, you know, I'm only two and a half years out of college, and there has to be more to the field. I started interviewing with other companies.

**LÉCUYER**: Before we move on Fairchild, I was wondering whether we could talk more about Transitron. How do you explain the fact that Transitron never really mastered the planar process, or the planar technology?

**VADASZ**: Well, you know, having the benefit of hindsight, I think what they were doing wasn't unique to Transitron. Many other companies fall into that trap of not being able to adapt to new technology. You have to change your method of operation. They knew how to operate for a certain stage of technology. They just did not adapt, did not get the right people, did not make the right knowledge commitment or financial commitment. And whereas in one area, in their original area, they were leaders, in this new area they were a distant follower, and never could really gain the position that would have allowed them to invest more. The various managers came and went, and came and went, and none of them achieved results. I wasn't the only one. There were many others who left before me, like Pierre Lamond, later on Dick [Richard] Bohn, and people like Nick DeWolf, and [Alex] d'Arbeloff, people who created significant companies, but for whom the Transitron environment just didn't fit. I mean, Teradyne was basically started by Transitron people. Fairchild also benefited a lot from people like Pierre.

**BROCK**: Do you think part of the problem with adopting the planar technology was that, as I understand it, Transitron doing a lot of second-sourcing of products, maybe for companies that weren't using the planar technology? Was that sort of a big part of the business?

**VADASZ**: No, I think it was when you are a "me too," you'd better have something to bring to the party so people buy from you, and they never had anything to bring to the party. I mean, when Fairchild introduced the new planar transistor, they tried to match the characteristics of that planar transistor, so they were six, nine, twelve months later, and with an inferior second-source device. You know, you don't get too many good customers that way.

In virtually any technology area in the semiconductor field, you make the best money out of a device in the first wave of its introduction, not two years later, because by two years later it's a pretty obsolete device, and there are new waves of devices that are capturing the new markets. If you are not there close enough to the initial introduction, forget it.

**BROCK**: Do you think people, even at this time, were aware of this dynamic, the economic dynamic?

**VADASZ**: Were they aware? I don't know. I mean, I was very far away from decisions, and certainly the people who were in charge, they didn't really make me feel very comfortable that there was a future there.

**BROCK**: So you had these concerns, and you had the concern that you really weren't learning enough about the cutting edge, let's say, and you started to look around at other firms. Were you looking around Boston and California, or where were you looking?

**VADASZ**: Okay, I can tell you. Westinghouse Research Lab in Baltimore; IBM Research Lab in Poughkeepsie; Sperry Research Lab in western Massachusetts, I think Springfield.

**LÉCUYER**: North Adams?

**VADASZ**: North Adams, yes, okay. Fairchild R&D in Palo Alto. I don't remember others. I remember these four. I got job offers from all four, and obviously, there was no question that if I got a job offer, I'd take Fairchild, because that's where things were happening. That was the heart of technology in the Valley; I mean the world. That's where new technology happened, and so there was no question where to go.

**BROCK**: Could you tell us a little bit more about the dialogue that you had with Fairchild then, leading up to you joining it?

**VADASZ**: Well, I was invited to visit the lab. I remember talking to a number of people in the lab. Pierre Lamond was one. I remember C.T. Sah was one. He probably doesn't remember me. That was a very unsatisfactory discussion, because I could never read what he was thinking, and he asked few questions. I tried to answer, but it was just—and I don't remember who else I talked to. I was offered a job. I came out in February of 1964, and I started my job sometime in March of 1964, so, it happened pretty fast.

**BROCK**: You're joining the R&D labs, obviously. Were you joining, then, the physics group?

**VADASZ**: No, no, no. I was joining one of Pierre Lamond's departments. It was, in fact, some integrated circuit group. We were working on CTL [complementary transistor logic]. It was a new kind of logic circuitry that Fairchild was doing, and I was working in that group on bipolar circuit design. I learned a lot about both bipolar and circuit design. Most importantly, I began to understand the industry. I suddenly started to deal with computer companies, representatives of computer companies, and started to understand the industry dynamics.

**BROCK**: Was that in the context of trying to define the customer needs for this sort of CTL logic?

**VADASZ**: Well, you know, again, that was relatively early time in integrated circuits. Logic blocks, before integrated circuits, were really the domain of computer companies. So you were beginning to see the shift of the responsibility for logic blocks becoming part of semiconductor companies, and shifts like this are not easy. A lot of frictions happen, because it's kind of "who's on first." The logic department of a computer company can easily say, "Hey, I'll tell you what to build. Don't tell me what I should buy. It's my responsibility to design logic blocks."

Of course, again going back to first principles, when you understand how devices work in an integrated structure, you can create the circuit in a more effective way than when you buy off-the-shelf components—where multiple worst-case characteristics fit together and create the circuit. So there was no question that semiconductor companies were beginning to be in an increasingly stronger position to create the foundational elements of computers, that is, the basic circuits, the basic circuit building blocks. That was when that shift was happening, and it was very interesting to learn.

By the way, that process is still going on. It took the personal computer to really drive home the fact that in computer design, there's more computer design going on at a company like

Intel than at any other computer company in the world, including IBM, Dell, HP, and others. That shift was the next shift that occurred later on. I think that these are very important shifts in the industry, but it was very interesting to participate in how this all worked.

**BROCK**: So in this first wave, if you will, of that change, let's say around 1964, that you find yourself getting into a situation where the technology that's being developed in the semiconductor firm opens up new and different possibilities for them to design circuits.

**VADASZ**: That's right. And as you capitalize on it, you're going to trample on some of the customer groups who feel that it's their responsibility to do what you are doing; you are trampling over their responsibility. On the other hand, when you do this, you're coming in with an economic proposition which is irrefutable. Many of the customers are between a rock and a hard place. Are they going to change the way they design their product and adapt to these new technologies, and basically eliminate the need for many of the functions and much of the 'proprietariness' of their old value proposition, or are they going to be stuck with a much higher cost structure, and just pursue design on their own and try to create a proprietary advantage? And is that really an advantage? That's a struggle. Again, that results in many companies getting flushed down the toilet, those that cannot adopt, I mean adapt.

**BROCK**: Maybe both, in that case. [laughter]

**VADASZ**: That's right, yes.

**LÉCUYER**: That period was also the time when there was the war of the logic families, right?

**VADASZ**: Oh, yes, the DTLs [diode transistor logic], CTL.

**LÉCUYER**: And CTL is one of these that never really bloomed, right?

**VADASZ**: No, CTL never really became the logic structure of choice. I think that, at least in the R&D department, they were much more hopeful for it than what it really turned out to be.

**LÉCUYER**: How do you explain the fact that CTL didn't bloom, and that TTL [transistor transistor logic] really became the dominant one in the industry?

**VADASZ**: How do I explain the fact? I think Gordon [E. Moore] could probably give you a much better explanation than I can, but I think the main reason is that Fairchild R&D had a very hard time transferring technology into the manufacturing side of the house, and basically, the marketing and manufacturing side of the house was one company, and the R&D facility was another company. It was a very difficult chasm to cross, and if CTL would have been in a more effective way manufactured and marketed, and just going with it in a more effective way, I think it could have been a more serious contender. As it was, you had as many internal fights as you had with the outside market. But again, that's my opinion from a distance, because, again, I wasn't close enough to the business side at that particular time, and I think that Gordon would be in a much better position to answer this. But there's no question that CTL never achieved the kind of market presence that we were hoping for.

**BROCK**: At the time, though, were you feeling frustration with the transfer to manufacturing, or with the attitude—

**VADASZ**: Well, you know, that wasn't my department, if you will. I saw that was going on, but I thought that was more the frustration of my boss. What I saw, what I really learned was that, "Gee, there is an issue between us and a potential customer, because when we're talking to the engineering people of our customers, there was resistance." At first I didn't understand why. And then it kind of clicked that, yes, we are talking about their role, their job, you know. Here we are talking about semiconductor economics impacting computer design in a way that totally changes the way computer design can happen.

Now, having said that, later on when IBM introduced their 360 line, I think many of us were shocked that IBM introduced the 360 line and basically did it with discrete circuitry. How come they didn't use integrated circuits? What the heck is going on? And we had—at least I had—all the range of emotions about it. "They don't know what they're talking about," all the way to, "We don't know what we are talking about." [laughter] So it was a very confusing thing—a very, very confusing thing—because on the one hand, we were really building the power of the integrated circuit and the economics associated with integrated circuits, and we just couldn't imagine that here is <u>the</u> major company on <u>the</u> major generation of machines not using this technology.

**BROCK**: When did they introduce that 360?

**VADASZ**: Was that 1966?

**BROCK**: I think that sounds right, yes, 1965, 1966.

**VADASZ**: About that time, yes. That was very confusing to me.

**BROCK**: We were just talking about the difficulties with Fairchild R&D and these other sides of the house, as you put it. Would you describe your impression at the time, of Gordon Moore, and him as a leader of the R&D side of the house?

**VADASZ**: We can probably talk much more about the latter phases, but in the early phases, I didn't have a great deal of exposure of Gordon, but the general aura and feel about Gordon was a very high degree of reverence. I mean, there was no other person with more respect in that lab than Gordon. I mean, he was thought to be really the heart and soul and the mind of that lab. That was the feeling at the time.

I probably didn't speak more than two sentences with him during the early time. Later, I got to know Gordon much more, during my other phase in the lab, as well as at Intel. But, you know, there were no cynical comments. There were no derogatory comments about Gordon. There may have been some frustration with the company's inability to transfer, but there was no question in people's mind that they are working on the most advanced technology stuff, under the direction of Gordon, in that lab. So it was just positive.

**BROCK**: In this early period at the lab, did people feel they had all the resources they needed to do what needed to be done to advance their projects?

**VADASZ**: I didn't feel resource-constrained. Now, again, I don't know about the people above me, whether they did or not, but I didn't feel resource-constrained. I was given all the resource and flexibility of doing my job.

[END OF INTERVIEW]

**INTERVIEWEE:** **Leslie L. Vadasz**

**INTERVIEWERS:** **David C. Brock and Christophe Lécuyer**

**LOCATION:** **Los Altos, California**

**DATE:** **19 April 2005 [Interview 2]**

**BROCK**: This is an oral history interview with Les Vadasz, taking place on 19 April 2005, in Los Altos, California. The interviewers are David Brock and Christophe Lécuyer.

As we were just discussing, in our last interview session we had followed you up to joining Fairchild [Semiconductor] R&D [research and development], and you were at Fairchild from 1964 through 1968. Would describe for us the Fairchild R&D operation in those years?

**VADASZ**: First you have to recognize that I was a pretty junior engineer, about three years out of college, so I came in at a starting phase of the whole hierarchy, and I don't necessarily know all the R&D hierarchy. Although over time I learned more about it as my position advanced. I think we talked about it before that in a serendipitous way Pierre Lamond, who was involved in hiring me at Transitron, was also involved in hiring me at Fairchild R&D, in a building located on the corner of Arastradero and Junipero Serra. It was quite far away from the manufacturing building, which was down in Mountain View near [Highway] 101.

Strangely enough, either before or very soon after I joined, Pierre left again, and this time left for National Semiconductor [National Semiconductor Corporation], which was quite an event. It created quite a stir there. For a moment I thought that maybe I had something to do with chasing him from one place to another place to another place, but I'm sure that was delusion of grandeur on my part. [laughter]

I joined a group which was developing a new kind of integrated circuit called CTL. It was supposed to be a higher-performance product than what the current volume was in the integrated circuit product in the market. For reasons not totally clear to me, it never really caught on as a major market force. There was the early DTL, then there were TTL, which I think was a product of TI [Texas Instruments Inc.]. Then there was some very high-speed circuits called ECL [emitter coupled logic]. I think CTL, if my memory serves me right, was supposed to compete with TI's TTL, and I don't think it ever really caught up to it.

There were reorganizations within the R&D lab. At one point I remember becoming part of a group which was doing—it was the digital electronic group under Bob [Robert] Seeds. I would advise you to talk to him, but unfortunately, he passed away, so I cannot do that. So they became more, I would say divisionalized, the R&D area, I guess, for attending to some management issues that Gordon may have felt existed in running the lab.

Another organization was a group that was designing computer systems. They invented a new kind of computer called—was it Symbol? Anyway, somebody by the name of [Rex] Rice, I think, was the head of that group. You know, I really need to think about what was the relationship between the group I was in under Bob Seeds, and the other group, but I think they were going to use CTL as the logic for their computer.

Then there was a sector created around MOS technology, and I became the head of this sector. Obviously, part of the work was trying to use MOS in logic circuits. I became a very strong advocate. In fact, I had some experience at Transitron in thinking about MOS technology. And I had a paper with one of the guys there, on MOS. So when I came to Fairchild, even though my first work wasn't in MOS, I kind of gravitated toward that, because it interested me; I felt that was the future of the electronic business.

**BROCK**: Could you talk a little bit more about that? It strikes me that that's quite early on to become a convert. Could you tell me a little bit about how you first encountered the MOS concept, and the paper at Transitron?

**VADASZ**: Well, I assume that I either heard about it at a conference, or read about it, and suddenly, since I was in a small R&D group and we had a fair amount of flexibility of what we did, what we worked on at Transitron, David Root and myself started to work on this. I believe David was my supervisor at that time. We published a paper where we tried to understand the temperature behavior of the electrical characteristics of MOS.

You have to understand that what I tried to do in all of these areas was relate how a device behaved in an electronic circuit, to the physical parameters of making the device, or the chemical parameters, whatever. The fundamental parameters of creating the device would behave a certain way in an electron circuit. And so later on at Fairchild, when I continued in this area, a significant part of my work was to create some CAD [computer aided design] capability. Again, I think I have a paper with Dov Frohman on that, using the physical parameters of MOS devices to derive the electrical behavior of those devices in circuits. So using those parameters that you measure in the manufacturing area, in effect, plugged it into the program and then you could understand how your circuit will behave.

**BROCK**: So the design tool was really translated from that sort of physical process to its function. Interesting.

**VADASZ**: That's right. Yes. That's right. And that was pretty important work, and I think that if you look at CAD today, that was fundamental to doing today's CAD, using the measurement parameters that you do in a manufacturing setting, and relating it to the electrical parameters. You know, you could min-max it, and you could develop min-max characteristics of the circuits. So I had a fair amount of my early work in that area, in one way or another. I also had a paper, I think with Andy [Andrew S. Grove], on another configuration of MOS transistor and its behavior, based on physical parameters.

But to cut the story short, I don't remember all the sequences. But then I was heading this MOS technology group, and we had a private developmental manufacturing line of our own. We had some design capability. One of the first projects that I remember was trying to do a self-align gate structure, self-align meaning that you create a gate, gate electrode, and then use that, in a way, as a diffusion mask for the source and drain, so you don't have an alignment issue there, because every time you have an alignment issue, you're not only paying for it in silicon area, but also you have parasitic capacitances to account for.

So we were trying to do this. My view here is pretty scattered, because I don't quite remember the sequences. But this was around 1967, 1966 or 1967. Anyway, we were trying to use some refractory metals like molybdenum as the gate material, and the idea was that they should be able to withstand more [high temperature] processing, so we would use it as a diffusion mask. Well, nothing worked. It was a mess.

That was around the time when I heard about silicon gate. The way I heard about silicon gate was an interesting process. Fairchild R&D had this structure that when your scientists went to conferences, they came back and reported to an open group about what they heard. And I remember Ed [Edward H.] Snow—by the way, another person that you may want to talk to—reporting on this interesting process that he heard from a couple of people from Bell Labs. I remember the end of his discussion was that, "Yeah, and they also said that this process is discontinued. They're not interested in it anymore." So it made a nice paper for Bell Labs, but basically it was thrown into the garbage bin.

Again, when I looked at the structure I was really fascinated. I thought that that really had to be something that gave us virtually all that we were looking for—high-temperature processing, self-aligned, and also burying the whole structure under silicon oxide; you look at it and your intuition tells you, "This is more manufacturable than anything else that we have done before." And again, that concept was really very important, at that point in time MOS transistors were pretty difficult to manufacture because they were unstable, they had a reliability problem.

In fact, some of the early work that was done at Fairchild R&D, which I found out later, really resulted in a number of spin-offs who tried to do MOS. And why did they do that? Probably because Fairchild had difficulty getting their head around how to capitalize on the technology in the manufacturing environment, so they went out on their own. I remember people like Frank [E.] Wanlass, who left before I came, and that was the genesis of AMI [American Microsystems Inc.], I think, that started AMI.

**LÉCUYER**: I think he worked in GME [General Microelectronics], right, and then—

**VADASZ**: Was it GME?

**LÉCUYER**: I think he worked in GME. Then he went to General Instruments, in New York, and then moved back to the south—I forgot which one.

**VADASZ**: Anyway, the point is that while some of the early work was done at Fairchild for trying to understand and make an MOS device more stable, Fairchild wasn't the first one to capitalize on MOS technology. So by the time my group was established, there were companies in the business, and even though it was a difficult process to manufacture, and it had all kinds of potential reliability problems, there were startup companies who were succeeding, of a sort, as a first-generation capability. In fact, that was the rage at that time, of the industry—MOS, MOS, MOS.

I remember that Gordon talked at a conference, and there was a headline after the conference, "Moore Warns About MOS Enthusiasm Danger." [laughter] And me working on MOS, I kind of said, hmm. But, you know, he was right. There was incremental improvement in the bipolar area. MOS was kind of struggling to gain ground, and not only was it a technology in trouble, but also in many areas, technology looking for application. It was a very slow product, compared to bipolar. You had to niche it to areas where its performance capabilities were going to fit.

So it was one of those typical oversell that our industry has done—I'm going back and forth here—that everyone was enthused about it, but, you know, it really was not performing according to expectation. And so I think that for some reason—it must have been that both Gordon and Andy believed enough in my ranting and raving about silicon gate being the technology, that I basically started to run that in our line, worked in a development line, and hired a fellow from Italy by the name of Federico Faggin. In fact, we even presented a paper—I think it was in February 1968—at the International Solid State Circuit Conference, that was using silicon gate.

But, you know, interestingly enough, even though my early hope was that this was really about eliminating the manufacturability issues, reliability issues, gaining circuit density, plus gaining performance, we couldn't make the damn thing! I mean, it was very difficult to do anything, and while at Fairchild, I never really understood why we couldn't make it work. I mean, we worked and worked and worked at it, and when I left in August 1968, there wasn't a process that was a viable process. Yet, you know, I guess I must have been a pain in the neck enough to convince Gordon and Andy that Intel should really be starting with that technology. But as it turns out, we had another year before we could make it work. There were all kinds of minor details that inhibited you to make it really work.

But back to Fairchild. I remember some little vignettes, stories about this difficulty of R&D to manufacturing transfer. I went to one of the marketing guys in manufacturing and talked about a product that we were going to use as a vehicle to try to transfer this new process, silicon gate process, and to manufacture it. I'll never forget his reaction, and it stayed with me, which is still kind of incredulous. But his first question was, once he understood what I was doing was, "Well, how many millions do you think we're going to sell of this?" He missed the point, or I missed the point. I mean, obviously he was in the business of selling millions of whatever, and my business was to have a practical enough vehicle to transfer the technology from an R&D organization to a manufacturing organization. And to me, I think that this chasm between our thinking in the R&D organization and their thinking in the manufacturing world had a lot to do with the big gap, the big divide. You know, new ideas start small. You have to nurture them. You have to be able to move them along, you have to protect them, and you have to give them enough to exist and to try to grow up. You can't have such a marketing activity in an R&D group. You have to have it in the real marketing world. But a real marketing world at that time, in that environment, couldn't care less about a little niche product. They only were interested in home-run products, in products that were going to sell in the millions. Those were generally an incremental improvement on the old. They were never the new.

**BROCK**: Couldn't they understand, though, that their future depended on eventually having a new process?

**VADASZ**: Yeah, but that was somebody else's problem.

**LÉCUYER**: Their sell numbers were quarterly numbers, right? So they needed to get their stuff out.

**VADASZ**: That's right. That's right. And I think that you will find this an ongoing story, and an ongoing problem of corporations. How do you handle the small? Its financial impact is in the roundings, yet the pain associated with it is quite a bit; there are all kinds of problems with the "small new things." I think that that was a problem, and it probably is today, the problems of most large companies. And I think that was a very important lesson to me, and maybe that's why I remember. You need to create a nurturing environment for something new that can transition into the mainstream of the company, and it's always hard.

