

# ROBERT METCALFE Ph.D.

# ORAL HISTORY

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## COMPUTERWORLD HONORS PROGRAM INTERNATIONAL ARCHIVES

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**Transcript of a Video History Interview with  
Robert Metcalfe  
Founder, 3Com**

**Recipient of the 1998 MCI WorldCom Leadership  
Award for Innovation**

Interviewers: Daniel S. Morrow (DSM)  
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DSM: It's March 26, 1998. This is an interview with Robert Metcalfe, who on June 8, 1998, will receive the MCI Leadership Award for Innovation. Unless otherwise noted, this interview will become part of the permanent research collection of the Smithsonian Institution's National Museum of American History, and may be used for all purposes consistent with the Museum's guidelines and standards.

You can stop the interview at any time if there are things that you would like to say that you would like kept off the record for 10, 20, 25 years. Stop us before or after, and we can do that. If you need to stop for a break, stop for a break. Most important, if there's an obvious question that we should be asking you and we haven't the foggiest idea we ought to ask it, stop us and let us know what we should ask, because it would be a shame not to have it on the record if it's important to you to talk about.

That said, I will start at the beginning. If you will just tell us where you were born, where you grew up, when you were born, a little bit about your parents.

RM: I was born in 1946 in Brooklyn, New York, and my parents were Robert and Ruth. But, I'm not a junior since my father and I have different middle names. I spent the first five years living in Brooklyn, and Bensonhurst, and Bay Ridge, and Fort Hamilton, approximately where the Verrazano Narrows Bridge is today. Then we started moving out on the Island. We moved all along the South Shore. We moved to Levittown for a year. Then we moved to Bay Shore, which is where I went to school, kindergarten through 12.

DSM: What are your most vivid memories of Brooklyn and Levittown?

RM: I have no recollection of Levittown. In Brooklyn, I had a fight that I remember. A playmate and I stood in front of my house for I don't know however long, taking turns kicking each other in the shins. The next morning I couldn't walk, and my mother assumed that I had polio, which was possible then. She grabbed me and took me on the bus and raced me off to find out that I didn't have polio. I had just been kicked in the shins too many times. I remember the stupidity of that event.

DSM: Do you ever go back to Brooklyn at all, back to the old neighborhood?

RM: I'm in Brooklyn all the time. I like to take the long way into Manhattan when I land at the airport there. I like to go along the Belt Parkway, which goes through my old neighborhood on the south.

DSM: Now tell me about early school years and early teachers.

RM: I spent two years in kindergarten, because in the process of moving we encountered a different age criteria. So I got a good grounding in kindergarten. And one of the things I remember about grade school was we had a highly channeled system. We were broken up into classes according to academic ability. These classes then progressed through the system all the way up through high school. There were some changes. I can remember in my own case, having two teachers a year for most years, because I kept moving. Perhaps I started at the bottom and moved my way up, but I remember that. I remember how channeled it was. Then by the time I got to the sixth grade, I can remember being in the "smart class" and really enjoying that.

DSM: Where were you when you were in the sixth grade?

RM: That was Bay Shore, Long Island.

DSM: Was there a junior high there?

RM: Yes, there was junior high. In fact, we were the first class to enter Bay Shore Junior High School, which has now been renamed. It's a middle school now. And I was president of the junior high school. It was my last political office. That was in 1959. My campaign posters were yellow cardboard, and I can remember them saying, "Elect me, I have a 92 class average," as if the electorate would be swayed by this. Apparently it was, because they elected me once. Then I so bungled the job, they never elected me to anything again.

DSM: So from junior high on to high school, were there high school teachers that really made a difference in your career?

RM: Well, there were teachers before that actually. I've told this story 100 times and I believe it's true, but I have no way of proving it. In fourth grade we were writing book reports. I waited until the night before the report was due, but I hadn't read a book. So I went down to the basement where my dad's shop was. He had a very neat well-organized shop with a lot of doodads he had brought home from work. There was a shelf with a bunch of books on it, and I basically chose -- you're not going to believe this -- I basically chose a book at random, and it was an electrical engineering textbook written by two MIT professors. Obviously it was a textbook that a 4th grader could not understand.

So I skimmed the book and I wrote one of those finessing book reports like, "this book had its high points, this book had its low points, but on average, it was an average book." Then, a little uncertain about the acceptability of this book report, I added a gratuitous line, calculated probably to enhance the attractiveness of this book report. I said, "I intend to go to MIT and get an electrical engineering degree." This is in fourth grade. And by the way, I did that. However it was purely accidental.

DSM: That's a fabulous story. Tell me about high school.

RM: I have a more interesting story in the eighth grade.

DSM: Tell me about eighth grade.

RM: In eighth grade I had a teacher named Mr. Gosher, who wasn't the first good teacher I had but he really stands out. He was the eighth grade science teacher. He had us build things as part of science projects. So we built anemometers and thermometers and all those other things you're supposed to build.