Now, other things back at Fairchild that were interesting: I started to work with a fellow on the other side of the aisle, the systems side. It was, I think, in Rice's organization, a guy by the name of Wendell Sanders. We created I think one of the first ASIC CAD [application specific integrated circuits] [computer aided design] capability. The concept was basically to define a rail on the chip, and put different circuits on that railing, and the metal rail was basically the interconnection. Then depending on the function, you put different integrated circuits on them, and those cells were a constant dimension in the vertical, but variable, depending on the function, in the horizontal, and this way you could create arbitrary functions using ASIC. And that was probably one of the first ASIC technologies. If you looked at integrated circuits today, that concept is still used. Then we had a paper on that at a conference.

**LÉCUYER**: What kind of technology?

**VADASZ**: MOS. Again, you know, it's one of those things that happened that Fairchild didn't take advantage of it, never got into that business, so it just went away and eventually picked up by others and used.

**BROCK**: I was wondering if the MOS technology group that you were directing, did that start in 1966, 1967, approximately?

**VADASZ**: I think it had to be 1966. There was another fellow there who was responsible for the technology side, a guy by the name of Tom [Thomas ] Kline. Tom is around this area somewhere, but I lost track of him.

**BROCK**: When you said that he was in charge of the technology side—

**VADASZ**: He was part of my group.

**BROCK**: So was he responsible for the line?

**VADASZ**: I believe he was responsible for the line. I believe, but my memory is very—

**BROCK**: Had you been following the work coming out of the collaboration of Grove, [Bruce] Deal, and Snow?

**VADASZ**: Oh, well, you know that work was a bit earlier than my involvement with the MOS at Fairchild. So to me, when I started to get involved with the MOS at Fairchild, that was kind of the bible. That was kind of the foundation. I learned it. It made sense to me. So it was just there as—

**BROCK**: Did you need to draw on them individually as resources for your work?

**VADASZ**: Not really, not really, because they were in the physics side and I was on the product technology side. But again, because of my affinity toward physics and device parameters and hence to electrical circuits, obviously I dealt with them quite a bit. In fact, we became good friends over time.

**LÉCUYER**: If we go back to the MOS group, were you reporting to Bob Seeds or Gordon Moore at that time?

**VADASZ**: Bob Seeds.

**LÉCUYER**: So it was part of the integrated—

**VADASZ**: That's right, yes. And, frankly, my visibility of Gordon Moore wasn't very much at that time. As that group was working—and, again, Gordon probably remembers it better than I do. I don't even remember how it came about that Andy became the assistant general manager of the lab, but there was some reorganization.

**BROCK**: I think the story is that Pierre Lemonde made him an offer to go to National.

**VADASZ**: It may have been. I think that Andy had some frustrations about the transfer of technology, or lack of. The time I really started to get direct exposure to Gordon was when there was another attempt—one of the many attempts that Fairchild decided that they're going to get their act together in MOS. They created this group in the manufacturing area, and a guy by the name of [Charles] Sutcliffe was heading it, and then there was a guy by the name of Lee Boysel working for Chuck Sutcliffe, and their bright idea was, I think, "Well, why don't we just copy what's out there and get into the business." So I think that there was some attempt of doing that.

I don't know how it came about, but there was an R&D/manufacturing task force created, in which Sutcliffe, Boysel, Gordon, and myself were a part of. So at that time I must have already been heading the MOS technology group. But that's where I had direct exposure to Gordon, because I went to meetings with Gordon.

**BROCK**: Does anything stand out from that?

**VADASZ**: Yes. That was the first and last time I heard Gordon swear. [laughter]

**BROCK**: Could you tell that story?

**VADASZ**: Gordon had a habit of doodling on his Styrofoam cup with his ballpoint pen. And as he did he pierced it with the ballpoint pen, and the coffee spilled on his tie. And I think that the word was "shit." That's about—I mean, I have known Gordon for, I don't know, over thirty years, and that's the only swear word I've ever heard him say. [laughter]

But they were not very good meetings. They were kind of group-grope. We tried to engage, but we had our own strong ideas. They tried to engage. They had their own strong idea. I think, in retrospect, we were just two ships passing in the dark. I don't think that any of us got a great deal of confidence about the other guy's operation. Then we left Fairchild. And, unfortunately for Fairchild, in that effort we never moved them into the MOS business in any significant way.

**LÉCUYER**: Because the other group, the manufacturing group, left as well, around the same time.

**VADASZ**: I think that kind of dissipated also, and I don't think anything ever came of it. I know Lee Boysel left and created a company called Four Phase Systems. Sutcliffe left, and I have no idea what happened after that.

**LÉCUYER**: If we go back a bit in time, how big was your group? How many people were reporting to you in the MOS group, in terms of engineers, technicians, and people on the line?

**VADASZ**: Probably one to two dozen people. It was a relatively small group.

**BROCK**: And your pilot line was at the R&D lab?

**VADASZ**: And again, you know, that was the way things worked at that time, that you created your own pilot line. I'm not sure that was the most effective way of doing it, but that's the way we did it. There was a bipolar pilot line and there was an MOS pilot line.

**BROCK**: At that time were you able to purchase most of the required equipment from outside?

**VADASZ**: It was a mixture. During my career we had really gone through a very interesting evolution of the equipment industry. When I started at Transitron, we made our own equipment. We had jigs manufactured to our needs, which attached to off-the-shelf equipment, like microscopes with some jigs that you got some local shop to manufacture were the mask alignment jigs. And, you know, you built your own furnace sometimes. I remember having to do my own furnace. It was a great educational experience, but I'm not sure that that was the most effective way to do development.

You could buy evaporation equipment, but they were initially not made for the semiconductor industry, and they were quite limited in what kind of vacuum you could draw. They required continuous tear-down and rebuilding, tear-down, and rebuilding. I remember at Transitron most of my technician's time was just babysitting the evaporation gear. Step by step. I mean you built your own tester. But, step by step, the industry started to develop, and there was the initial debate, do you make, or buy? Do you make or buy? Initially, you considered that as your competitive advantage, to make your own. Well, eventually—very fast you realized that that's just not affordable as things got more sophisticated.

One of the first test equipment companies was Teradyne, which was a spin-off of Transitron. Again, test equipment design people thought that, gee, there was a business opportunity here. If we need test equipment, everybody must need test equipment. So you could see the development of the horizontalization of the industry that suddenly you could start buying the gear that you needed. And you had to get very conscious about, okay, if we make it, what is my value-added?

When we started at Intel, we didn't even do our own wafer. We bought our wafers, and, you know, for some that was an absolute no-no. How do you know that you're going to get the right cleanliness, right defect density, right flatness, right everything that you specified? People will compete for your business. And indeed, that became a commodity supply. So at Fairchild I think we were in that transition phase of using some in-house made equipment, but increasing using a number of off-the-shelf purchased equipment.

**LÉCUYER**: If we go back to the two different MOS groups, your group and the group in manufacturing, would the equipment be similar in both groups, or would it be different, and if there was a difference, could it explain the difficulty in communicating between the two groups?

**VADASZ**: I don't know, but my guess is it was probably different, again because the two groups may not have talked with each other, or if they did, probably it was, "We will do this, and I guess the other will do that." [laughter]

**LÉCUYER**: Because the equipment is really critical for transferring anything, right?

**VADASZ**: That's right.

**LÉCUYER**: So if the other guy had different equipment, you can't transfer your process. It's impossible.

**VADASZ**: Yes, yes. I don't recall. But you know, we thought about that issue very much at the beginning of Intel. That was a big decision, in my mind, that we will not have a central R&D, because we wanted to really have a flow of people and knowledge from area to area, so that you minimized the transfer issues. Over time I got increasingly convinced that that was one of a handful of issues that every company needed to work out or they won't succeed. How do you transition technology from one area to another? You can't just throw it over the transom. There was a tendency to do that—and you can do that in areas where things were well defined. But when things were leading-edge technology, where you may not understand all the secondary or tertiary effects, you couldn't do that.

**BROCK**: At Intel in the early period and thereafter, did the co-location of R&D with manufacturing help with that equipment standardization issue?

**VADASZ**: Oh yes. There's no question about it, no question about it.

**BROCK**: It was the same stuff in the same place.

**VADASZ**: That's right.

**BROCK**: That's interesting. To go back to the Fairchild MOS program once again, it strikes me that Gordon Moore seemed to have a particular attention or interest in the MOS developments. Do you think that's true, or did you see any signs of that?

**VADASZ**: I think Gordon Moore increasingly spent more attention to it. I mean, it was a black eye for Fairchild that the foundation of real knowledge on how to make MOS work came from Fairchild, and Fairchild wasn't in the business. You know, I mean, putting myself in Gordon's shoes, looking at all the good work that my lab had done, I would have been very, very frustrated with the situation, so I am not surprised that his attention was more and more in that area. But, you know, the R&D lab was a big lab with many directions, I mean from microwave to light-emitting diodes, to computers, to even some RF stuff. I mean, there were lots of things going on there, and in retrospect, given the size of Fairchild, that was probably spreading way too wide.

**BROCK**: From your vantage point during those years, was Robert [N.] Noyce a presence at all? What was your impression of him, if any?

**VADASZ**: Not very much. I remember listening to some of his talks to the R&D group, talking about the company, talking about the business. He was a very engaging speaker and commanded a lot of respect, but as far as my operational knowledge of him, I really didn't have virtually any. I mean this was really the sad part, that the business part of Fairchild was a kind of a different world. In that R&D building we did our own thing, and the only times I really got over to the other side was on this task force, and the one time when I tried to peddle MOS technology to one of the marketing guys in operations. Otherwise, you know, I was in my little world. I think it wasn't good. It wasn't one company.

**BROCK**: Did you have any other questions here, Christophe, before we move into the—

**VADASZ**: I have a question. Did you get the same impression when you talked to others in Fairchild R&D?

**BROCK**: Very much. I would say everyone has that same impression, with varying degrees of empathy for what was going on, on the other side. But for some people it was—correct me if I'm wrong, Christophe.

**LÉCUYER**: I talked to Pierre Lamond about this in the past, and for him it was really a matter of turf warfare between the people in R&D and the people in manufacturing, who was going to develop the products? Was it manufacturing? Was it R&D? So there were lots of tensions about lots of topics.

**BROCK**: But that transfer frustration seems to be uniformly felt.

**LÉCUYER**: Actually, it's interesting that when Lamond and [Charles E.] Sporck left to National [National Semiconductor Corporation], they decided not to have a research and development lab like Intel. They decided to develop their products on the manufacturing line. So I think there must have been a very widespread unhappiness with the setup at Fairchild, and when the various groups left, they decided not to reproduce the same setups. That's my impression.

**VADASZ**: Yes.

**BROCK**: Could you describe for us the story of how you came to learn that Moore and Noyce and Grove were leaving to start a new company?

**VADASZ**: You really want to know that?

**BROCK**: I do.

**VADASZ**: Well, it wasn't on a very happy occasion. I was coming back from Montreal from the funeral of my father. My wife was waiting for me at the airport, and almost to the word she said, "Guess what? Gordon Moore and Bob Noyce left Fairchild."

I said, "Hmm."

"And Andy went with them." That really got my attention. And then, "And they want to talk to you." So this is how.

**BROCK**: They had called for you while you were away? So who did you then call?

**VADASZ**: I talked to Andy, and then talked to all three of them, and had to think about it for a very long time, like five nanoseconds. [laughter] I felt very happy about being called. You see, I asked myself a number of times, what was the downside in a decision like this? I mean, it was a no-brainer. You were going with people who you respected, some of the most brilliant [men] that you've ever known in the business, and you're young and have a pretty strong feeling about your own capabilities. If it doesn't work, I mean, you've still got your capabilities. You've still got your brain. If it works, it's a great thing. So I think the logic for deciding right away, "Let's do it," was very much there.

**BROCK**: And the reason you called Andy Grove first was because the two of you had developed a personal relationship?

**VADASZ**: Yes. We socialized a few times. We were friends. Andy came up to me once in the cafeteria when I joined Fairchild in 1964, introduced himself, and with his Hungarian name, Grof, and I couldn't figure out what he was saying. Finally it came to me that he was Hungarian. Then one thing led to another. Our families were, and continue to be, close, and we both had, I think, a high appreciation of the other guy's capabilities, and that was it.

**BROCK**: At that time, how would you have assessed what Andy Grove's real capabilities were that had impressed you by 1968?

**VADASZ**: His rigor, his rigor of thinking. He had to understand. I mean, he didn't take just other people's word. He kept asking. He drove you nuts. He'd ask you why. "Okay, I don't understand. Why?" And that rigor was different than most R&D people that I've ever met. He had no experience in manufacturing, but he had sort of this basic capability of just getting to the bottom of things. I think that was unique, and, frankly, I think it's still quite unique.

**BROCK**: When the four of you then met, you, Grove, Noyce, and Moore, did you discuss both what they thought the new company might set out to do and what your role would be?

**VADASZ**: Yes, yes. It was, again, very much fitting with my understanding, my view of the world, so it was a relatively easy thing. Their view was that technology has advanced enough that you can make very large-scale integrated circuit to the point of thousands of components, and that there was a function in computing that was very logical for this level of integration: memories. The company ought to be in semiconductor memories. It's a new field, and we ought to be focusing our effort on that area, making a business out of semiconductor memories, which was a zero-billion-dollar business at that time.

[END OF AUDIO, FILE 1]

**BROCK**: We were talking about the discussion of setting up the new firm to pursue semiconductor memory. Was there a discussion also at that time about which technologies the company was going to pursue?

**VADASZ**: Well, I was pushing MOS and I was pushing silicon gate MOS. There was certainly a buy-in by both Gordon and Andy. I don't think Bob was exposed to that enough to really have a very strong opinion one way or another. My role was going to be head of MOS engineering, and that's the way the whole thing started.

On 1 August 1968 we opened the door. I remember part of the day I was at Intel, the other part of the day I was moving from one house to another; I was just buying a house. I remember at one point Grove came and helped me move. [laughter]

**BROCK**: So what was your initial title at Intel? Did you have any real organizational structure?

**VADASZ**: Yes, we did. I was manager or director of MOS engineering. My first job was to try to buy some furniture, try to buy some equipment, equip the lab, have some drafting capability, set up a mask development area, cutting room. I don't know if you're familiar with the cutting tables—

**BROCK**: Sure.

**VADASZ**: —and those kind of things. Hire some technicians, hire some engineers, and start to go to work. My role was parallel with Gene [Eugene] Flath whose job it was to set up the manufacturing capability. He was equipping the lab with diffusion, masking, etching, all kinds of process equipment.

Then we hired Bob [Robert F.] Graham, who came on as a marketing guy. John Cobb came on as a finance guy and there was a fellow from Stanford by the name of Ted [Marcian E.] Hoff who seemed like a good addition. He was not really experienced in the semiconductor industry, but he was a very bright fellow and he came onboard with the very hazy title of "applications research," whatever that means. Later on that paid off very well, as you know.

And what else? I think very soon after we started, an opportunity came to do some bipolar memories, some high-speed memories for the Honeywell Company in Framingham [Massachusetts]. That's when the bipolar engineering team was hired. A guy by the name of Dick Bohn was hired as head of bipolar engineering, and then I think it was around the time also—I think Ted [Robert T.] Jenkins and maybe Gerry Parker—I don't remember when that was, whether it was 1967; no, 1969?

**BROCK**: Must be 1969.

**VADASZ**: Yes, 1969. And a little ego bruiser to me was the fact that not only did they rig up a nice little bipolar memory product, but also pulled together a bipolar process in no time, and we delivered bipolar memories before we ever delivered any MOS memories. And by the way, the first bipolar memories were a better product than the first MOS memories. There was more history in the bipolar business than MOS business, but that's rationalization, really.

I think by the middle of 1969 we began to have some doubts about silicon gate, because it just was not yielding. There were a variety of problems, a variety of edge coverage issues, as the metal goes down over the silicon oxide edge. A variety of contact problems also. And again, this is where I think you probably heard it from others, that Gordon started to get more involved in the details, and made some very significant contributions in making the process work.

**BROCK**: Particularly on that metallization problem?

**VADASZ**: That's right, and the contact problem. Yes, both the metallization and the contact problem, I believe. And again, this was a little thing, and there probably were dozens of bright engineers, and on their own they didn't do it. We didn't do it. We didn't, somehow, have the common sense to come up with some of those things; he did. And how do you value that? When you work with him, you value that. When you work with him, he becomes the kind of guy you go to, to discuss your problem with. From the outside it's a little bit more difficult. I wouldn't be surprised that—I mean, I was beginning to be a bit shaky, and I wouldn't be surprised that others were seriously thinking about switching from silicon gate back to the more regular process. I certainly wasn't there yet, but my confidence was shaken that this process could be made to work.

**BROCK**: Just because it was taking longer than you thought?

**VADASZ**: That's right, much longer, much longer. You know, just one little nit-shit detail after another. After a while, the manufacturing people had that cynical smirk on their face about anything you fiddled with, and it was not a comfortable feeling.

**BROCK**: But it wasn't the case that anybody else had the silicon gate process going at the time?

**VADASZ**: No, which didn't necessarily give you a great deal of confidence if you're just banging your head to the wall and saying, "It's not working, it's not working."

There was a fellow by the name of Tom [Thomas] Rowe also in the manufacturing line, working for Gene Flath, who was very heavily involved in the process development.

**LÉCUYER**: So the process development was done both by your group and the manufacturing group?

**VADASZ**: My group was not a process development group. My group was basically working with the process development on the electrical side, trying to develop the product. But since I worked on the process before, it was an overlapping area. That was one of the beauties of those early times of Intel. It was nothing like the Fairchild world of the big manufacturing machine and the R&D acting separately. It was an overlapping activity, with distinct responsibilities.

**LÉCUYER**: So what were the products you were developing then? They were shift registers and—

**VADASZ**: No, the first product was a 256-bit MOS memory. And we introduced that product in 1969. It wasn't a great product and we also had a hard time identifying big markets for that. But it was kind of a foot in the door and it started things going, and very quickly after that we decided to develop some products that were already on the market. Second source, a better second source. That's when we started developing shift registers.

I remember the dual-100 shift register was an immensely successful product, but it was really a follow on to somebody else's dual-100 shift register. We could, you know [snaps fingers], create those almost like with a cookie cutter, because the process was working and the circuit was very simple. Initially it was memory and shift register. It was a Honeywell Framingham group that came to us with an idea of a dynamic random access memory, and we worked with them. It was a very marginal product, as far as a circuit was concerned. Along the development process, we also learned about another dynamic random access memory which was actually invented by Shell Laboratories, of all people, which because the mainstream of the dynamic RAM [random access memory] market, where you had three transistors and a capacitor.

The interesting thing was that we then had all kinds of internal debates about which way should we go. The Framingham people wanted us to go their direction. Internally we were gearing up more how to make it work, and it wasn't working very well, so we ended up with two parallel projects for a while, and then, actually, we made devices of both. Using the Honeywell Framingham technology was very difficult and very marginal, so we discarded that, and eventually 1103 became the three-transistor device, and 1102, which was a two-transistor device, was discarded.

In the meantime, we hired a number of the Honeywell Framingham people to be part of Intel. In fact, there was a group set up at Intel to do memory systems, and that came from that Honeywell organization. The idea was that since these are new, many companies would not know how to utilize these dynamic RAMs and create systems out of them, so we provided them with a board-level product, which was isolating them from all the problems in the circuit. The circuit was clearly a very difficult first-generation circuit, very hard to work with.

**BROCK**: This circuitry around the DRAM [dynamic random access memory]?

**VADASZ**: Yes.

**BROCK**: I think I've read somewhere that making that board-level product, wasn't that also an opportunity where you could use a particular DRAM device that might have a defect on it, but you could still include it?

**VADASZ**: You could because you had error correction on the memory system, on the board, so you could use some randomly defective devices if the defects were few enough. Frankly, I don't remember that ever became a big deal, but somebody else may know differently.

**BROCK**: And no one, prior to the Framingham group and the Shell [Shell Laboratories] group, had basically come up with designs for DRAM?

**VADASZ**: Yes.

**BROCK**: No one had made them?

**VADASZ**: The idea of semiconductor memories was a bit strange—if you think about it. The common memory device was this donut-shaped magnetic core which you either set in one state or another state, and you could remove the electricity and it was still in that one state or another state. You turned it back on again, it was still in that one state or another state. In semiconductor memory, the power goes off, the information goes away, so that by itself it was a bit of a stretch that, you know, "How am I going to use this turkey?"

Then the next issue was, okay, I have this capacitor—which was basically a leaky capacitor—that I'm storing charge on and in order to just keep the charge on it, not only do I have to keep the power supply on, but I have to continuously refresh that information. It decays and then you refresh it, and read it out, and if it was a one, you write back a one. If it was a zero, you write back a zero. So these were not necessarily obvious concepts for a product designer. Why on earth would I want to use this product? Obviously, why you wanted to use the product was because of the cost implication if—if, if, if—everything works. But you were creating some marginal systems that as a system designer you felt uncomfortable about.

So that's really what the early phase of semiconductor memory business was, and there were some brave souls, probably the bravest soul of them all was Reese Brown, who was engineering manager in charge of the Burroughs memory program, who was willing to fight inside their company and say, "Hey, this is the future. We have to work on it. We have to make this work for our systems, and by golly, there's no 'other hand.' That's the way it's going to be." He became a champion, and he became really the first very major user of dynamic RAMs in mainframe systems. After that, it was kind of a no-brainer. But it takes a bit of getting used to the concept in order to use it.

**BROCK**: Right. Well, in thinking about the process of actually producing that first 256-bit static RAM, and then I guess it's only a year later that you're making the 1103. What was the interplay between, on the one hand, developing and improving the silicon gate process, and the design work for these memory products. How did the two inform one another? Did the process make you do some things about the design, and did the design make you do some things about the process?

**VADASZ**: Well, the way it works, or it worked at that time, was that—and I kept emphasizing how circuit engineers really needed to understand the technology at that time—when you designed a product, you started to really ride as much on the edge of what the process gave you as possible, and then you screwed up here and there, and then you went to the technologist on the manufacturing line and say, "Gee, how about if we reduced the alignment tolerance by such-and-such, or could you give me an oxide thickness of such-and-such?" And so it was a back and forth. Maybe eventually the manufacturing guy tells you, "Go away!" It was never a "You will." It was always sort of an understanding of the constraints that each side had. It was always a tension between what a designer wanted to do versus what the manufacturing guy wanted to do. Manufacturing guy didn't want any yield degradation, didn't want any operating sensitivities in his process, wanted to have the easiest life possible, right? And the design engineer didn't want to deal with what just the run-of-the-mill manufacturing process would give you, wanted tighter tolerances, wanted certain electrical parameters, and so they were orthogonal in their requirements many times.

**BROCK**: Just so I know that I understand, is it the case that the things that the designer would tend to want from the manufacturing side of the process side would tend to be things that would endanger the yield?

**VADASZ**: Yes. It made manufacturing harder. Like, for example, you wanted to place metal lines closer, okay? Now when you made lines closer, it was harder to etch in between. So you would find sometimes metal-to-metallized bridging. That was a typical issue that you would be facing.

**BROCK**: I see.

**LÉCUYER**: So that's the advantage of building very close personal relations with your counterparts? [laughter]

**VADASZ**: Yes, you have to buy lots of pizzas to get development to happen with different people.

**LÉCUYER**: When I think about the history of the semiconductor business, there have been these couples, if you will, I mean linear circuits, for instance, right, Talbot, the linear circuit designer at National. I think there were similar things at Signetics going on, too, right?

**VADASZ**: Oh yes.

**LÉCUYER**: So I was wondering whether these types of relations could be found at Intel, too?

**VADASZ**: I think if you looked at today, it still goes on. Each pushes the other side, and I think that's a healthy tension and good part of progress.

**LÉCUYER**: So your counterpart was Gene Flath then?

**VADASZ**: Gene Flath.

**LÉCUYER**: So the development relationship was you and Gene Flath.

**VADASZ**: Yes. And you have some embarrassing moments, like when you come in to work and you find Teflon cases after cases of wafers on your desk, and it turns out that you screwed up on the mask with your design, and there is maybe one hole missing out of the mask, and so you've ruined dozens and dozens of wafers that went through the line and don't work. And in some way, you know, you just say, "Hmm." That's kind of humbling, and gives you humility, and it happened to me a few times.

**BROCK**: We talked about how the silicon gate process was taking longer than you had anticipated, and it was one thing after another that was keeping the yield down. Do you remember a moment when it really seemed to turn the corner and your doubts went away, and you thought, "Yeah, we can do it"?

**VADASZ**: It was that moment when we were able to cover the edges and when we were able to clean the contacts. To me Gordon Moore had two major contributions to silicon gate. One was going along with the crazy idea of basing your whole company on an unproven process; and second, of solving those problems which were just nagging us, on and on and on.

**BROCK**: Was that this re-flow idea?

**VADASZ**: Yes, glass re-flow idea. That was one problem, but then there was another problem of no contact, which meant that we had to dip the wafer in solution to remove a layer of oxide, and help creating contact between metal and silicon. And I don't know who did that; I think Gordon, but I'm not sure.

**BROCK**: I had heard about that re-flow to fix the breaking edges. So that's when you knew it had turned the corner?

**VADASZ**: That's right.

**BROCK**: Did you also know at that time that those would be important craft knowledge that you would have and other people wouldn't?

**VADASZ**: Oh yes. I mean, trade secrets have always been an important part of the business, because it's so much formula, so much recipe-driven; at least at that time it was much more than today. Today I think a lot of the technology is defined by the manufacturing equipment you buy. At that time, that wasn't really the case.

**BROCK**: Right. Did you have any questions here, Christophe?

**LÉCUYER**: Yes. I have a question, if we could go back to the very early days of Intel, we didn't talk about the people you recruited to your group and where did they come from.

**VADASZ**: Well, again, you have to look at it chunk by chunk. There was a fellow by the name of Joel Karp, who became the first engineer we hired. Did he work at GMI, General Microsystems, or AMI? I'm embarrassed to say I don't remember.

Later on in the static RAM area, we also had a guy by the name of Jon [Jonathan] Reed, and there was another fellow—I'm sure I could go back and—[Robert Abbott]

**BROCK**: We could add it later.

**VADASZ**: Well, later probably. So that was in the memory area, the two guys I remember quite well. Then Dov Frohman was a technologist who joined the group. I think he was just back from Ghana. He went with the Peace Corps. We knew Dov from Fairchild R&D. I think he had a summer job there while he was at Berkeley; maybe a more permanent job, I don't recall, and then decided to go to Ghana with the Peace Corps. When he came back, I was very glad to hire him. He got the problem of the next reliability issue, which resulted in the EPROM [erasable programmable read-only memory], which we probably will talk about.

Then came the microprocessor situation, which had its own cast of characters. Ted Hoff had a key role. Then I hired from Fairchild a fellow who used to work for me there, Federico Faggin to lead the group, so that became a small group of its own. But those are really the three different times, three different phases.

**BROCK**: But these developments are all pretty close in time, aren't they? So if the 1103 is in 1970—

**VADASZ**: Nineteen seventy, I think.

**BROCK**: Nineteen seventy, 1971; I mean the microprocessor—

**VADASZ**: The EPROM is very close to—it's, I think, 1970, and the microprocessor is 1974, I think. Nineteen seventy-two?

**BROCK**: Nineteen seventy-two. I think all three happened between 1970 and 1972, which is just an incredible—

**VADASZ**: Very productive years. I mean, we created basically a manufacturing technology which fuels a 200-billion-dollar business today, the silicon gate. We created the memory business, the EPROM, the microprocessor business, which are all the foundation of the modern semiconductor business.

**BROCK**: Is this all happening within the context of the MOS engineering?

**VADASZ**: That's right.

**BROCK**: That's fascinating to me, again, just thinking of this process manufacturing viewpoint. I mean, if you look at them as devices, they seem very different, you know, what a microprocessor is, what a DRAM is, what an EPROM—I guess there's some—but they seem like three very distinct things. But it's really fascinating, at least for me, to think about that these are really—this is the silicon gate area, if you will. Do you think that's right?

**VADASZ**: Well, in the semiconductor business, to a large extent you depend on the manufacturing machinery. You designed the devices to fit the manufacturing machinery. While you had this tension with manufacturing to cut corners, to increase density, to do the best design you can and get the most out of manufacturing, it was basically this manufacturing machine that was the foundation. The masks changed, but the process did not.

**BROCK**: Do you think that's the case if we're looking in this period?

**VADASZ**: Yes, definitely. Definitely.

**BROCK**: The masks just changed.

**VADASZ**: Yes, masks just changed. There may be a little tweaking here and there. I remember some of the big fights at that time were, "You mean you're going to have a different package?" In other words, we wanted even the package to be the same, because that different package required different assembly gear and different test jigging, and everything. I mean, that cost money. So those were—it may seem ridiculous debates at this time when you have three, four, five hundred pins, and every package is designed custom to the device you make, but at that time it was really trying to take a manufacturing approach.

And by the way, you have to give Andy credit for that. I mean, he was really very rigorous on that, and he's the one we had to fight on the package issue. [laughter] Finally, I think that between engineering and marketing, he finally gave up, because everyone kind of converged on him, and then, "If it's forty leads, it's forty leads."

**BROCK**: But he really pushed that—

**VADASZ**: Uniformity, manufacturing uniformity and simplicity for the manufacturing line.

**LÉCUYER**: So it meant that the process would be exactly the same for the EPROM, for the microprocessor, and for DRAMs? It would be the same line and exactly the same process?

**VADASZ**: That's right. And, you know, like in our real-life situation, as you start trying to get the most out of each of these, you diverge.

**LÉCUYER**: Did that mean it was the time when different lines were established for the different products?

**VADASZ**: Eventually, eventually.

**BROCK**: In that period, though, I think if my memory and the things that I've read serve me correctly, I think it was something only like two years, or maybe something like that, after the introduction of the 1103, it has become the largest-selling semiconductor device.

**VADASZ**: In a relatively short time it became the largest-selling semiconductor device, and, you know, the more we manufactured, the more we realized how marginal a product it was, because they're a very difficult product, because—how should I explain? If you looked at today's, dynamic RAMs, all the complexity in operating this dynamic structure is inside a chip, and the outside you're dealing with a relatively simple device.

Now, at that time, most of the complexity that made the memory bits work was outside the chip, and you were dealing with having to shape timing parameters very precisely in a relatively high-voltage environment, and in later generations, when they eliminated that, that's when you really started to realize, "Gee, what a complex device we created." I started to believe that because it was such a difficult device, we placed such a constraint and such a demand on the testing industry that the state of the art of testing had galloped ahead just because of the 1103; it was such a bitch to test.

**LÉCUYER**: If we could talk a little bit more about the circuit around the chip, would the circuit be designed by your group or designed by the customers?

**VADASZ**: Well, we initially thought that we would just leave it to the customer. But I think that this was where the system group coming from Honeywell became very useful, those who created the application notes on how to design and what was the circuitry we should use. You know, you found that very much in early integrated circuits that the companies provided you with application notes, which meant that somebody at least in the lab tried out some circuitry and made it work. That was the practice. Even today there are some circuits where this is applicable.

**LÉCUYER**: So the application notes would be sent with the device somehow, right?

**VADASZ**: That's right. You know, this was a very important element, and nothing to do with chemistry. When you are in such an early phase of business, like semiconductor memories, microprocessors, market development becomes a very important role for the company, and you cannot do market development just by advocating on the side, "Use it, use it, use it." You have to get involved in looking at the product from the customer point of view.

If you look at the early times of Intel, there were memory boards, the application notes, later the microprocessor development systems, and the motherboards, all were attempts, successful attempts, at developing the market. They were efforts to make the products much easier to use by the customer. You didn't have to be a memory system designer, necessarily, to use our product. You didn't have to be a computer expert to design a small computer. And those were all very important elements in market development, which is an element of the business that I didn't think many people understood, and we kind of fumbled our way through this.

**LÉCUYER**: So it meant that the salesmen would go out to the customers with the device, to sell, with the application notes?

**VADASZ**: Not just application notes; actual running boards, where your system was running and you let the customer program the boards to run the way they wanted. You know, suddenly, in developing our market, the fact that we had memories, then microprocessors, then we had EPROMs, gave us tools that we could prototype systems and use the actual programs that the customer needed to run their system with, and make it work. And that was pretty unique for a semiconductor company. It wasn't just selling a device.

**LÉCUYER**: So you were really selling a package, a microprocessor, and the various types of memories.

**VADASZ**: Yes.

**BROCK**: From where did that come?

**VADASZ**: Somewhat serendipitous, somewhat serendipitous, and it wasn't necessarily a smooth road. I think in the case of memories, it was partly the opportunity, partly the need to sell this new kind of memory, and the opportunity to sell at the highest level. In the case of the microprocessor, it was initially some of the lab equipment that Ted Hoff created, the development system, just to be able to program these little beasts that became the initial tools.

In the case of EPROMs, somehow you needed to program them, so we created our own little programmer, and eventually there were companies who actually were selling programmers. So, taking a more complete view, it became more and more natural that—today we would call it a market ecosystem, at that time we didn't know that word—that you needed to figure out what buttons do you need to push in order to make the market move forward? And sometimes it's the design. Sometimes it's the collaterals around it.

I probably learned this most clearly when I went out to the field and saw how people were trying to use our first DRAM. I found it devastating, how difficult it was for them to use it. I never realized it until then, and so my attitude changed totally from that experience, and I tried to look at more and more from the customer side anytime we did something internally, because really it was the other side that had to be able to use it; otherwise it wouldn't sell.

**BROCK**: Part of that flip in your vision, or your appreciation for how hard these memories were to use, did that then lead to the idea of the memory systems operation?

**VADASZ**: No, no. I think it was independent. But, you know, I did not have the appreciation of the difficulties until I really went out in the field and I started understanding the issues.

**BROCK**: I think you're entirely right that it's a very underappreciated dimension of the Intel story. You have to do a lot of looking to find out that there's this memory systems operation, and then later producing the motherboards, and, in fact, building a whole machine.

**VADASZ**: Yes, whole systems.

**BROCK**: You just put the label on for other people. The development systems were a very successful business in and of itself. I was wondering, was anybody else in the semiconductor industry doing that same thing, that same sort of thing?

**VADASZ**: I don't know of anybody else at that time that was approaching their business that way. I learned the semiconductor business by somebody giving a specification, and us trying to match it. I remember back at Transitron we had the Minuteman Program, and devices had certain specifications and if you wanted to be in that business, you had to develop those characteristics for your devices. That was, to me, the way semiconductor companies operated. Now, obviously, on the other extreme, when you have this new device, new technology, and want to develop a market for it, you have to do something overtly different.

**BROCK**: Was there a point in time where you started to notice other firms in the semiconductor industry beginning to take that more comprehensive approach by learning from what Intel was doing?

**VADASZ**: To be truthful, I don't think anybody even today does it to the level of Intel.

**BROCK**: Is that because Intel is so much about the forefront?

**VADASZ**: Well, I think it just became almost genetic within the company. That's the way the company thought, at least a good portion of the company. I mean, if I looked at a cell phone product, for example, a good portion is still probably—in the overwhelming majority of the market there are companies that provide some basic building block, but really the design of even some of the circuitry, which are application-specific circuitry, is by the handset manufacturer, like a Nokia, who then specifies the ASIC core, application-specific circuit by TI or whoever else, who they manufacture it very much to the requirements of Nokia. That's different than the way generations of microprocessors introduced. I mean, look at the Celeron. Not the Celeron, I'm sorry, the Centrino. I mean, it's a different animal than your cell phone development. So more of the system responsibility is with the designer, in the case of Nokia, the cell phone designer, and in the case of the personal computer business, much more of that is with the provider of the part.

**BROCK**: Is it correct, though, that you can see that really foreshadowed even in this earliest period with the DRAMs?

**VADASZ**: Absolutely. It's probably clearer there than it is now. By the way, I think that the time when we became comfortable with that approach is really when [William] Davidow came onboard.

**BROCK**: And he was in marketing.

**VADASZ**: In marketing, with a system background. He didn't have a manufacturing technology, semiconductor technology background. He had a system background. But he gave quite a bit of credibility to this approach, and under his activity the development system business became a significant business of its own.

**BROCK**: So he sort of validated the approach and then—

**VADASZ**: Took it a step further.

**BROCK**: What was a day life in your work life, in, let's say, the 1103 project?

**VADASZ**: The other guy whose name I forgot was Bob [Robert] Abbott who came onboard.

Well, the 1102, 1103 projects kind of intermingled. You know, my days were spread between various internal activities to the lab, development activities, to sometimes talking with customers, sometimes dealing with the manufacturing technology development people, and a variety of interruptions, a variety of things which had nothing to do with 1103, because 1103 was one project, you know. There are a lot of projects going on within an engineering lab. One of the elements of running an engineering organization was that your involvement got thinner and thinner, and your involvement was through discussions with others, yet at the same time, even before you had a product, marketing needed to develop the market, so you end up being dragged into meetings, meeting potential customers, and dealing with vendors who wanted to sell you stuff. So it was a typical random day. But the interaction was generally sideways and downward and to the outside. At that time, and later, there was not that much upward.

**BROCK**: In this period, I guess, any product project must have been extremely important for the company, since it's just so new. Did you feel highly pressured, or was it more exciting than stressful?

**VADASZ**: Well, you know, a development project is always stressful, and then when the first products come off the manufacturing line, you have the elation that you think it works. Then a couple of days later you find out all the problems, and then there is a downer, and then eventually you fix all the problems, and by the time it finishes, "Oh, goddamn it, finally it's working," but it becomes a drag, because all the anticipation and the elation was misspent at the time that you thought it was working. [laughter]

And, frankly, I have to tell you, I would be more coherent about these things if I had a sense of history. I would have probably noted things down if I understood or felt that they would be as important as they turned out to be, but I didn't. We didn't spend our time talking over the water cooler, "Oh, what a great thing. We are revolutionizing the world." That wasn't the case. It was just one project after another, and trying to build a company, trying to make things work, trying to create a business, and sometimes, you know, you moved forward, sometimes you got knocked back. So they were not romantic times.

**BROCK**: It's a lot of hard work.

**VADASZ**: Just a lot of hard work, a lot of anxiety when things didn't work.

**BROCK**: Was there a point in time—there must have been a point in time when you had a realization that "Maybe I'm involved here with something that's beyond just selling a very successful product," or that "This is really something that's big and changing things."

**VADASZ**: I don't think that came until really—well, in some measure those things were there, but until the PC [personal computer] business began to be what it is, which was around the mid-eighties, latter part of eighties, we didn't realize the full consequences. I think there were big "ahas!" along the way. The microprocessor—creating general-purpose machines in small, few packages, and spreading that intelligence, if you will, into every nook and cranny, was a big "aha!"

**BROCK**: When did that happen for you?

**VADASZ**: That probably happened very soon after we introduced the microprocessor. I mean, that happened around the time when we started to talk about—and I wasn't the first one, really, to talk about that—this calculator chip that we created, that was really a general-purpose machine. That was really Ted Hoff who started, who said, "Hey, it can do more than a calculator." And Bob Noyce really picked up on that and was moving that forward. But that's when it really started to get to, "Oh, we have here something very interesting."

Then we introduced the microprocessor, and then there was, I remember, a TV crew from Toronto, I think, and there was this very sharp lady who was interviewing me—I was running engineering—about the significance of the microprocessor. I fumbled my way through some sentences, and then she said, "Is it going to take away people's jobs?" I choked up. [laughter] I didn't know what to say. I mean, history being the guide, every new generation of development took away one job, but created ten new jobs. But I wasn't quick enough on my feet, so I just choked up.

**LÉCUYER**: So a TV organization from Canada sent a group of journalists to Intel?

**VADASZ**: To Intel, and they talked to a number of people about the microprocessor, because it was pretty hyped at that time.

**LÉCUYER**: So that would have been 1972, 1973?

**VADASZ**: Yes, or 1974.

**BROCK**: And that was hyped by Intel's marketing people?

**VADASZ**: Yes.

**BROCK**: So what were some of the other "aha!" points for you?

**VADASZ**: I think that after the microprocessor, obviously the PC. I mean, my "aha!" point really goes back to first MOS, then silicon gate. Memories were a logical step; microprocessor. The next was the PC, and then the Internet. There hasn't been anything since then.

**LÉCUYER**: Maybe you could go back to the microprocessor, the EPROM story. It might be the right time for the EPROM story.

**BROCK**: Maybe I'll take it one half-step before that. In thinking about the 1103 project, are there any names of other really central people to making that thing work that we should talk about?

**VADASZ**: Joel Karp, Bob Abbott, Gene Flath, and Bill [William] Regitz, who came from Honeywell Framingham. Bill [William] Jordan was the general manager of the Memory System Division. The fellow who was really key on the systems side, unfortunately, passed away, Hank [Henry] Bodio. But those are some of the people.

**BROCK**: Going then to the 4004 microprocessor—

**VADASZ**: EPROM is a more interesting story.

**BROCK**: Should we go to that for a minute? Which happened first?

**VADASZ**: EPROM.

**BROCK**: EPROM. Well, let's go in order.

**VADASZ**: Well, we had a manufacturing problem. The manufacturing problem was that when you applied voltage to the circuit and was testing the circuit, it may have been misfunctioning, but at least there was nothing dramatic, catastrophic. When you started to stress the voltage, apply higher and higher voltage just to stress it, made sure that it had the integrity, suddenly the whole thing shorts out, and we couldn't figure out why. Out of a marginally functioning circuit, when you stress it, you create a short.

So it became part of my lab's job to figure out what it was, and the guy who got the project was Dov Frohman. Dov explained the phenomena, that what was happening was really that you have a gate, which was connected to nowhere. It's floating. So it gets some voltage via capacitance, and the circuit may function somewhat marginally, or it may not, but the point is it's really not connected to anything.

Now, what happens is that as you apply a high voltage to the drain, you create a break-down mechanism in between the drain and the bulk, you create hot electrons, which then jump—tunnel through the oxide, onto the gate, and you charge up that gate. And then this device is "on," because we charged up the gate. You cannot turn it off. I hope I remember this right; this was a long time ago.

But anyway, then he says, "All right. That's a problem, but that could be a memory device," because if you could intentionally create floating gates and charge them up selectively, only the ones that you want "on," it's a nonvolatile memory device. You can take away the power; the charge is still going to be on the gate. He also postulated that because of certain physical properties, ultraviolet should be able to erase that.

**BROCK**: Because it would release the electrons off the gate, and get them to jump out.

**VADASZ**: That's right. So this was the idea. And so we had to kind of sell it to ourselves. We had to go through a number of internal discussions, "Would that really work?" I mean, we could fix the problem of the broken gate then, relatively easily, but that begged the issue: "Was there a new device here or not?" Okay? So there were two different problems, the fact that you found a problem of a floating gate, of a broken silicon gate, that allowed manufacturing to fix that problem. The fact that there was a potentially new device there, that was for our group to develop. Dov has really done a marvelous job of proving all aspects, including designing the first product, the 1301, I think, or 1302—1301, I think—that used this physical phenomena.

There was also a kind of interesting marketing angle to this. This was basically competing with mass-programmable read-only memories. The new device was an electronically programmable read only memory, but you could do the same thing with a metal mask in the manufacturing process, except it's in the manufacturing process, and it has to be done for thousands and thousands of devices, rather than to one.

Initially, the marketing approach to it was, well, it has to compete on the cost structure with these high volume read-only memories, and that's when our new marketing V.P. came in and said, "Well, no. This is a prototyping device. It's just for prototyping." And I think they sold it for something like three hundred and fifty dollars apiece, or some crazy number, and we sold unbelievable numbers of those. So here we are. We solved a manufacturing problem; we invented a new device; we proved its reliability and capability for application and manufacturability; we developed a new marketing concept around it, and created a pretty good business, all in a period of about two to three years.

If you go back—I mean, MOS concept, the MOS transistor concept was invented in the late thirties. It didn't become viable as a market entity until the sixties. This sucker was invented in 1969, 1970, and it went on the market in 1972, 1973.

**BROCK**: Unbelievable.

**VADASZ**: So it was a very satisfying development, and in a serendipitous way, it contributed to making the microprocessor a big market event, because it provided the prototyping capability, quick prototyping capability for machines, because you could put one of these products onto the circuit board and program your machine, your microprocessors, to do the functions you wanted.

**BROCK**: Using the EPROM?

**VADASZ**: Using the EPROM.

**BROCK**: I see.

**VADASZ**: So while we never thought about it that way, it turned out that all these roads led to the same end. DRAM gave us high-density memories. The EPROM gave us prototyping capability, and eventually it became cheap enough that programmable memories likely became the volume product, and the processor gave us the computing capability.

**LÉCUYER**: So the EPROM was able to help you sell the microprocessor?

**VADASZ**: That's right. That's right. And the microprocessor was a different story. Noyce wanted us to grow in other directions, because the memory business was market development. It was fairly slow in developing, and he wanted us to design more products in more areas. It was always difficult to discourage Bob with, "We have to focus. We have to focus on memories."

It turns out that he knew these people in Japan, Busicom, a calculator company, and it's very hard to refuse the CEO [chief executive officer] of the company when not only he had the business idea, but he also had the customer. [laughter] So we started to engage with the Busicom people more and more. Well, what Bob I don't think knew, and certainly I didn't know, was that these people didn't want one calculator, they wanted four or five different calculators; scientific calculator, general purpose, accounting, or whatever. They did different functions, and matter of fact, it required over sixteen different chips to be designed. And, you know, I didn't have the engineers.

Ted Hoff came up with the idea that, well, what if we just created a few chips, but a programmable machine, taking the program-store concept from computers and applied to a few chips. Then I think we ended up needing only about five chips to be designed, instead of sixteen of them, and they became very exciting. That's when I hired Federico to be the project leader in the development, and he and his team did a very nice job, fantastic job in developing the microprocessor, the first microprocessor. It worked, all the different permutation and combination of it, and the rest is history.

Probably the most ironic about the whole thing was that while Busicom had been basically the catalyst to all this, Busicom doesn't exist anymore. That company has really not succeeded in their business. When the momentum started growing that there were general-purpose applications for the microprocessor, and the fight really was picked up by Bob Noyce, he was a leading proponent of that, I believe he led the negotiation to basically release us from the obligation with Busicom for anything other than calculators. That's when really we started to get more interested in development systems for general-purpose markets.

**LÉCUYER**: If we go back to the very beginning of the Busicom project, it seems to me that there's an interesting shift there, because at first you were focusing on standard products, right? I mean, the memory products were standard products. Then you were moving to application-specific products somehow.

**VADASZ**: We weren't moving very happily. I mean, it was just, Bob won. He had the customer. But we won in a way, because we could keep within our standard product mentality when Ted Hoff suggested the microprocessor, because they were all becoming standard parts. But Bob basically won the argument, that, "Hey, we need to grow faster. We need more products. Here is a company, wants products. Let's design a calculator chip set." It was hard to argue with the logic. But don't assume for a minute that we were—at least I wasn't a very happy camper, because it was just more headache, in areas that we were not involved.

**LÉCUYER**: Actually, there was quite a delay from, I mean from what I've read, between the time when Busicom came to ask Intel to do that project and when Intel actually started working on it. Am I right? It's the standard story that appears in literature.

**VADASZ**: I don't know. I don't know. I mean, the discussions went on for quite a while. I think Ted Hoff was involved with the discussion earlier, but I was initially focusing on the memory side and didn't hear about Hoff's adventures. [laughter]

**BROCK**: Until you heard Hoff's idea.

**VADASZ**: That's right. Then it was a much easier concept to accept, because then it was promising to be a project we could handle.

**LÉCUYER**: So if I go further in this discussion of Noyce trying to extend the market, was there any discussion of making circuits for watches?

**VADASZ**: You know, I don't know when the watch idea came, whether it was before or after. I wasn't involved in the decision of acquiring this little company called Microma. But that was a very important thing to get CMOS [complementary metal-oxide semiconductor] technology off the ground, because without it—you have to have CMOS for watch circuits; period, end of story.

**LÉCUYER**: So Intel moved to the circuits for watches by acquiring Microma. So Microma needed circuits and Intel started working on that.

**VADASZ**: That's right. Now, again, if you want to think back to what if, we were probably the first manufacturers of LCD [liquid crystal display] displays, and we never made anything out of it. I mean, there is a huge market today for LCDs. Our vision wasn't broad enough to see that.

**LÉCUYER**: So it was again related to Microma, right? These were the LCDs for the watches.

**VADASZ**: That's right. Yes, it wasn't the kind of LCDs you have on your computer, but you know, I mean, it's the origin. That's the same way—Flash is not what the first EPROM was, but in LCDs, our instinct wasn't good. I believe a lot in company instincts.

**LÉCUYER**: I think it's a very different business, right?

**VADASZ**: That's right.

**LÉCUYER**: The technology is quite different, quite a bit different, right?

**VADASZ**: That's right.

**LÉCUYER**: And it's different markets. The customers are quite different, too, right?

**VADASZ**: Well, you know, I mean, we were in the watch business. That was one thing. We were in the PC business, so the customer is the same.

**BROCK**: Why was it that you hired in Federico Faggin into that microprocessor project?

**VADASZ**: Because I trusted him. I worked with him at Fairchild. I felt he was a very capable guy. I just like the way he worked, the way he thought. He was a very hard worker and didn't ever, during the Fairchild time, didn't ever hesitate to roll up his sleeves and do whatever needed to be done. You know, when you have a project that is of that scope, a new project, you know that it's going to be a hard project, you gravitate towards known capabilities in the people. I trusted him, based on working with him before.

**BROCK**: I was wondering if there was a connection between the experiences that you had working with him on the silicon gate process?

**VADASZ**: Well, that's the only project I worked with him on.

**BROCK**: Well, I was wondering if there was a connection where you thought maybe you knew that he had this kind of good knowledge of silicon gate, and that was going to be important for designing the microprocessor.

[END OF AUDIO, FILE 2]

**BROCK**: So we were talking about the issue of a new project, a complicated project. You can get one base of certainty, which is a person.

**VADASZ**: And I knew—he was working on this product that I was discussing before. It was a multiplexer, I believe, at Fairchild, which the marketing people wanted to sell millions of, so I knew how he worked. I knew how he thought, and it was with circuitry and products. We weren't designing computers at Fairchild, so it was not because I saw him designing a computer before; it was just based on capability and comfort factor.

**LÉCUYER**: Was it the fact that he was European, too?

**VADASZ**: No.

**LÉCUYER**: Because there was quite a European contingent at Intel.

**VADASZ**: Well, I think you find that the whole electronic business, semiconductor business, has a lot of foreigners. That's true today; it was true at that time. Maybe at that time it was more European, and today it's more Asians, but you go into the R&D labs—but that's another subject. We won't go there.

**BROCK**: Who was your boss during this amazing time in the early seventies?

**VADASZ**: Andy.

**BROCK**: How often did you see him, and what was that like?

**VADASZ**: Well, I saw him mainly in two ways. One, we had staff meetings. The other one was that we had one-on-one meetings. Andy was a strong believer in one-on-one, and I think that he propagated that culture all throughout Intel. And, you know, we had our agreements, and we had our disagreements. I think that neither of us shied away from confrontation, whether it was needed or not, and I think the results showed that it was a productive relationship.

I think that probably those early interactions at Intel, not just between me and Andy, but between all of us, gave us pointers to what's Intel culture. We spent a fair amount of time trying to articulate what's Intel culture. Probably many of our interactions were what we would call today "constructive confrontation." We were after the results, and we debated that, and I don't think we focused on the individual; I think we focused on the issues.

One of the few things I remember was debates about package pins, numbers of pins of packages. It used to drive me up the wall. [laughter] Because I was on the product development side and I wanted more pins. But I'm just joking.

**LÉCUYER**: So if I understand you well, very early on there was a discussion about what made Intel different from other companies, in terms of corporate culture.

**VADASZ**: When we started growing, that became more and more of a concern. You know, we are hiring a lot of people. We're growing rapidly. We may even move out of the area, and what are some of the core elements of the culture of the company, so that we can at least tell others.

**LÉCUYER**: So they knew how to replicate that in other places.

**VADASZ**: That's right, yes. It's never the same, you know. People are people. But I think you can't write down all the rules of engagement. There are certain things people do because it's the right thing to do, by their definition of their culture, and that's what we tried to do; articulate some of those concepts.

**LÉCUYER**: So were you using the word "culture" then?

**VADASZ**: Well, what else is it?

**LÉCUYER**: Because I think it was around that time that some of the consulting companies started to push that culture concept onto industry, so I was wondering whether there was a connection between that. It was one of the larger consulting companies in the U.S. that tried to do that; but I forget its name.

**BROCK**: McKinsey?

**LÉCUYER**: A name like McKinsey, yes. So I was wondering whether there was a connection between your thinking at Intel and that sort of thing?

**VADASZ**: Not at all. As you'll see, I mean, you'll find that Intel used very few consultants over the years. We sometimes used a university professor for a lecture, and we've picked some stuff from him and formulated our own methods. Again, the general concept was that it's okay to learn seed ideas, but you have to build on them to really make it your own, rather than just mouth it as it becomes a cliché.

For example, one of the things that I had been heavily involved is the concept of matrix management. I heard this guy, Jay [R.] Galbraith, talk about matrix management very early in Intel's history. And we brought the guy in, and we started to be much more conscious about some of the things that we were doing and some of the dilemmas that we were facing, you know, like we were opening up a plant in Livermore. Okay, security. Where is security going to report to? To the manufacturing guy in Livermore or to the security guy in Mountain View? It's not a yes or no answer. So you start developing the concept that, well, there are situations where you have to live in a matrix, whether you like it or not. And, you know, it's an awful organization structure, except all the alternatives. You have to have it. I'll bet you have it in your world.

**BROCK**: Yes, we sure do.

**VADASZ**: But, you know, these are the kinds of things that we did: if we heard something; that applies, we bring the guy in, build on that concept, and then make it part of our operating method.

**LÉCUYER**: Which means that there was some theorizing within Intel about your own practice, right?

**VADASZ**: That's right. That's right. And one of the first ones was, I mean, probably <u>the</u> first one was this notion of central R&D or no central R&D. That was a very conscious decision that, based on our experience, we are not going to do this.

**LÉCUYER**: So would the theorizing be put on paper, or would it be common knowledge?

**VADASZ**: Just discussion, yes, discussion.

**BROCK**: It does seem that there's almost like an engineer's approach to management, and also to the culture work, if you will, in that from what I've seen, for example, that Intel culture, it's very clear, simple statements, and some of the practices are also very clear. So in a way, it almost seems to me like it's an engineering approach to culture. For example, the emphasis on things being sort of fact-based or empirically-based, so people can argue about it or—

**VADASZ**: Yes, yes. Just to be able to communicate it, you have to simplify these kinds of things, because otherwise people's eyes glaze over and it just becomes meaningless. In fact, one of the problems with this kind of simple statement is that there are some guys who really try to make more out of it than what it is, and start weaving the yarn, and interpret it in a zillion different ways, and by the time you hear it, you don't recognize what it is. You need to keep these concepts simple, and leave it at that level, and our own behavior will be modified by it, but not totally changed.

**LÉCUYER**: So it was a tool somehow, right?

**VADASZ**: That's right. It was a tool to communicate certain value concepts.

**LÉCUYER**: And it was not reified, right? It was something that could change, something that was not—

**VADASZ**: You may feel that from time to time something needed some clarification. But I think today, with the size and complexity of the company, we may be making too much of a deal of—I mean, keep it simple, not a big bullet with a number of sub-bullets.

**LÉCUYER**: A set of ideas rather than a doctrine.

**VADASZ**: That's right. Yes. And if you cannot understand a one-liner, certainly ten more lines are not going to make you understand it better.

**BROCK**: Going back to the constructive, or at least the confrontations that you were having with Andy Grove, how would you characterize his involvement in these three big development projects that you were working on in the early seventies?

**VADASZ**: Well, don't forget, Andy's primary role that he took on was not as a technical contributor as much as keeping the beat going. He kept driving for results, results, results, results, and I think it was the right thing to do. And obviously, when you do that, you cannot do it in a manner that you won't confront issues, and so that was where I'm sure that many of the discussions were. He was just driving and keeping the beat going.

**BROCK**: Maybe in thinking about that, did that help, for example, with the coordination of these projects between you and Gene Flath in manufacturing, to have Andy Grove there kind of keeping the rhythm going, checking on where things were going, making sure there was clarity?

**VADASZ**: Oh, actually, it helped a lot. But, you know, one of the things that Andy propagated right from the beginning was that he was not going to be the go-between. I mean, he had this philosophy that, hey, you were paid to do a job, not to love the other guy, and whether you love the other guy or not, you have to deal with him. You have to make it work. And that was his general philosophy.

[END OF AUDIO, FILE 3]

**BROCK**: We were just talking about how Andy Grove's philosophy was, "You guys have to work it out. I'm not going to be the go-between," and one of the worst situations you could get in was—

**VADASZ**: Was to try to explain that you had a problem with the other guy on a certain issue, and have him find out that you and he didn't even talk about it. Those were the kind of things that frustrated him to no end, and in retrospect, rightfully so. But, you know, what you have to realize is that a startup environment like that is very tense, lots of anxious moments, because whether things are working or not working, you're always on the edge. It was very hard, and emotions were high, and on top of it you had a number of people who were thrown together, each of them with their own ego, so the environment was not necessarily the most sedate, easy environment. And of all these people, Gordon was always the coolest, the most level-headed. I don't know of one occasion that he lost his cool. He provided probably <u>the</u> emotional stability to the company at that time.

**BROCK**: Were other people occasionally losing—

**VADASZ**: Oh, we were all very emotional. Yes.

**BROCK**: But did it help, though, for you, for both sides, from product development and manufacturing, to at least have Grove setting one common sort of theme?

**VADASZ**: Oh yes. It absolutely helped. And while there was actually no problem of me getting mad and shouting at Grove, or him getting mad and shouting at me, I could have never imagined that I would have shouted at Gordon. There was just something different.

**BROCK**: What was his role like during, let's say, the 1968 to 1972 time period? Did you see him frequently?

**VADASZ**: You know, again, those were more of a nudging type of engagement. He worked much closer with Andy, and Andy worked closer with the rest of the people. He got involved in the technical issue we discussed. I mean, it was just sort of getting in, getting out. By the way, that's another characteristic of Gordon. There are people who micromanage, who just get too much into the details. Gordon never did, never meddled, or never second-guessed; tried to lead you to an opinion, but never really meddled.

**BROCK**: Would he nudge by asking good questions, maybe uncomfortable questions, but insightful questions?

**VADASZ**: Well, you knew when Gordon didn't like something, when he said, "Gee, I wish it wasn't this way," or it was different, or something. Then you knew that he didn't like this. Other people may have said, "Gee, this is all screwed up." [laughter]

**BROCK**: I saw that then, I believe it was in 1972, that you became director of engineering, not just MOS engineering.

**VADASZ**: Yes, it was all engineering.

**BROCK**: All engineering. Was that a big change for you?

**VADASZ**: Not really, because it just added bipolar engineering into the mix, but otherwise bipolar wasn't the major emphasis of the company. In fact, I probably didn't do a particularly good job of nurturing the bipolar effort, because I didn't feel personally that it was that important of a direction for the company. So I think we may have missed something along the way, of not getting more out of our bipolar efforts, because my focus was really more and more on MOS.

**BROCK**: How big was your operation by this time, in 1972?

**VADASZ**: I don't remember. I really don't remember. It wasn't that big. I mean, we didn't have hundreds of engineers.

**BROCK**: I think you served in that role of director of engineering from 1972 to 1975?

**VADASZ**: I was V.P. of engineering, yes, which I think was mainly the title changed.

**BROCK**: Okay, not a change in really role or responsibility.

**VADASZ**: Probably it was more of recognition of my contribution or whatever, but it wasn't a major role change that I remember.

**LÉCUYER**: Then you become an officer of the company, right?

**VADASZ**: Yes, V.P. of engineering.

**BROCK**: What stands out in your mind as some of the most important things that you were engaged with in that period from, let's say, 1972 through 1975?

**VADASZ**: Well, probably the most important thing was more toward the 1975 time. I was getting tired of running engineering, because the problems were always the same. The device number may have changed, but the problems, you know, were up and down and up again. The organization was big enough that by that time I wasn't really that directly involved with any one of the devices. It was just less and less satisfactory as an activity, so I was trying to gravitate more toward the business side of things. I think when we divisionalized, I became assistant general manager of the Microcomputer Division, which came very soon after that.

**BROCK**: I think right after that.

**VADASZ**: Yes, right after that. That was when Davidow was general manager. He combined both the system and the components business, because it was more of systems sell initially, and the development systems were the major part of the business. There were some Multibus motherboards that became a significant part of the business. Then I think it was a little bit later that we split the component and the system businesses, and I became the general manager of the Microcomputer Component Division.

**BROCK**: Right, in 1977, I guess that was. Could you talk a little bit more about two things. One was what you meant by, and what attracted you to the business side, and then the story of the divisionalization of Intel, if you will, of the first divisionalization.

[END OF AUDIO, FILE 4]

**BROCK**: You were talking about what attracted you to the business side of things, rather than from product development.

**VADASZ**: I don't think it was as much attraction to as running from. It was just getting stale, and that's about it. And, you know, I always liked to learn new things. I mean, even today I try to get involved in learning new things, so that was a perfect way for me do that.

**BROCK**: Obviously, in developing the type of products that we've been talking about, you surely had exposure to all these different areas that you were interfacing with, from marketing, finance, with general operation.

**VADASZ**: Yes, but I think that mainly in that new role I was learning more about the software and systems side of things. That was what really interested me.

**BROCK**: You mentioned that, I guess it must have been around 1976 when the company divisionalized. Could you talk about the thinking going into making that decision, and what impact, if any, it had?

**VADASZ**: I think, you know, you have a situation with every company with a broadening product line, that you have to think about how are you going to create a management structure where you can get your arms around the business in a cleaner fashion. That's when you start to think about creating division, more self-contained business activities. Even though Intel had a lot of its element always centralized, there were certain things that were better handled decentralized.

**BROCK**: So did you then, at that time, divisionalize by sort of product groups?

**VADASZ**: Product groups, that's right. We had the Memory Division. We had the Microcomputer Division. Did we have Microma? We had a Memory System Division. That's about it, I think.

**BROCK**: Was there a cross-divisional group then, or I don't know, a functional group then for technology and process development?

**VADASZ**: Well, you had—and this probably comes up later, that memory devices were the largest product volume, so that drove the technology development. If you wanted more density, it was really memory technology that you used for technology development. And you took into account microprocessor needs, but basically, when it came to technology development, microprocessor needs were second cousins. It wasn't really a major driver. So my involvement with the technology side, the silicon technology side, got less and less over time.

**BROCK**: By this time, by, let's say, 1976, was the process needs for the microprocessors very different from the process needs for memory?

**VADASZ**: Not really. Not as I recall. I think there was at one time—the big change was going from P channel to N channel, then adding CMOS to the line.

One thing we didn't talk about, which happened in 1975, was the establishment of Intel Israel, which turned out to be a pretty important event in the company, because that was still in my career as engineering manager—maybe we can talk about it another time.

**BROCK**: Well, why don't we talk about that now, and then maybe close with the story of that. Now, that was to establish an engineering design center in Israel?

**VADASZ**: Yes.

**BROCK**: As a fab, or just as design?

**VADASZ**: No, just as a design center.

**BROCK**: So how did that come about?

**VADASZ**: Well, that was around the 1974 timeframe that we were increasingly thinking, we don't have enough engineers and we don't have access to enough engineers, and we need to somehow solve that problem. We came up with the concept that, well, there were places in the world where there were more engineers produced than jobs created for them. And Israel was very high on the list. That was further aided by the fact that we lost Dov Frohman, who basically wanted to emigrate to Israel. His parents died in the Holocaust, and he felt a very strong need in his personal life to do that. He went there and became a professor at a university, and he kept campaigning us that, well, why don't we do something there. So the two thoughts converged and we really wanted to do that in 1974, when the war broke out, so that kind of killed that effort. But we went there in 1975 and it was really Andy, Arthur Rock, and me.

**BROCK**: The three of you went together?

**VADASZ**: Yes, we went together, and our significant others. We interviewed some people. We were helped a lot by Technion [Israel Institute of Technology] people in Haifa [Israel], and we founded the design center there. Today that design center is an outstanding design center for Intel; it's world-class.

But what was unique, in my mind, is that it was the first integrated circuit design center in the world where a company decided that it wanted to do the same complexity, high-complexity work there as in the U.S. Because generally, at that time the custom was that the design center that you established in Scotland, in France, in wherever, as a satellite of an American company, they got the simple stuff. Well, there was no simple stuff. We were going to do complex stuff there. Now, it took many, many years to finally make that happen in a way that we were hoping for, but that was really, in my mind, another unique thing that Intel has done that probably never will be recognized.

**BROCK**: Who made that decision that "We're going to use this—"

**VADASZ**: I think, I mean I was responsible for it, but who made it I don't know, because I was running engineering.

**BROCK**: Was that your idea, or was that, certainly, an idea that you pushed?

**VADASZ**: Oh yes, because we didn't make simple products. We made complex products, and so if we had an engineering organization that will be useful, they must do the same kinds of products as we do here. We hired some really bright kids. Initially, we got the help of the faculty there, to recruit and everything. Eventually, there was a number of design centers created in Haifa and around there, to the point that Technion had a hard time keeping their professors. And ten years later I visited there, and the same professor who helped us was not very friendly to me. He said, "It was all your fault." [laughter]

**BROCK**: These were other semiconductor firms.

**VADASZ**: Yes, they established design centers, or computer companies, like DEC [Digital Equipment Corporation] had a design center there. But we were the first to really establish a state-of-the-art design center outside the U.S., in my opinion.

**LÉCUYER**: Was Dov Frohman involved in this center afterwards?

**VADASZ**: He was involved indirectly. He was not running it, but he became a key driver of all the various activities for us there. He wasn't really doing day-to-day operation.

**LÉCUYER**: So an employee rather than as a consultant, right?

**VADASZ**: That's right.

**BROCK**: On that trip, Arthur Rock must have been at that time the chairman of the board of directors?

**VADASZ**: I believe so.

**BROCK**: What did he think of the decision? I mean, he obviously went along with it.

**VADASZ**: Yes. I think that there was generally strong support. There was also some nervousness that, hey, were we risking too much, given the instability of the Middle East. We lived with that nervousness for thirty-five years now, and that situation is as much of a mess now, probably more so than it was then, but we had always had a very disciplined, committed organization there. The reason I bring it up is because I think that we did something unique.

**BROCK**: Does that remain unique, do you think, today, if we look around at other semiconductor—

**VADASZ**: No, no. I think that you have very highly sophisticated designs coming out from many parts of the world. I think that today that—

**BROCK**: Design is design.

**VADASZ**: That's right.

**BROCK**: Was there the same sort of—I guess I'm thinking about the capital investment to start a design center.

**VADASZ**: No. Design centers generally cost relatively little, compared to a fab.

**BROCK**: But it's a huge investment in training up that whole generation of designers.

**VADASZ**: That's right. And again—and I'm sure that others will talk about it, or have talked about it—that is the process of being able to take baby steps. Operating in a multinational setting is a non-trivial step, and just like you have to worry about how I am going to transfer technology, you have to worry about, okay, I have two groups. How am I going to have these two groups working on parallel projects or interacting projects? Those are not simple problems.

**BROCK**: If you think in this period, certainly you had that assembly and packaging function going on overseas.

**VADASZ**: That's right.

**BROCK**: But was this the first example of—certainly didn't have any fabs overseas at that point, so this must have been the first non-packaging and assembly—

**VADASZ**: That's right, other than your sales.

**BROCK**: That's interesting.

**LÉCUYER**: What kind of circuits were the Israeli engineers working on in the early days there?

**VADASZ**: I don't remember. But the first really complex product that I remember from them, which originated there, was the 8087. It was a math co-processor. That's one of the first that I remember. That had to be some before that; a number of very successful microprocessors came from there. I don't remember. I'm sorry. I should. I should find it out.

**BROCK**: Perhaps this would be a good time then to break, and then we'll begin again with the Microcomputer Division when we talk again.

[END OF AUDIO, FILE 5]

[END OF INTERVIEW]

**INTERVIEWEE:** Leslie Vadasz

**INTERVIEWERS:** David C. Brock and Christophe Lécuyer

**LOCATION:** Sonoma, California

**DATE:** 7 June 2005 [Interview 3]

**BROCK**: This is an oral history interview with Les Vadasz, taking place on June the seventh, 2005, in Sonoma, California. The interviewers are David Brock and Christophe Lécuyer. So Christophe, if you'd like to begin.

**LÉCUYER**: Last time we talked quite a bit about the early days of Intel and some of its competitors, but we didn't talk much about Mostek, which was one of the most aggressive ones, right?

**VADASZ**: Yes.

**LÉCUYER**: And Mostek was also, I think, the first company to make MOS memories with ion implantation, so could talk about this competition between Intel and Mostek in memories, and also about the ways in which Intel went into ion implantation as well.

**VADASZ**: Now, Mostek. Frankly, my memory of Mostek mainly comes at the 4k complexity level. I think they introduced a very good device, a very interesting device, a better device than what we had. They did a couple of things. The most important thing I remember is sort of the typical second-generation phenomena, that in the first generation, like the 1103 generation, you proved the concept of dynamic RAM, but in the second generation you have a chance to take care of some of the problems associated with the first generation, and the main problem as I look back was, that 1103 had was it was a very difficult device to use.

My memory of what Mostek did was that they basically simplified the user interface and buried many of the complications of the circuitry that 1103 devices required on the outside, to be inside the chip. The issue of ion implantation or no ion implantation I just don't remember. Probably somebody who was working closer to the manufacturing line would remember. I just don't. To me it was, gee, that was a neat device.

**BROCK**: Maybe we can talk about this period in the middle seventies then, 1975, 1976. I think we talked about last time, in 1975 you became a vice president at Intel, and you were talking about your growing interest in the business side of the activity. How did that growing interest in the business side of things relate to this additional role, or new role that you had in 1976, where you became assistant general manager for the Microcomputer Division?

**VADASZ**: Oh, God. Well, Intel was going through a growth period not only in its business revenue and production, but also the breadth of the activity. There was the memory business. There was this new microprocessor area. There were development tool, development system area, and it was getting a pretty broad activities, and we, like every organization as it grows, tried to cope with growth. The way we tried to handle this growth was to create business divisions, which was more focused on a combination of products and markets.

You know, there's many ways to define a market. You can define a market as the market for these widgets, or you can define a market as the market for devices that are made by a particular technology, or you can define a market as the application segment, like cars. It was logical at that time to put microprocessors and microcomputers together and systems and components together, because the sale was to the same customer. The customer who wanted to use a component, generally bought the system to design his particular version of the computer. So that was our logic of creating this Microcomputer Division, which was both Component and System Division. We designed within that the components. We designed the systems. We manufactured the systems, and there was a common manufacturing line to manufacture all the components. We didn't split the manufacturing line for the component. That was really central.

Then there was a fair amount of specialization within the sales force to be able to sell component, microprocessors, or memories, and definitely specialization on the application side. So you always kind of worry about what do you keep central and what do you divisionalize. The more specific you are to the product, the more you divisionalize it, and the more general the resource, the more you keep it in a central organization. And that was just an opportunity for me to learn more about the business side of the activity, as opposed to running the engineering side, and it was a very good experience. Basically, Bill Davidow became the general manager and I became the assistant general manager, and within this duality he took leadership of the marketing roles within the division, and I took leadership, of the operating roles within the division.

**BROCK**: What were the sorts of operating issues that you were contending with? You had manufacturing process and technology. You were sharing that with the Memory Division?

**VADASZ**: That's right. Well, but we needed to design the product, both the system and the component. This was the first time, that I got fairly heavily involved on the software side of things, because that was also part of the group; operating system development, some of the programming language development. It was all part of that activity.

**BROCK**: Was that software side focused—

**VADASZ**: On microprocessors.

**BROCK**: —on the microprocessors.

**VADASZ**: That's right.

**BROCK**: So could you describe that space of activity a little bit more for me? I'd like to know more about that.

**VADASZ**: Well, there was microcomputer marketing. There was microcomputer system hardware engineering, microcomputer system software engineering, and chip design, and all the other regular functions like H.R. [human resources], and finance. I was sort of overseeing the operations side, which was manufacturing, system manufacturing, system development, both hardware and software, and component development. So it still had a heavy engineering emphasis, but was looking at it more from a business point of view, rather than merely a development point of view.

**LÉCUYER**: How big was the division in terms of sales and employees?

**VADASZ**: God, I don't remember. I mean, the interesting fact was that the majority of the sales were systems. You know, it was really a situation where early activity in microcomputing, microcomputer business was, you got a design win, but the first phase of the design win is that the customer needs to design his system. So what do you sell? You sell a system to design the system with, and it's only when you go into production with that system, then you buy component. So the component sales always were delayed from the system sales.

**BROCK**: So the software you were developing was the software for these development systems.

**VADASZ**: That's right. There was a fellow by the name of Terry Opdendyk who was the head of our software development, and there were some interesting things done in that group. The software we developed for a development system was called ISIS, many thought was better than what eventually DOS [disk operating system] became, but we never made that software available on the open market, because for some reason we felt that it had more value as part of the development system, which was a traditional way of looking at operating systems. In retrospect, that wasn't one of the wisest decisions that we could have made, but that's the way it played out. And a development system was, of course, in every respect a forerunner of what the personal computer is today, but again, we never recognized it as a personal computer. It was more of a specialized machine.

Now, during that time also, we started to create board-level products which we called Multibus, meaning that you could build your computer by having a number of these different boards, so the customer didn't have to design his own system from the bottom up. He had to design the program for his system, and he could buy the board level products. Think of it like DEC who originally started to sell boards that people could make into computers. This was a higher level version of it. Because this contained microprocessors it was a more complete computing engine. And that also came from that division.

**LÉCUYER**: So, who was buying these systems?

**VADASZ**: Well, generally people who—first of all, anybody who wanted to use a microprocessor as part of his system. If you wanted to create a sewing machine with electronic controls, you may have bought one or more of these systems. If you wanted to create a traffic light controller, whatever, those were the people.

**BROCK**: What was inside the development systems, were those Intel microprocessors?

**VADASZ**: That's right, yes.

**BROCK**: So in a way, was the development system itself advantageous for marketing? I mean, if you're sending it to a customer who's interested in making their own computer using your components, here's basically a computer.

**VADASZ**: Well, I'm sure that it gave them some satisfaction that, yes, indeed, you can make a computer out of it, because I have this computer. But I don't think anybody would have bought a system without first committing to using our components, because those were really specifically aiming at programming the systems based on our components. So it was a relatively narrow market, and I guess that's where I say that while it was a forerunner of the personal computer, it was really a very narrow target, those that wanted to develop systems based on our components.

**BROCK**: Sure.

**LÉCUYER**: So if one thinks again about competitors, National and ZiLOG and other companies were doing microprocessors around that time, too. Would they be also selling systems, to their own system customers?

**VADASZ**: Well, they came later. ZiLOG was formed by executives coming from Intel who really developed microprocessors at Intel, and by that time Intel was selling development systems. But I guess when you're talking about a compatible microprocessor, you could use our systems, and ZiLOG's Z-8 was compatible in many respects, on the code side. Others like National [National Semiconductor] or Rockwell [Rockwell Automation]—I don't think they sold development systems to the level that we did. I don't know what they did there. I don't remember.

I think that that was a pretty unique thing that we had done, because it was initially pretty controversial. Should we really do this? I mean, it wasn't the most obvious thing for a component company to say, "Okay, we're going to sell these system boxes." But I think it really created a broad base of applications much faster for microprocessors, because people could reach it easily. I think that was a major innovation, marketing innovation, and we were leading in that. That was really groundbreaking, and I think that major credit has to go to Bill Davidow.

**LÉCUYER**: So you might be able then to talk about Bill Davidow himself. Could you tell us about him as a person, as a manager?

**VADASZ**: Well, you can talk to him. I see Bill periodically at the Giants baseball game, so he's local. I think I'm safe to say that Bill and I had a very productive and good working relationship. I think that he was very effective without being as excitable as I was. Our personalities were different, but I think that we worked quite effectively, and I learned a fair amount from him on the marketing and the system side. So I look at it as a very good relationship, very productive relationship. The reason why that relationship evolved into two separate activities is because the growth of the businesses required that kind of focus. But I think you ought to talk to him. He may be able to shed some light, more light on—probably he would, because he wrote books about it.

**BROCK**: So that sort of arrangement for running the Microcomputer Division lasted—

**VADASZ**: Until 1978, I think.

**BROCK**: Okay. Well, I saw that, or I think I found out, if I'm correct, that in about 1977—

**VADASZ**: Maybe so.

**BROCK**: —you became general manager of the Microcomputer Components Division.

**VADASZ**: Yes.

**BROCK**: Was that another organization?

**VADASZ**: Well, that's all because of growth and just getting your arm around the problem, it was logical to split the component and the systems, and so I became manager of the Microcomputer Component Division. That's the first time we created the division, where I had to worry about the development and sale and marketing of the component side of the microcomputer business. That's when it really dawned on me…as I was going around and talking to salesmen, and they were talking about this design and that design and then that design, and how many wonderful systems they sold, and I said, "Okay. Now, where are the component sales, where are the component sales?" And they were not much. They were not much, because they were all initially system sales.

**BROCK**: So when you take up that title in 1977 and you look around the Intel business, you know, where do the—

[END OF AUDIO, FILE 1]

**BROCK**: I was thinking about in 1977 you've got this new role. You have this new division for the microcomputer components. If you look at the Intel business, how big is that relative to—

**VADASZ**: Tiny, tiny.

**BROCK**: —to memories?

**VADASZ**: Memory is the main business, systems are the next main business. I believe at that point we must have had memory components, memory systems, microcomputer component and microcomputer systems. I'm not 100 percent, but I think those were the business line. Memory definitely was the biggest business. I am almost 100 percent sure that microcomputer systems were the second, then memory systems, then microcomputer components.

**BROCK**: But you must have anticipated that the microcomputer components would be expanding on the trail of the systems.

**VADASZ**: That's right. That's right. Yes, definitely expected to grow, and we could see by generations that the volumes were sort of tracking. I mean, the 4-bit machine, the microcontrollers, the 8-bit microcontroller, not the 4, but the 8-bit microcontroller volume was going up and up and up; 16-bit was just beginning to come on. It was mainly design wins, design wins, design wins. So you could definitely see it, but don't forget, all that time, we felt that the mainstream of our business was, and going to be, memories. We didn't look at the microprocessor as the future of the company.

**BROCK**: How did you see the microprocessors and the memories, those businesses interrelating? Was microprocessor seen as yet another tool for selling more memory?

**VADASZ**: No. I think it was more of, "Well, let's see what we can make of this. Where does this lead?" But it was clear in our mind that the cost driver for the technology was the memory. The high-volume memory business was really giving us the manufacturing capability to drive cost down.

**BROCK**: I see. So the memory was giving you—just to recap.

**VADASZ**: Because of the volume associated with it. Don't forget, at that time the prevailing philosophy came from an old Boston consulting study that volume drives cost. The more you make of something, the lower its cost will be because you get manufacturing efficiencies. And so that was very important in the business, to have high-volume products to drive your costs down.

**BROCK**: And then the microprocessor manufacturing would essentially benefit—

**VADASZ**: Exactly.

**BROCK**: —from the sort of development of the manufacturing technology for the high-volume memory.

**VADASZ**: That's right.

**BROCK**: So that was your real advantage that you saw. That's interesting.

**LÉCUYER**: What was the difference in complexity between the memories that Intel was making at that time, and the microprocessors?

**VADASZ**: Well, if you tell me at that time what was the state-of-the-art memory; oh, boy.

**LÉCUYER**: Would they be using the same number of components on a chip?

**VADASZ**: Probably comparable, although, you know, in memory you can always do higher density because of the regularity of the structure. So my guess is that memories had more transistors per chip than the leading-end microprocessors.

**BROCK**: Who did you directly report to at that time?

**VADASZ**: There was a time, and I don't quite 100 percent know exactly the time, but there was a time when I was reporting to Ed Gelbach, who left sales and was running a number of business units, but I don't quite remember when that was. You may—

**BROCK**: I'll find that somewhere.

**VADASZ**: That's right.

**BROCK**: I guess the more important question would be, who were the people that you were interacting with, the most important relationships that you had? Who were the real key people that you were working with?

**VADASZ**: Well, I worked with sales management quite a bit. I worked with the people who were within my division, marketing and engineering. I was learning furiously about P & L [profit and loss], and I think that Paul Ottolini was my comptroller. We had some special programs also. Names that I remember, Dick Bouchet was part of the organization handling the automotive business, because we started to get to the automotive side as well.

Who was the fellow—somebody handled microcontrollers; Ekis, John Ekis. I guess I can't remember. I should look it up and see. That's really embarrassing.

**BROCK**: I think you served in that role of general manager of that division until 1979, or into 1979, so for those couple of years, what would you describe as the largest problem that you were facing for the division, and the greatest success that you had in that division?

**VADASZ**: The largest problem I think we faced was learning how to run a business. That was seat-of-the-pants learning. It was really trying to balance all the various internal needs, external thrusts, competitive thrusts, and it was personal growth and personal challenges from that point of view.

Biggest success during that time: microprocessors, microcomputer components as a business. We became a business that eventually it was something that we could build the rest of the company on, although that time I never looked at it as, well, we are preparing for the next phase of the company. All the blocking and tackling, all the trial and error, you know, you're just trying to do a variety of things; some worked, some didn't work. Some component family became very successful, like the X-86. Some component family didn't become successful, like what eventually became the 432. Some things became very good business for a while, like automotive. Some business then eventually got phased out, like the microcontrollers, but became a very significant business for quite a while. So those were good things, good stuff, but it was more the learning you got out of it than any significant product that I can think of.

I mean, for example, a 16-bit family, at that time it was a real struggle. You had the design wins, design wins, design wins, but the volume really didn't come until the early eighties, the mid-eighties, when the personal computer became something of a product. So at that time, that wasn't a very successful product, because it was just very early in the market.

**BROCK**: So that was the first of the X-86 family.

**VADASZ**: That's right.

**BROCK**: I guess if you look back on it, right, that was a tremendously important family to get started.

**VADASZ**: That's right.

**BROCK**: At the time, did that appear to be special in any way, or was it sort of the next developmental step to do?

**VADASZ**: It was special. It was a logical—in retrospect logical—evolution. We tied, in retrospect, probably too much to its predecessor, in the 8-bit family, the 8080. It didn't need to be, in retrospect, because there wasn't much of a market for its predecessor. I think sometimes you carry on compatibility for no good reason, because you feel, "Oh yeah, we must have compatibility," even though sometimes it doesn't make any sense. And in retrospect, I don't think that compatibility amounted to a hill of beans.

**LÉCUYER**: Was there any pressure for compatibility from the customers?

**VADASZ**: First of all, I don't think there were enough customers to be that meaningful, but, again, that's retrospect. When you're sitting in the middle, obviously there is a desire to be compatible, because you feel that you have a foot in the door for the next generation if there's some level of compatibility, some level of carryover. But when the market is small and very young, it really doesn't matter. It really doesn't matter.

**BROCK**: In this period, what was your impression of the attitudes of Moore and Noyce and Grove toward the microprocessors?

**VADASZ**: Attitude?

**BROCK**: Their interest, engagement in—

**VADASZ**: Well, they definitely had interest. I mean, after all, Noyce, particularly, has done more to create the microprocessor business than either of the other two, because he really campaigned in a way that, "Let's take advantage of this special-purpose machine," which was really based on a general-purpose component called the Busicom calculator. So there was that level of interest. But the business was basically memories. I think that memories and focusing on being an effective, efficient manufacturer was perhaps the main focus.

**BROCK**: Was the process technology the real common concern between the memories and the microprocessors?

**VADASZ**: Well, I think that during those times some tension started to develop between what do you need for most optimum memory structures, and what do you need for microprocessor product requirements, and sometimes they have common requirement, sometimes they're diverging requirement. If you look at it over time, really microprocessor technology and memory technology diverged quite significantly. But if you take a snapshot now and look at dynamic RAMs, how they are manufactured, versus look at microprocessor products, they are different technologies to a very large extent. The silicon, the silicon gate, they use many of the same manufacturing steps, but they have different structures. There are many steps which diverge, and that was sort of the beginning of that.

And, of course, as long as the mainstream of activities was memories, microprocessor designers kept complaining that, "I need these. I need that. I need that." But in the back of our mind we felt that since manufacturing cost is driven by the highest-volume product, which are memories, you first and foremost have to take care of that requirement. So that's the closest I can remember of what life was at that time.

**BROCK**: Well, 1979, then, marked another change point for you in your work life. I believe you were named senior vice president and director of the corporate strategic staff. Could you describe that new role and the discussions leading up to you taking it on?

**VADASZ**: Yes. Let's talk about first how we got to that. I was kind of interested more and more in how do you grow in multiple directions, memories, systems component, microprocessor system component, whatever other leading-edge product we made. How do you plan? How do you develop the institutionalized smarts that a small startup company have, where their managers do the planning of what happens within that business segment.

I was advocating that we need to do the same thing. We ought to develop a structure, sort of a corporate framework in which a bottom-up, top-down process continues to be modified up and down, up and down. Process can be developed to plan these businesses and create strategies for these businesses. It shouldn't come from a corporate edict, but it should come from within the business unit, with some top-down direction from corporate. That's what was really the role of the corporate strategic staff. To make that happen. And I guess I was loud enough advocating this scheme that eventually I was asked by Andy, would I do it. So it was, again, something interesting to bite into, and I started doing that.

That was the beginning of the strategic planning process. Over time this needed quite a bit of modification, because it's still a very difficult thing to do. It is difficult for corporations to do good strategic planning. I don't know of one single corporation that does it really well. Intel probably at various times has done it well. Today they may be doing it well, but it's a continuous process that requires modification.

**BROCK**: As the organization itself changes?

**VADASZ**: That's right. And individuals change.

**LÉCUYER**: I would say that planning is especially difficult in a business that is very fast changing. My question would be it would be especially difficult to plan in a business that is changing so fast, right, as integrated circuits, it might be easier to do that in the chemical business.

**VADASZ**: Well, you know, today, at any given time there are segments of the business which are growing incrementally, and there are parts which are much more subject to change. I think it's very important to recognize the difference and apply the kind of operating methods that are required for one or the other. The ones which are rapidly changing, you have to roll with the changes much more, and have to be able and ready to adapt. The one which changes less, I think that incrementally you can plan it quite well. And, you know, if you look at a corporation like a high-technology corporation, you have to have some very solid planning, given that you have to invest billions of dollars into product and manufacturing development before you see a dollar returning out of it. So you have to make some important bets.

**BROCK**: What was the planning process like, or lack of planning process, that was leading you to call for wanting this new process, this modulated bottoms-up, top-down?

**VADASZ**: Well, if I remember, the planning process was quite centralized; discussion between a few people, rather than discussion within the organization, with the involvement of top management. There are two kinds of things that you needed to plan, business areas and capability areas. So we define strategic business segment and we define strategic capability segment, like a manufacturing capability, technology capability, sales capability. Each of these started to have their own planning. They created little groups in which the people who do the work together with the managers.

For example, in a technology-planning section you may see Gordon Moore in the same group with a twenty-some-year-old Ph.D., just recently out of college, discussing topics of interest. I think that's one of the healthiest things that you can do, you know, combining the most current knowledge power with position power, and everybody leaving their ego at the door, and basically focusing on the problem. It's a learning for both, and I think that at the beginning, our planning process really got the best out of our people. You didn't have this hierarchical top-down thing, but it was a top-down, bottom-up, top-down, bottom-up. Andy did write about knowledge power and position power. I think that was a very important initial phase of what the strategic planning organization needed to do. This became part of the culture of the company. And even though we needed to modify it many times, this is still a fundamental element of the company. It's still there.

**BROCK**: Did establishing that process run counter to the existing organizational culture, or did it seem to fit?

**VADASZ**: Well, I think that people were easily adapting to it, because probably there was that need. People felt the need that there ought to be something, so when we started to systematize this, I don't perceive that there a resistance to it.

**BROCK**: And your role in it was then the overall process?

**VADASZ**: Well, basically to set up the system. Again, it was just trying to think through the problem.

**BROCK**: We talked about the planning process involving mixing people with knowledge power and position power. How did the interface with the board of directors work with the whole planning process? Was that an important factor?

**VADASZ**: Frankly, I do not have a great deal of visibility of that. I think that Gordon and Andy would be a better source for that than I am.

**BROCK**: Okay. Were business issues addressed in the same manner, in this planning process, as more technical matters? Was it the same form of planning?

**VADASZ**: What do you mean?

**BROCK**: Well, was it different for, if you're thinking about, let's say, planning for process technology and planning for sales capability, was the form of that planning process the same?

**VADASZ**: Well, in effect, similar, but you have to realize that when you are running a manufacturing line you need some idea from the business unit of what are they going to need, in order for them to do the manufacturing line, or the technology development area to do their activities. So there has to be an interaction. There has to be input from the business unit. Business units, need to be able to make some assumptions of what they will need. But once those inputs are there, then they can really look at technology, to capacity, to cost, to geography, to organization, all of those factors. What is really important, is these various interactions.

**BROCK**: And the planning process itself helped facilitate those.

**VADASZ**: Absolutely, absolutely. It was an integral part of it. And even today, at least when I left, when manufacturing does the planning they need to know roughly what's the expectation of the business unit for their business.

**BROCK**: So if my research serves me well, really driving that strategic planning process and instituting it into the culture of the organization was a big focus of yours throughout the mid-eighties. Is that correct?

**VADASZ**: Early eighties.

**BROCK**: Through the early eighties. In this period I think maybe two things are happening. One is rocky times beginning for memories, and the PC or the IBM PC and that phenomenon starting. How did those two occurrences figure into the strategic planning? Did they become hot topics? Were they captured there?

**VADASZ**: Well, obviously, the memory situation was a hot topic, and we certainly found that we were not ready. The microprocessor situation was much more loosey-goosey. We didn't quite know—there were a number of different product lines gaining some ground, but we didn't quite have the clarity of that business in our head as the memory area. And just as importantly, the IBM design came about very quietly, like it wasn't such a noticeable event. I don't think we were ready to wave the flag. It was later that we recognized its significance.

So that did not factor in as much in our thinking than the fact that our memory business is not doing well. So it was a bit of a culture shock for the whole organization when Andy Grove proposed that we get out of the memory business and put all our eggs into the microprocessor basket, and that turned out to be the most dramatic decision that the company ever made.

**BROCK**: In what role were you serving when that conversation was going on?

**VADASZ**: I really had no operational role in that. And initially, I have to say, I found it very, very worrisome, because I believed also in this volume cost driver; needed a high-volume cost driver. But I think increasingly I satisfied myself that the microcontroller volume was pretty high, and also, Andy's logic was irrefutable. I think that the arguments against Andy increasingly were more and more based on…it was emotionally hard to get out of the business that was the foundation of the company. But his logic was just overpowering, and I certainly did not feel that we should stop that change. I cannot say that I was leading that change, because Andy was leading that change.

**BROCK**: But I would just imagine such a huge shift would be <u>the</u> central discussion in terms of the planning.

**VADASZ**: Yes.

**BROCK**: Is it your impression that part of his argument was not so much that Intel couldn't compete in memories on the technical playing field, but rather that the investment required to do that would no longer be fruitful?

**VADASZ**: Well, I don't think that he broke it down that much. He basically said, "We are not successful in this business. We have been trying; we are not successful." I think his words were, "if we were new management, if the new management came in and looked at the business we have, what would they do? They would most likely cut the business that doesn't produce, and move on to the business that has a chance to produce. Why do we need the new management for that? Do what is the right thing to do." And eventually that's what we did.

There were many factors that created the situation, and one of them, you have to say that others had very competitive and in some cases better devices than we did. The competitive situation with dumping of products in the U.S. market definitely was a factor. It probably created an overall environment where for other U.S. manufacturers, not just Intel, made it difficult, if not impossible, to be really an effective competitor. So I'm not questioning that, but even within that, you know, our devices at that point in time did not excel technologically. But, frankly, even if they did, I don't think it would have mattered, because the whole U.S. memory business was in a dire situation.

**BROCK**: Certainly for a period of time the company did enjoy a technological, or let's call it a technical advantage in the memory—good devices, good quality, things like that. What do you think counted for that sort of reversal of technological fortune in the early eighties or so?

**VADASZ**:  Well, you know, I think you see this over and over again.  There's a market leader with a certain position in the market, putting all or most of his effort into that product line that is creating that position.  A competitor comes and is able to look at the strengths and weaknesses of that line, and does something better, while the market leader is having a hard time both doing something better and maintaining his line.  That's kind of the situation repeated over and over again, and I think that that's what happened there.

And, you know, given enough time, given the right market dynamics, probably that wouldn't have mattered.  Eventually we would have had the right devices, the right capability.  If you look at Intel's history since then, any temporary disadvantage, in a year or two years later turns into a very strong advantage, because the company is able to focus various resources on it.  But I think that the underlying market was so difficult because of the dumping situation, that there just didn't seem to be a feasible alternative.

Now, don't forget that when that decision was made about DRAMs, that wasn't a decision about some of the other memory products.

**BROCK**:  EPROMs.

**VADASZ**:  EPROMs.  We also felt that the static RAM did quite well, but then eventually we started to focus the static RAM activity on embedded area as part of the microprocessor.

**BROCK**:  So after establishing, embedding the new planning system into the organization, what was the next role that you took on?

**VADASZ**:  Well, while I was doing that I was also doing a variety of difficult projects, and probably the most difficult of these was the nurturing of what eventually became the 432 Project, the Gemini Project with Siemens.  Then after that I became—that was the mid-eighties—became head of the system group.  Then in 1990 I did yet another new thing, is setting up our investment activities.

**BROCK**:  If we can go to that period in the early eighties, before you become the general manager of the systems group, did this 432 Project and the Gemini Project, neither of which I really know about, so I'd be interested to learn a little bit more about them, but was this the case where you were deployed to kind of put out a fire, so to speak, or tackle a particularly difficult thing?

**VADASZ**:  No, no.  Back in the earlier time when we were developing the 16-bit machine, the 8086, there was a rather controversial project that we were also nurturing, that was originated by

Justin Ratner, one of the engineers who came from HP, who basically wanted to create a machine that was sort of starting with a clean sheet, taking a bunch of computer science results, if you will, and combining it into a new-generation machine. Now that we had enough silicon power we could do some of those things. And so Gordon Moore defined this project as, you know, unfettered by the past, if you will.

Well, that project never got much traction versus the 8086. The more pragmatic engineers created a simpler and more mainstream machine, and on that generation that machine won the market. Yet at the same time, the concept of a machine unfettered by current designs and using the latest technology was just too hard to walk away from, so we kept nurturing that thing. But as you can imagine, this kind of thing can easily become an orphan in a business environment. Management is required the utmost rigor of running that business, and a new idea becomes, you know, a bigger and bigger project with no home.

And as you can probably see from the previous history, I have always been drawn toward the lunatic fringe of ideas, and to me this was a very worthwhile thing to continue with, and I absolutely wanted to nurture it. And, you know, in a way, just as a sidebar, one of the best parts of the Intel career to me was that I was always able to nurture ideas. Some succeeded, some failed, but I had the ability and the means and the trust of management that probably they thought that, "Well, gee, Vadasz may be crazy, but when the right time comes he will probably be ready to walk from it, or ready to move it along to some other areas." And that's what happened in most of those cases.

Now in the case of this project, it really needed incubation, nurturing, separate from the business unit, and so I took it. Not only that, but it needed to get enough funding so that we could really get the benefit of all these new ideas, which required new system development, new software development, and definitely new component development. So we created this—we negotiated with Siemens, who had requirement for a new generation of machines, and our engineers convinced their engineers that this was a reasonable thing to do.

So we had this joint project which became the Gemini Project, which ended up delivering many of the capabilities that we were aiming for, like the kind of reliability, uninterrupted operation, change cards in the machine while running, the failsafe fault-tolerant capability, object-oriented programming, and a number of capabilities that really were state of the art. The problem was that in some of the basics it did not achieve its goals, like initially the performance was not up to par with what we could do with the simpler machines. And certainly the momentum of the other business was such that it really never amounted to a significant enough business.

And while we ended up using a heck of a lot of the technology in other areas, finally after many, many years—I think that was in 1986, probably—we basically quit on the project. And I have to say that that was probably the hardest call I've ever made.

**BROCK**: To stop.

**VADASZ**: To stop. But it was again obvious that even though we had won many of the battles on the technical side, we didn't win the war. That was not going to be a mainstream microprocessor family, it wasn't going to be a mainstream system business, and time to quit.

**BROCK**: What were some of the end products that that component went into? Siemens computers?

**VADASZ**: Well, they were fault-tolerant high-performance machines, mainly servers, basically. The chip work ended up in two directions. One, part of that work resulted in some of the math co-processors that we ended up selling with the 86 family, and the other derivative was the 960 family, which was a 32-bit machine, again very much niched and never really achieved a very high volume, but at least resulted in some revenue. Obviously, the system and the software concepts ended up in bits and pieces everywhere else. But as a coherent project, we finally stopped it.

**LÉCUYER**: So was this a joint venture with Siemens?

**VADASZ**: Yes, it was a joint project with Siemens. It wasn't a joint venture as much as a joint project.

**LÉCUYER**: That would be really managed by—

**VADASZ**: Well, it was basically managed by both Intel and Siemens managers. There was an oversight group, I was part of it, with some colleagues from Siemens. There were Siemens engineers working in the U.S., and some Siemens managers working in the U.S. There were projects in the U.S. There were some projects in Germany. It was a fairly extensive project. And again, the ups and downs of that project, at least in the way the outside world could get information, has been written up.

**LÉCUYER**: If we go back in time, how did this project come about, this collaboration with Siemens?

**VADASZ**: Basically, I felt that we cannot do that all ourselves, because the financial requirements of the project were just too much, and I wanted to get a partner. So Siemens was a logical partner because they needed a new generation of machines, and we kind of collaborated on it.

**LÉCUYER**: Was RISC one of the technologies that you and Siemens considered at that time?

**VADASZ**: What?

**LÉCUYER**: Was RISC, reduced instruction set computing—

**VADASZ**: We were looking more of tops-down. RISC is basically how you do a CPU. We were looking at, okay, what does a system capability have to be? How do you program this system? What kind of physical reliability characteristic does it have, failsafe characteristics, on and on, transaction processing capability, scientific processing capability. To me, going from there down to how you do the CPU—a number of us felt that whole RISC debate totally missed the point about looking at the minutiae rather than the system capability. And if you look today, those of us who felt that was an oversimplification basically were pretty much right. RISC versus CISC doesn't matter; it's what your machine can do that matters.

**BROCK**: Was it around the same time when you had to make the decision to end the Gemini Project that you were also moving toward this new job of general manager of the systems group?

**VADASZ**: Actually, I took that job with me, so I think that when I went to become general manager of the system group I still had this whole project. I was the chairman of the company we created around the project (BiiN), and finally we called it quits.

**BROCK**: At that time in 1986, what else was in the systems group? Development systems?

**VADASZ**: Development systems and the board-level projects. Multibus II, I believe was a product line.

**BROCK**: You'll have to forgive me that I don't have this on the top of my tongue, but when did the '386 come out, in 1987? Was that around this time?

**VADASZ**: The ‘386 was around—no, earlier than that; mid-eighties, I think. The 486 was, I think—no, ‘386 was earlier; 1984?

**BROCK**: I think you’re right.

**VADASZ**: Again, when the ‘386 came about, there was again a question, is the ‘386 the right machine or the 432 the right machine? The same thing happened in that generation as on the 16-bit generation, is that it became more and more obvious that the ‘386 could deliver what the market needed, and the 432 just didn’t come close in performance to it. Plus at that time, compatibility did matter. Compatibility did matter a great deal, and as a result, it was very important to nurture that segment of the market.

**BROCK**: What I was wondering was with these board-level products, for the systems group in the early days when you were running it, I’ve read in some places that often Intel would be supplying the computer manufacturers with the motherboards—

**VADASZ**: That’s right.

**BROCK**: —for their new machines for a while, until they did.

**VADASZ**: That’s right. I think that we did that for special-purpose machines with the Multibus. I told you earlier that Multibus moved to Multibus II generation. And eventually, we did that with the PC motherboards as well. That has always, in retrospect, served us well as a way of accelerating the designing of a new generation of computers, because we could design that motherboard parallel with the design of the chip, so that we could move that into the market as a board-level product. This was used earlier than if the customer had to design his own board.

And, frankly, Intel as a system company really wasn’t a very successful company, but it was a very effective company in using system capability to accelerate the market for its component. The motherboard concept was, and continues to be, a very important one in developing the component market. As a business by itself, it doesn’t compare in either success or in significance, in terms of number, to the component business. And at various times we had, to be frank, the delusion of grandeur, that we will be a more significant system company, and we’ve never really became that.

**BROCK**: Now, when you say that vision of being a more successful systems company, was that, at certain points, considering, “Well, let’s just make Intel make a personal computer”?

**VADASZ**: Well, there are limits. Any time you make an end product which competes with your customers, and how far you can carry that business is limited. No matter how far you want to carry it, eventually your sales force will tell you, "Damn it, it's hurting my component business." So you're pursuing those kinds of businesses successfully to some level. Beyond that level, it's competing with one hand tied behind your back. I think that has been fundamental to what always limited, and in my mind will limit, Intel's participation in the system business. Having said that, system technology is an essential part of Intel's needs, because that is a major influence on how they design their products, and also is a way to accelerate the acceptance of those products in the market. But I think that it took us probably thirty years to figure this out.

**LÉCUYER**: But there's also a long tradition at Intel whereby the company helped the customer design its products, right? It seems to me that was the case for the design aid for microprocessors. I mean, they were of some help also with the 1103, if I'm not mistaken.

**VADASZ**: Well, I mean they did that—

**LÉCUYER**: There is a long, I mean—

**VADASZ**: A long tradition, there's a very long tradition. But all I'm saying is that anytime you think that you can become a Dell, think again. You can help your business with a Dell, by providing them initially some motherboard, and I have no idea whether—I don't remember whether Dell ever used them, but that's beside the point. I'm just trying to make a point that there is a limitation there.

**BROCK**: In some ways it seems that there's a parallel dynamic with the decade before that, with the development systems, a similar sort of function that it was serving. Maybe earlier, the development systems themselves were more important or more successful from a business standpoint, that they were really facilitating—

**VADASZ**: That's right. That's right. All of the successful system activities of Intel essentially—yes, I think all—was in facilitating component sales of one sort or another, which I wouldn't be sneezing at. That's a very good role, as long as you recognize that that's the role.

**BROCK**: Right, which might be hard for some of the people designing, you know, working in the systems area to take, if they thought, oh, we have a much better product here.

**VADASZ**: That's right.

**BROCK**: In 1988, I believe, you joined the board of directors of Intel.

**VADASZ**: Yes.

**BROCK**: Could you tell us a little bit about how and why that happened?

**VADASZ**: Well, it happened because I was asked to. [laughter]

**BROCK**: Who asked you?

**VADASZ**: Well, I was reporting to Andy at that time, and Andy was the person who told me that I was nominated to the board. I felt that that was an honor, hopefully a recognition also of my ability to contribute at various levels, and I was probably in seventh heaven.

**BROCK**: I had a couple of questions about the board of directors, then, in this period, let's say from when you joined, the first couple of years. Gordon Moore was chairman of the board in those years, and in the context of the board work, could you describe his role and styles and contributions as chairman?

**VADASZ**: Well, there are a number of distinct places where Gordon's presence really was sort of the major influence on the behavior of the group. Probably none of them were as obvious as in the board. I mean, Gordon was very much—if Gordon believed in a technical direction or a business direction, it was clear that that had a major impact on the thinking of many on the board. He's very highly respected as a man of great intuition, really at the gut level. Everybody trusted Gordon's understanding of the business and of the technology.

If Gordon said that we need to spend five billion dollars on manufacturing plants next year, you know, obviously there were some figures associated with various details, but if it was okay with Gordon, it was okay. That was the kind of respect that he elicited from that group. And, of course, the major role of the chair, in my mind, is to manage the agenda of the board, and Gordon's job was to drive the agenda of the board and make sure that it satisfied our internal operation need, as well as the needs of the board. But, I don't remember—if you're asking me is there an event that I remember, I don't.

**BROCK**: How often did the board meet?

**VADASZ**: Every two months.

**BROCK**: Did the board activities consume a lot of your time?

**VADASZ**: No, no, no, no, no. Don't forget that I was an inside board member, which is a different role than being an outside board member. I think over time the biggest amount of board time for me was talking about the various investments and acquisitions that the company had done. But otherwise, no, it didn't take much time.

**BROCK**: This next question I have might stretch out a little forward in time, but how would you describe your role and contributions to the board, and how that may have changed or evolved over the years?

**VADASZ**: I think that when you're an inside board member, in a way you are a resource to other board members who do not necessarily have as intimate knowledge of the business and technology, and to some level I served that role. Sometimes board members talk to me even today about a particular issue or question, so to some level, even though I'm not on the board, I probably still serve a role here.

**BROCK**: Keeping it maybe to the early years of your participation, would you describe that board as effective, well-functioning? Were there any problems about the board per se?

**VADASZ**: Well, I think that the best way to look at it is that the company was doing very well, and the company was making some very bold bets, investing huge amounts, and the fact that the board supported management in many of these things, and at the same time provided the kind of oversight that required—Intel was written up as having one of the best boards year after year, one of the best corporate governance examples year after year. That happened—I don't remember whether Andy was chairman or Gordon was chairman. It was a continuity. So I have to say overall, Intel board has excelled. It's just that there are very few corporations in the world which have done better on corporate governance than Intel, or even close to as good.

**BROCK**: What do you think goes into that success? Why is that?

**VADASZ**: Well, it starts with feeling comfortable with the management, and complementing management rather than second-guessing management. At the same time, it's your fiduciary responsibility to ask for accountability. You select the right board members, the right mix, good thinking capability, and hopefully you get the right results.

You cannot give a cliché answer. I don't quite know how do you write a formula that, well, if you only do this, it will work. You will know when it doesn't work. Like everything else, you nudge it along. Remember, management by nudging.

**BROCK**: Becoming a board member, was that helpful for you in running the systems group, to also be a member of the board of directors?

**VADASZ**: No. No. Hopefully it was helpful, as I said, me as a resource for others. Certainly it was helpful for me; another opportunity to learn corporate governance. But just specific to my day-to-day job, I didn't really get much help from it.

**BROCK**: I believe it was also in this period, somewhere in there, that you spent some time at the Harvard Business School. Is that right?

**VADASZ**: That's right. Basically, my running of the system group ran its course around 1990, and the change was that I was going to start looking at investment areas for the company. Frankly, I took a breather and went to the AMP program, which was very useful, because I had an opportunity to look at, in a rapid-fire way, look at analyzing various business models and businesses for three months. Two months, three months? Dozens and dozens of case studies that you do, some related but many unrelated businesses, and you can understand well what makes these businesses tick. You learn to analyze the various businesses, from finance point of view as well as from operations, technology, market, competitive environment, points of view. And that was very helpful.

But what really I came back to do was almost like combining all my previous experiences of both component and system and business and technology, to look at how does a company use its financial resources to influence what happens on the market. What Intel Capital really became is an organization that tried to recognize that there's a market ecosystem in each market segments, and you are delivering one or a few products into that ecosystem. But that ecosystem is made out of a number of players, and if you really look at how these market ecosystems develop, they are sort of a random motion.

When you develop a microprocessor, eventually somebody develops the right software. Eventually somebody develops the right systems, and then, you have a market. Then the next microprocessor comes; the whole thing starts all over again. So you can ask yourself a question, what if I could accelerate these ecosystems developing faster, in a way taking the same concept, what we have done internally with our system products, and trying to accelerate what happens in the marketplace by making some judicious investments in companies who are in our same ecosystem, but you want to accelerate development of their products.

Considering what kind of lifecycle we are talking about for these products, I mean, a microprocessor doesn't last for ten years. A small single-digit year is its prime life. So if you can accelerate during this prime, the ramp at which this market develops, that can mean billions and billions of dollars, not only for you, but also for the whole market. And conceptually, that's what Intel Capital has always tried to do. Sometimes it was a modest step. It was only—well, we need to accelerate some new equipment for our next-generation manufacturing line. Sometimes it was much more ambitious, like in the Centrino product line, when you really tried to get not only the system elements, but also services, the wi-fi services out in the marketplace, to get them faster and broader coverage, and make sure that they work with your devices.

So it took different concepts, and it evolved over time, but that was the idea. Use your financial means to get the market to move faster. And, of course, if you do it right, financially you should be doing very well, because you can't just invest for the love of technology. If those companies don't succeed in their markets, it doesn't help you. So you have to have a significant part of your decision process be: are they going to succeed, or do they have a chance of succeeding. So you're using venture capital methods that were developed over the last several decades coupled with your knowledge of the Intel product line, with your knowledge of how businesses work, and the financial resources of the company. And, frankly, it's the best job that one can ever have. People asked me, "Do they pay you for this?" [laughter]

**BROCK**: Now, in the early stage of setting up Intel Capital, that ecosystem idea, that was your motivating idea for getting Intel Capital established?

**VADASZ**: Well, you know, the first job was—I mean, we moved along step by step. The first job was more basic. Because of our own needs we have had a number of investments. Each of them made logical sense on their own, but in sum total they were kind of mishmash. One investment may be to a little company that was developing some algorithm for multimedia. Another investment may be an equipment company for next-generation manufacturing. But all investment had to do with some business interest of Intel. We started from that, take stock of what we had, and start moving forward into where we want to be. Broadening and getting bolder and bolder about the total ecosystem was an evolution over a decade. But it was always to invest in the business interest of Intel.

**BROCK**: We talked before a little bit about, well, for example, in this project with Siemens, in a way, and maybe not explicitly, but I think kind of de facto, that was sort of an internal venture, investment for new business. Around 1991 when you're getting this really going for the external investments, what was the situation like for the internal new business sort of venture investment?

**VADASZ**: You mind if I break?

**BROCK**: Oh, not at all.

[END OF AUDIO, FILE 2]

**BROCK**: Yes, that internal sort of venture investment.

**VADASZ**: Well, Intel has always nurtured a variety of projects at a variety of levels. I do not have the feeling that it was a particular strength of the company to create new businesses out of these things, particularly because Intel was so focused for a long time on the personal computer side. So many of these things did not really result in new avenues for the company, but various projects were nurtured at various times, sort of outside the mainstream. The farther they were from the mainstream, the harder it was to try to create something out of them. The closer it was to the mainstream, the more the ideas could be absorbed in the mainstream. But that's a different thing than when you look at the market for your product and you start investing in companies that can help your products.

**BROCK**: Right. So you have a different practice for this.

**VADASZ**: That's right, yes.

**BROCK**: When you're establishing Intel Capital, what was its organizational or legal status? Was it a subsidiary of Intel?

**VADASZ**: No. In order to assure that the right investment vehicles existed, you structurally do a number of things. But basically it was an entity that was part of Intel, very much linked into all the business activities of Intel. I mean, our finance side was part of treasury, and they were in my staff meeting, but they were also part of treasury. Our legal side was part of legal, but they were on my staff, yet they were part of legal.

This is the kind of matrix Intel has done all the time, and Intel Capital was very heavily matrixed. Many of the investment people were either in my organization with a linkage to the business unit, or in the business unit linkage to my organization.  It was a worldwide organization, because, you know, what you do in Japan is different than what you do in Germany, and we really had a worldwide presence.  By developing the ecosystem for your product in China, that's a different animal than worrying about what you do in the U.S., and you have to really have not only a product-line strategy in these, but also a geographic strategy.

**LÉCUYER**:  So, I mean, in a way it was an international division of Intel.  In many ways it was an international division.

**VADASZ**:  Oh, it was very much multinational.

**LÉCUYER**:  It was a division.

**VADASZ**:  Division—

**LÉCUYER**:  Am I right, or—

**VADASZ**:  It reported to the CEO.  It was really part of the activity of every division.

**LÉCUYER**:  I see.  So the analogy would be to corporate—

**VADASZ**:  It was a corporate organization, very heavily linked to the business units, and the people, the business people, the investment people spent most of their time out in the market, out in the venture community, out in—essentially be present in the environment to understand what are the deals, what are the companies, what are technologies that we potentially can be involved in.

You know, also the group served as a knowledge base to make the division understand a broader market than their product market.  I really think that is very important; to look at the market.  If you look at today the company's evolution in its organization structure, "mobile," "enterprise," and "home," that's very much of the same view that you need when you are looking at the world from Intel Capital's point of view; how am I going to get this computing device to be part of the whole.

**LÉCUYER**:  I was wondering, did you hire any people from venture capital partnerships to work for you?

**VADASZ**: We hired some from there, but we tended to grow our own, and the reason for that was, in order to be effective you needed to understand Intel. You needed to understand the labyrinth of a big company, of how to associate what's happening on the outside with what's happening on the inside. See, that's where many, and probably most, corporate venture organizations really failed; they looked at it as a venture activity, a financial activity, and even when they tried to associate it with their business trust, they couldn't really, because it was a separate entity. Intel has woven it into the fabrics of the organization. We don't do anything simple. [laughter]

**LÉCUYER**: Except it was a very interesting insight.

**BROCK**: How did the Intel Capital activity relate or interconnect with just outright acquisitions that the company was making?

**VADASZ**: Well, again, Intel Capital had the knowledge of how to do these things, but the acquisitions were really the responsibility of the business unit. But we, Intel Capital, provided both the structure of how to structure a deal, and many times the sanity check of "Does this make any sense?" So we were almost like a support activity for the business unit, but the leadership had to be from the business unit; they had to want it.

In fact, when we were structuring the deals for presentation for the board, I made it a specific issue that I want the business unit manager to stand up and try to justify his deal to the board. I will help the individual with all the necessary tools and ammunition, but it's his deal. Obviously, if I thought that a deal was an absolute bummer, I tried to stop it before it happened, and it happened in many cases that we did stop it. But if you expect the business unit to make a business out of it, you cannot do it outside of the business unit. You have to do it inside the business unit. That was the dividing line in the responsibility.

**BROCK**: I asked you a question before about how engaged or what was the attitude of various people toward the microprocessor business. Here I'd like to ask, what's your impression of Gordon Moore and Andy Grove's sort of orientation to Intel Capital, what it was doing, and its motivating idea about shaping the ecosystem?

**VADASZ**: Well, I think they supported the concept. I think Craig [R. Barrett] was probably the most supportive of it, because he was out in the field and he saw the impact that it had, and he utilized it as a way of marketing Intel. But I never felt lack of support from either Gordon or Andy. Of course, during that period of time Gordon was less and less and less involved, and Andy was somewhat removed, but he liked to come to Intel Capital events. He liked to engage with the people, and he felt that we had invested in some very bright companies, and was very much interested in engaging with some of the stuff. So I felt supported by—I mean, these kind of things you cannot do, like what Intel Capital has done, without the very top layer of the company supporting it. And since I retired, a number of companies asked me, "What is required to make something like this successful?" and I asked them, "Well, what does your CEO think about it?" And generally I get the answer, "Well, yeah, he's interested, but he's too busy. This is going to report to one of the underlings." And I said, "Good luck. I'm very suspicious that it's going to work."

Yet at the same time I got the other input from others who—people were sent to us to look at what Intel is doing, where the CEO said, "How come Intel can do this and we can't?" And I say, "Well, did they have an Intel Capital?" So it works both ways.

**BROCK**: Do you think that an activity like an Intel Capital or a sort of institutional venture capital function in a corporation, it needs that very top-level support because of the timeframe it takes for the investments to bear fruit, both in terms of advancing the business interests and just the financial?

**VADASZ**: Well, I think it does. I think it does, because that's where the total corporate interest comes together. You know, no matter what you do, when you get down to various business units you're talking about local optimums. It's very hard to take a global view of the total business of the company when you focus on local optimums. Even in the best companies, you tend to look too much in your own lab rather than looking at the world out there. So I think that I would be very skeptical if something like that didn't report to the very top level.

**LÉCUYER**: If we go to the details and we take the details of Intel Capital, how did you find the deals? How did you select them?

**VADASZ**: Well, first of all, the selection process comes through the organization, and the deals can come from many sources; your barber, conferences that you attend, or from unsolicited inputs. I mean, it's really random. Or a VC calls you that wants you to be a partner. But I think the main thing is that you participate in conferences where small companies participate. Sometimes you participate in university conferences and engineering conferences, and you start understanding what's happening.

**LÉCUYER**: So then would entrepreneurs come to you or come to Intel?

**VADASZ**: Or we go to them and we start engaging, and then, you know, the deal gets through various phases of vetting. You start working with the business unit and with the engineers, or the marketing people. Eventually there are some decision meetings that general management gets involved, and eventually it comes to Intel Capital management, and that process can take a month, three months, six months. Sometimes it's faster than the VCs, sometimes it's slower than the VCs, but it always gets business unit involvement.

**LÉCUYER**: If you have any goals or rules regarding the share of the company that you want to get—I mean, what was the percentage of the stock that you wanted to get control of?

**VADASZ**: No, no, no, no, no. You work with certain rules that we developed ourselves. One is that you make sure that you invest a meaningful enough amount. You should have some level of business relationship. If there is only a financial return on the investment, you don't go into it. There has to be some other return. You never take board seats, because it creates some liabilities for big companies that are hard to handle. You know, an Intel is deep pockets…things may not go well with a company. You don't want to be sued that it was your action on the board that may have created some situation for the company. So you made the investment, you have the business relationship, but on corporate oversight you depend on others. Hopefully, you invest with good VCs who can provide the right oversight. Those were generally the rules.

**BROCK**: In not too long a span of time, Intel Capital, I believe, became one of, if not the world's largest and most active institutional venture capital investment organization. Was achieving that position more by chance or by design?

**VADASZ**: I never looked at it as something that you strive for. It was not by design. I always looked at it as you invest in order to have an impact on your market. Sometimes that's more, sometimes that's less. Obviously, in that crazy go-go time of investments, there were lots of companies that we and others invested in. Some of them were smart investments. Some of them were dumb investments. But basically I always looked at it as, what do we need to do to have an impact?

Interestingly, whenever we discussed this at the board, Intel Capital never had a budget. We always did it in a way that, "We will invest based on needs and opportunity." There were some placeholder numbers, but we felt that if we have a budget, say next year your investment is going to be three hundred million dollars, then the natural reaction of the organization is that they'll invest three hundred million dollars, whether it makes sense or not. So what we did was really try to aim it toward just what are the right investments.

**BROCK**: So growing to that sort of size and that amount of activity was determined more by what you thought was needed to shape these markets.

**VADASZ**: Shape these markets, and have a worldwide presence. You know, that was the time when we really started to expand heavily outside of the U.S., and if you look at today, Intel's market is something like 75 percent outside the U.S., so it matters a lot how those markets develop.

**BROCK**: That's very interesting. One of the things that I've read, that several people have pointed to as distinctive about Intel Capital, is the practice of providing companies in the investment portfolio with services, and also interconnecting them in various ways.

**VADASZ**: Yes, correct.

**BROCK**: Could you tell us a little bit about that?

**VADASZ**: Well, we gave some seminars for these companies based on our experiences with growing a human resources organization, or what are some of the financial controls that we feel are needed, you know, just basic blocking and tackling stuff. This may be obvious to you once you have run a corporation like we did, but it's really needed for the new entrepreneur, and it was the kind of knowledge transfer we had no problem doing. I don't know whether it's going on now or not.

The other thing is that through a variety of means, including once-a-year Intel Capital event, the CEO event, we created some groupings, connected the companies to potential business partners, sometimes to potential investors. Again, something that they would have had a harder time doing on their own. We provided a sort of "oiling the wheels" function and these were well accepted, very well received.

**BROCK**: I can't think of the right term for it, but were there technical linkages, almost engineering help, things like that?

**VADASZ**: Oh yeah, oh yeah, oh yeah. I mean, we could significantly improve the software of a company running on our machine. Sometimes as much as a factor of several, a factor of five, a factor of ten. Now, when you improve a factor of ten you ask yourself, gee, what poor software did they write? But the point is, our people know how our machines work, and they can help other software engineers. That's one of the most in-depth technical involvement, but there are some others. Just understanding better Intel's roadmap, will provide them with some ideas of how to steer their product line. So that was definitely an integral part of our engagement.

**LÉCUYER**: What were the greatest successes in your investment activities?

**VADASZ**: Well, to me, the biggest success story that I remember is the Centrino family, where we have invested in companies that deliver pieces of the products, to the total product. We have invested in companies that provide service capabilities. We have influenced both the internal organization, about what the market looks like, and the external organizations, what our product's technology capabilities are going to be. That probably was the culmination of all the various learnings that we had over the years, and I expect that that's the kind of activity which is going to be baseline for the future.

And, you know, it never mattered to me—I mean, obviously it does matter, but it never was the most critical thing; "Gee, we invested this much in this company, and look how much money we made." We made money overall, to the level of billions of dollars cash on cash on these activities. But it was never really the most satisfying element to me. It was could you really influence, move the market? I hate to put it in that term, but sometimes you feel like a puppeteer.

**BROCK**: It seems to me from what I read that this whole—just to try and stick the label on it, but the whole wi-fi phenomenon, which is what we're talking about here, really seemed to be one that was—I mean, you were a particular champion, let's say, of that technology from the early days. Is that fair?

**VADASZ**: Yes, but that is my techie part, okay. But, you know, it's really Intel Capital that's able to take a more business and market view and utilize a little technical push.

**BROCK**: Yes, but I just think it's a very interesting situation, or an interesting development, where you're in the position to, by inclination, you know, oriented towards new stuff, being able to appreciate the potential of that technology, having a natural link to, okay, well this would be great for selling more microprocessors, and then having the amount of resources to really create an environment where people are going to be providing this signal, so people would want this capability in their machines. To me it seems very interesting, given especially where wi-fi is now, you know, at McDonald's.

**VADASZ**: Yes, and that's why I was saying that to me the most satisfying of them all was the Centrino, because it had all these elements. But I'll let the market judge.

**BROCK**: Do you think that these same sorts of considerations have shaped how you look at, or how Intel Capital looked at things like digital media and all the copyright sort of issues around that? Because that would seem to me to be another big area.

**VADASZ**: Now, you relate it to my activities in Congress?

**BROCK**: Well, I read this thing in the *Wall Street Journal*, yes, from a year ago or something. Is there a connection there, do you think?

**VADASZ**: Well, again, as part of getting involved in some lunatic fringe type of engagements, this whole area of digital rights management got me interested, because, it's an industry issue, a technology issue, it's a social issue. I got very concerned that we're going to take some misguided steps which are going to really be disastrous for the industry as a whole. See, I have a very strong feeling that technology, no matter how badly it has been misused at times, has been a great boon to society over the years and the centuries, and we have benefited tremendously by taking advantage of the result of our creative minds.

When I saw that through some misguided action the government may do some really serious harm in this, obviously I had no problem getting involved and being as much on the frontline as needed to be, to try to stop that. So when this bill—and I was not looking for this role, but what happened was this bill was introduced by Senator [Ernest F.] Hollings [D-SC], which basically would have required that government has to pass judgment on what's inside a CPU. In other words, Hollywood basically wanted to put some mechanisms inside the CPU which would have stopped copying and putting media content on the Internet and exchanging it freely. In a way, make a DVD player out of a PC. Now, a PC is a general-purpose machine which, you know, among its millions of positive uses there are a few misuses, and one of them is that, indeed, some people copy and freely exchange media product on the Internet, and that problem is worse with broadband than without it.

So alarm bells went off in my head and in the whole technical community. I think that when it comes to Washington, no matter how competent we are now compared to thirty years ago, we are still very incompetent compared to Hollywood and others, and we generally know these things way down the line when a bill is already introduced. So when there was a hearing, I testified; Michael Eisner [the Walt Disney Company], and [Peter] Chernin from FOX [Network], and myself were the key people testifying there. I wasn't conciliatory at all. I basically—my position was, and you can read the text. I don't know if you read it.

**BROCK**: No, I haven't.

**VADASZ**: If you read it, that this is going to do enormous harm to a very significant industry, and that these people are crying wolf, just the same way as they cried wolf about the VCR, and the best thing that Congress can do is to tell them to deal with it, and face the business realities, and engage the market. So it was a pretty tough session. I mean, I got really beaten up on that session, including from Senator Hollings, who was very upset over my testimony. But it was carried by I don't know how many dozens and dozens, probably two hundred different papers around the world, and other than the *Variety* in Hollywood, all the papers were supporting our position. So that bill died; never got out of committee. Frankly, I'm very proud of it. I think that we have done the right thing. I think that not only it was very satisfying to be able to stop a dangerous bill, but also it was an opportunity for Intel to be heard with a consumer voice, and it was a very heady time, if you will.

Then when that other bill, the "induce" bill got introduced after my retirement, which is another loony bill, I decided that, well, even though I'm not engaged, I'm retired, based on my notoriety I may have something to contribute here to this debate, and I wrote that editorial. Apparently it was very effectively used, and to this date that bill never got out of committee, and never returned yet. So I have no idea how much impact that had on it, but it was consistent. And that, to me, is a battle important enough that it's worthwhile to come out of retirement for, because I don't want government to stop our ability to benefit from technology. I want government to focus on criminal activities when they need to, rather than try to stop technology. I feel the very same way about this whole stupid stem cell debate, but that's another subject. [laughter] See, I'm not competent in that area. I'm not making any public statements.

**BROCK**: In the case of that first bill for which you testified, or against which you testified, first of all, around what year was that?

**VADASZ**: I think 2002.

**BROCK**: And that was really calling for, in essence, a hardware implementation—

**VADASZ**: That's right.

**BROCK**: —of sort of protecting copyright, copyrighted material.

**VADASZ**: That's right. Basically giving the entertainment industry control over how a personal computer is designed. That was the fundamental—

**BROCK**: And with that control, your position is that that would imperil just the development of the technology-driven, just by the more general—

**VADASZ**: Well, okay. Now imagine that you are competing in a market and trying to bring out a new generation of machines as fast as you can. Then you have to submit it to a government agency for review. I mean, that by itself is the looniest thing you can imagine, in that you continuously go through design adjustments as you go, and each time you're going to get an approval from the government? And then you know that the government will have the people who will not have necessarily all the competencies required, so where do they go? They go to the entertainment industry, ask the question, "Well, do you think this is good? Does it serve your purpose?" It's an impossible situation, an absolute non-starter for one of the most highly competitive markets, to insert the deliberate processes of government in an area where they are not even competent to judge.

**BROCK**: Or perhaps the media producers were interested in it being a worldwide thing to protect their worldwide copyright privileges, if you see what I mean. I was thinking, okay, you're making microprocessors and you're serving all these markets around the globe. You're having this one center of sort of media production and they want to transport it around the world.

**VADASZ**: Well, you know, it still would not have stopped people copying the DVDs and selling it on the corner for fifty cents apiece, like what happens in China. It would not have stopped other people outside the country developing microprocessors, suddenly competing with Intel, and they don't have to go through that government review. Then I'm sure there would have been another law that, well, let's stop them on the border. So before you know it, the whole thing becomes more a lawyer's game than a technology game. That's just horrible.

**BROCK**: What was the more recent bill proposing?

**VADASZ**: Oh, the most recent bill is that if your product is capable of being used for stealing, then you may be liable. Now that could fit an iPod. That's the "induce" bill. I understand where this is coming from. They basically tried to stop a Kazaa or a Grokster. They said, "Well, Grokster allows you to share files, so they are liable," even though the court said that the Betamax decision eliminates Grokster from that role. Now, that case is at the Supreme Court and I have no idea how the Supreme Court is going to rule.

But, you know, I want to separate the notion from the stealing that goes on versus the technology development that is happening. I do not condone stealing. I have no problem with people being sued and locked up for doing that stuff. But we don't stop producing knives just because people kill with a knife.

**BROCK**: In your opposition to that first bill, while you were certainly very passionate about it, what was the dialogue like about having you go to Capitol Hill to sort of represent the Intel position, or were you representing an Intel position?

**VADASZ**: I was representing an Intel position. Obviously, I would not have gone without it. We just simply talked about it, and in a way we divided the appearances. Craig Barrett went to appear in front of the Judiciary Committee on a somewhat similar situation, and I went to the Commerce Committee. It turned out that my session turned out to be a much more volatile session.

**BROCK**: To maybe take us a couple of steps back in the sequence, back into the Intel Capital story, two developments happen that I was curious about. One is organizing Intel Capital into these two funds, around 1999. Was that a significant change?

**VADASZ**: No. No. Everything was the same, but—well, let me give you a more complete answer. The first fund that we did was the 64-bit fund. Basically, there was this new family of products coming along, and we wanted to create an investment mechanism for investing in some of the companies who will develop software or maybe hardware products. We made that investment also available for outside investors who would be early users of that product, so that we could create an environment where early users, product companies, including us, would all have a common financial interest.

A couple of learnings from that was that, (a), it was very difficult to do a fund like that; (b), its success was very limited because we were late with the product, and many of the companies that we invested, in order to have a life they had to move on to other architectures to get their business going. And we would never try to force them not to, because they have to act in their own financial interest. So that made that activity not as successful as I certainly was hoping for.

In the second case, we simplified life and said, “Okay, this is not going to be available for outside investors. This is going to be just a carve-out.” We say that we want to notify the world that we are serious about communication and we’re going to create this communication fund. Now, after that happened people did take notice, and we were quite effective in engaging companies in the area that we were interested. As part of the outgrowth of that idea, we announced how much we were going to be investing in the wi-fi area. And I think that really had the highest impact. So I think it makes sense to create this carve-out as part of your marketing effort, but to create this complex fund with outside investors, that really is a very difficult thing to do. I would not attempt to do that again.

**BROCK**: Could we talk a little bit about what you just mentioned, that announcement about how much Intel Capital was going to put into wi-fi? I’m sorry if I sound like a broken record, but I think it's very interesting. When did that occur? When did you make that announcement, and what was the sum that you announced?

**VADASZ**: I think we announced one hundred and fifty million dollars. Later on we also announced three hundred million dollars of marketing budget for the merchandising of Centrino, so it was a lot of money. But there was a wi-fi conference, I remember. In 2002, I think, there was a wi-fi conference, I went to Washington and I was a keynote speaker. Basically, I talked about the importance of wi-fi and how it fits into the logical future, and the last 10 percent of my talk was, "We are willing to put our money where our mouth is, and are going to invest one hundred and fifty million dollars." So that was really the lead of that whole story. And after that, we used that very effectively to lead the rest of the investors to focus on this area.

That's one of the things that we didn't talk about, and it's a very important concept. Let's say Intel invests a dollar. The rest of the VC market invests ten dollars. So every dollar we invest has a ten-to-one leverage, in how much investment goes into a given area. When you say, "I'm going to invest one hundred and fifty million dollars"—and we did it at a time when, if you may remember, when the venture community was sitting on the sidelines, not really investing, because they were just hit by the crush of 2000, 2001—and here Intel says, "This is the way to go. This is the direction—wi-fi, wireless connectivity—and by the way, we are investing one hundred and fifty million dollars." That is huge, because others notice that. Intel is going to not just invest, but going to be a marketeer out there. And lots of other companies started to invest. That's why that was big.

**BROCK**: Really leveraging sort of the Intel position—

**VADASZ**: Exactly.

**BROCK**: —and reputation.

**VADASZ**: That's right. Exactly. And by the way, this is why I'm saying that other CEOs sent their people to me and said, "See what Intel is doing, how they do this Intel Capital game."

**BROCK**: Well, 2002 also—was it earlier?

**VADASZ**: I think it was 2002. Maybe my testimony was in 2001.

**BROCK**: You don't have to re-check. That's my job. Well, I think it was toward the end of 2002 I was reading that Intel Capital sort of absorbed this internal investment activity, for new businesses, I guess.

**VADASZ**: Yes. Well, it was very simple. I was looking for a way to transition into retirement, and I was trying to get the individual who was running that internal group to be my successor, and so we combined the two, and basically I was in a very active training mode, basically try to phase out. That's all to that, nothing more sophisticated.

**BROCK**: Who was that person?

**VADASZ**: John Miner, who, by the way, just recently left Intel—that was pretty surprising to me—and wants to do something on his own. Arvind Sodhani, who used to be Intel's treasurer, has taken on the Intel Capital role.

**BROCK**: Just looking quickly at my question list here. I guess, then, that really brings us up to your thinking about, planning when you were going to retire. Could you tell us a little bit about your thinking about when you were going to do that, and how you were going to do it, and the considerations there?

**VADASZ**: Well, I wanted to do a logical transition out of my role, and so I tried to plan it years ahead, but I didn't really have a very specific date in mind. But as time went on, I was more and more interested in doing a transition, and so I agreed with Craig that we're going to work on it. I had a second-in-command before John Miner, but he decided to retire. So then I scrambled and got John Miner on board.

It's an interesting thing. There's a point in time where you almost fear retirement. Then there's a point in time that it can't be soon enough. You love the place, you love what's happening, but you suddenly feel that the clock is ticking and you want to do some other things. Somehow that happened to me over this last five-year period, and I can't specify what happened when, but there was a point where I was really running toward wanting to retire, the next phase, and I think it happened pretty successfully. I wish John was still there. That kind of disturbed me.

**BROCK**: In your thinking about what you were going to do after you retired from Intel, with the sort of stature you had in the venture capital community, did you consider doing anything sort of more formally in that area?

**VADASZ**:  Absolutely not.

**BROCK**:  Why not?

**VADASZ**:  Because first of all, I didn't want to worry about other people's money.  Second, I didn't want to get back to the routine, if you will.  I was looking for something which has more freedom of actions, freedom of involvement.  If you look at my existence today, it's exactly that.  I'm far busier than sometimes I want to be, but I have the freedom of action.

We started developing this vineyard back in 1998.  I was still working, obviously.  My wife is the chief vineyard officer.  I'm only a second fiddle, but it's a very satisfying second fiddle.  I continue to be interested in technology in different ways.  I try to work on a number of areas in the community here, to diffuse technology into our school system, diffuse technology into our healthcare system and the like, and through either my individual activity or some philanthropic activity, I try to make that happen.  When I do philanthropy, I do it with the same venture capital mentality as I did my other job.  You know, I want to see the success measures, and I want to see not just a concept, but how are we going to get there, how are we going to succeed.

I have a number of lectures at Stanford Business School.  I co-teach a course with one of the professors that I got to know over the years, Robert [A.] Burgelman.  And again, what I try to do is get the class involved in the real world of today.  More and more business schools talk about new technology and new business kind of problems, but hardly anybody talks about the impact on this that government can have.  So I try to talk about subjects that bring the regulatory environment into it, because we live in a world where we tend to say, "Oh, the Internet is going to change the way we do everything.  And by the way, government, keep out of it."  Well, the problem is that government will not keep out of it.  So when you're a businessman today or tomorrow, you have to be very conscious of the fact that, hey, this is really having a fundamental impact on the structure of the world around us, and that we have to be conscious of government actions, and provide our knowledge and vigilance, if you will, that the wrong things don't happen.

And again, I happen to have some experience in that which we talked about, but I could repeat the same thing about the telecommunication area, particularly our involvement in broadband.  We didn't talk about it, but I spent a lot of effort in Washington, trying to get broadband going, not very successfully, given the state of the art in the U.S.  But we have some serious issues there as well.  So the topics that I get involved with in the school are really these messy subjects.

And I am dabbling in a few little technology companies that are of interest to me; if they happen—they are early-phase companies—that if they happen, they can have a big impact.  I don't intend to be an executive of these companies.  I'm on the board and may have some small investment in them, but it's not other people's money.  So I am trying to do in my private life, in a way that I have some choices, some of the things that I learned in my corporate life. So that's what's happening. I'm not on any public boards. I avoided those. I'm not part of any VC firm. I've avoided those. I don't have any intention of forming my VC firm. It's a pretty good life.

**BROCK**: I have just a few sort of closing-type questions, but I would like to hear, if you'd like to tell us about it, a little bit about the broadband story, because I didn't pick up on that in doing my preparation.

**VADASZ**: Well, again, part of my territory was the whole ecosystem development area. This whole area of broadband, high-speed connectivity was part of it. I started to engage with the FCC [Federal Communications Commission] way back in the early 1990s, and learned a little bit more about what they do. When I first talked to them they didn't care very much about this whole area of computer-communication in everyday consumer environment. The staff may have, but the commissioners—TV, phone, that kind of stuff, and compartmentalized thinking. I think that the first time our ideas started to get some traction was when Reed Hundt became the chair of FCC, who had the dubious distinction of being suddenly thrown into the fire of the early age of Internet. I think that a lot of good things happened then, and I think that [Michael] Powell FCC has done a lot of important things as well.

But I participated both in public forums, given a number of speeches, and participated in the FCC hearing about the need for broadband. In fact, I do have an editorial in the *San Jose Mercury* [*News*] related to that, and had lots of engagement with the various communication companies, from cable to telcos [telephone companies].

Very interesting story. As part of our Intel Capital activity we started to kick around this broadband issue, and there was a little company, Hybrid Networks, I think it was called, which had the first cable modem, and we started to work with cable to deliver broadband. It was pretty crude. In fact, we, together with them, took a computer to the National Cable Television Association's annual meeting in Anaheim, sometime in the early nineties. I stood way back from the crowd—that was the only PC on this huge floor in Anaheim. I mean, there was everything from cables to cable shows to, you name it, to wires, to plugs. People kept looking. "What's this PC doing in this cable show?" And then some people—we showed them that you could go to the Internet, and things happened fast. [snaps fingers] I mean, you know, because we had high-speed access. It was kind of an "aha!" So we had some engagement with cable companies. Now it turns out that it was Broadcom that really got the early business, because they developed some chips very fast, and that really created the early broadband market in the U.S.

So I credit Intel Capital activity to opening the eyes of the cable industry to what broadband needs to be, and since then I've engaged a number of times on this debate. One of the cases, in the class at Stanford Business School, is on broadband, and another case builds on broadband with the Voice-Over IP. So I looked at it as part of the Intel Capital job, to advocate, invest, sometimes argue. We had many interesting debates with some of the executives in the telecommunications industry.

**BROCK**: About broadband?

**VADASZ**: About broadband.

**BROCK**: Arguments of what kind?

**VADASZ**: Well, the initial attitude toward the Internet was that, "Gee, I invested a lot of money into the Internet. Look at all the extra switching circuits I installed," because people started to get second lines, and other things.

And then we said, "Well, you need higher speed, like ISDN."

"Well, ISDN is not economical."

Then the next phase was DSL. You know, "DSL is a technology that is really not proven, and we are going to invest based on a guaranteed rate of return." And how can you invest in new technology with no guaranteed rate of return? So what we started to do in Intel Capital is started to invest in CLEC.

**BROCK**: I don't know what—

**VADASZ**: Competitive Local Exchange Carrier. After the 1996 act, the CLEC could buy at discounted rate lines from a Local Exchange Carrier, and they moved much faster. They were the "rabbit" in a new market. While I didn't have a great deal of confidence in CLECs being very successful, I was convinced that they would be showing the way. Today, the big companies are the biggest DSL providers, and initially they were really the minority. It was the CLEC who were the big DSL provider.

**BROCK**: Interesting.

**VADASZ**: So again, using our financial muscle, put some money to work, and then a market moved. Then there were all kinds of regulatory issues, for example: the telcos are part of the "common carriage." They have different rules applied to them than the cable companies," and would I support regulating the cable companies, same as telcos? I said, "No, I won't support regulating a cable companies, but I would support deregulating you if you fight for deregulating yourselves." So those were the kind of engagements and debates that we had, and my involvement was, obviously, very singularly focused on how do we get more broadband, and how do we get higher-speed broadband, and the tactic differed depending on the issue of the day.

**BROCK**: In the cable area, were you then investing in equipment makers like the cable modem company?

**VADASZ**: We may have invested in—we were, by the way, an early investor in Broadcom. We were an investor in Hybrid Technology. Actually, we did invest in @Home. So we were, again, investing in the ecosystem.

**BROCK**: Right. And the business interest that's on the other side, you know, of increased broadband and higher speed is just another demand driver for faster microprocessors?

**VADASZ**: That's right. Well, see, the thing is, what you have to recognize—you've probably seen pictures of this. We talked about this a lot, that there was this duality of progress. You introduced a piece of hardware, and then your software people write software to the capability of the hardware, and a little bit more. You need the next-generation hardware to catch up with, and maybe go beyond, of what software can do. And this goes up and up and up and up.

Now, imagine that suddenly the world becomes increasingly online, that this hardware is sitting on the Internet, but that everything which happens through the Internet is through a very slow pipe. So then who needs all this high-performance hardware? Unless I do local applications all the time, how could I benefit from what's on the net and take advantage of what's local as well? You need more and more bandwidth. You need more and more high-speed connectivity. So broadband, if you believe that the Internet is important for your future, broadband is important as well. And so that became part of the higher-level goal.

Now, on the other hand, eventually, when we had the goal of also benefiting from actually selling products into that market, we found ourselves behind, because companies like Broadcom created the early products for cable modem and the like, and at that time we really didn't have the business interest of those elements. We had the business interests of computing.

**BROCK**: Yes, I see. Interesting.

Well, unless Christophe has a question, I guess I couldn't help but ask you a question. I've read several people, including Craig Barrett, describe you as either the ultimate engineer or the engineer's engineer, which the latter, I think, is actually the higher compliment, I think, from that community. But I just wanted to know, one, what you think lies behind people characterizing you in that way, and what you think of that characterization.

**VADASZ**: I'm not sure I ever even thought much, positive or negative. It was, okay, fine. But I think what lies behind it is that no matter which way I moved in my career, technical knowledge has always been an integral part of what I try to do. I try to keep learning, so that I have enough knowledge to understand the big picture, and drill down enough to make sure that the right decisions are made. It never meant, in my mind, that I tried to micromanage and do my people's work. I think it was more meant that technical knowledge was an important foundation for all my work, whether it was investment, whether it's starting a business unit, whether it's doing strategy or whatever. Since I spent all my career in technologic change, and expanding from semiconductor knowledge into the use of semiconductor into the other areas, I never went away from the technical knowledge. I always kind of tried to expand it rather than transition away from it. At least that's what I think of the explanation. I don't know what other people thought. [laughter]

**LÉCUYER**: Well, at the same time, the social context of your activities—

**VADASZ**: That's right. I do look at my activity that has to fit a larger scheme. I do believe passionately about engineering's role in society, in betterment of our life, so it's pretty natural for me.

**BROCK**: I was thinking of a parallel in that characteristic that you were just describing, of always trying to listen to the technology, or in your career it seems that Intel has been led by a number of people who exhibit that basic characteristic, in different ways and in different degrees.

**VADASZ**: That's right.

**BROCK**: Would you agree that that characterizes Gordon Moore also?

**VADASZ**: Very much so.

**BROCK**: And Craig Barrett, too?

**VADASZ**: And Andy. Absolutely, absolutely. I mean, you look at the world differently when you understand how things work. Okay?

**BROCK**: Yes, and you look at the world differently in all aspects.

**VADASZ**: That's right. We're at the end.

**BROCK**: We're at the end of my question list, but there's always one more at the end, which is—

**VADASZ**: Oh, there's one more.

**BROCK**: Which is, are there any questions that we really should have asked you?

**VADASZ**: I have no idea, after all this. I have no idea. You did a very thorough job. In fact, I'm embarrassed to say that your questions pointed out many voids in my memory. [laughter]

**BROCK**: Well, let me just switch this off.

[END OF AUDIO, FILE 3]

[END OF INTERVIEW]

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