So he had us building scientific instruments. Then he gave us a class project at the end of this project. I had an arch-competitor through all this. He was actually a good friend as well as an arch-competitor, Ron Rosenbaum. We had this class project, which was to build something really cool, and Ron and I decided to build a computer. This was in eighth grade.

DSM: This was what year?

RM: 1959. Actually, I did not call it a computer, but Mr. Gosher called it a computer. I took my electric train set in the basement, which my dad and I had been building for years, which involved toggle switches and electric lights and relays, and I designed, on a scrap of paper, a computer that could add any number between 1, 2 and 3 to any other number between 1, 2, and 3, and turn on a light corresponding to the sum -- 2, 3, 4, 5 or 6.

So you would flick one of these switches and then you would flick the other, and a few moments would go by while the relays all clacked, and the answer would come out. And it was the correct answer.

Now if you're wondering why I stopped at 3, it's because I couldn't manage the complexity of the design beyond 1, 2 and 3, because, as I learned only a few months later, I had not learned about binary arithmetic. So I had to have every case in my head, and I just couldn't manage the complexity. So I stopped at 1, 2 and 3, which taught me a big lesson, which is, knowledge is power. If I'd only encountered binary numbers before that, who knows! I might have been adding numbers as high as 7 or 8.

DSM: Whom did you hang out with when you were a kid?

RM: That changed dramatically in eighth grade. We used to live in Bay Shore in a big tract, where all the houses were basically identical. This was South Thompson Drive in Bay Shore, New York, all these brick one-level ranch houses.

Then around eighth grade, my father, who was a technician in the aerospace industry, got a promotion. So we moved to the incorporated village inside of Bay Shore, where all the houses were different. Then we moved to Hiawatha Drive there, in not a mansion, but a house that was different than all the houses around it. That was a big event because up until that time my best friends had been Billy Dibinski, and Tom Ramey, and Gary Poe, and Rocco D'Amato. We were the melting pot. We were seriously into sports – football and basketball.

When I moved to Brightwaters, my friends suddenly became Ron Rosenbaum, Richey Spivak, Ronnie Kleinman, Richie Abrams, Larry Kaufmann. Notice a difference there? They were all Jewish, and studious, and they weren't into sports. Well, ping pong was a big sport in this crowd, so I fell into a completely different milieu. Not that it was a bad milieu before, but these people studied. So Ron Rosenbaum and I fell into a competition then that lasted until our senior year in high school.

DSM: Did you still have it in your head when you were in high school that you were going to go to MIT and be an electrical engineer?

RM: I don't remember having that so clearly, but MIT was on my mind. I had already committed myself to go. So I specialized in math and science, I suppose.

DSM: Tell me about getting into MIT and your first classes there. What was it like?

RM: I got into MIT my junior year in high school. Then didn't go because everyone said that I would do well to spend another year in high school and learn stuff. So I took typing and art, and things I hadn't had time to take before, and I finally showed up in the fall of 1964 at MIT.

DSM: While you were there you did some designing of your own course work. Can you tell us about that?

RM: That wasn't until my junior year when I applied for and was accepted to a program, which was under the guidance of Jay Forrester. It was called the "Undergraduate Systems Program." This program had many benefits, but its key feature was that for your junior and senior year, you didn't have to take any courses or get any grades. Now that probably wasn't the reason I did it, but it was the most outstanding feature of this class.

This was in the Sloan School of Management. There were twelve of us in this group took on various projects that we designed to learn how to understand systems dynamics. And since we were in the Sloan School, the projects were also designed to teach us how to manage companies.

DSM: Which professor at MIT do you remember most fondly, or best? It's a tough question, I know.

RM: That's a very hard one. Jay Forrester, of course. Mike Trutunas (ph.) who's still there to this very day. He taught me a brand new course, "Introduction to Linear Systems." Amar Bose, a physicist who is known for the Bose speakers. In fact, I became involved in a project early in my career to clone Bose speakers. We built a set of 20 pair in the basement of our fraternity house. We built them ourselves, cloning the Bose so we could save money.

Ken Olsen was a hero because he was an MIT guy who went on to build a very successful company. He started DEC in 1957, and by the 1960s DEC was quite an important company.

DSM: Now that was my next question, who were your heroes when you were growing up, both real and sort of the Long Ranger kind.

RM: John Kennedy was a hero until he was gunned down in 1963. That happened while I was in high school. Eisenhower had been a hero before that, because I can barely remember the Korean War on TV. I remember just it was automatic to admire him. Then there was also Einstein.

DSM: Did you ever think that you would be considered a hero?

RM: Am I considered a hero?

DSM: Did you ever think that you would be? You are, by definition.

RM: I don't think I ever formed that thought. I did know always, that I wanted to not do just straightforward, simple things. I didn't want the simple life. My parents had the simple life. They didn't go to college. My dad was a union man, and he worked union for 30 years before he retired. We had dinner every day at 5:30 sharp. We had baked macaroni every Wednesday night. We had spaghetti every Friday night. But so my parents worked so hard, and my grandmother, by the way she ran the family.

DSM: This is your father's mother?

RM: My mother's mother. Anna Christina Sorenson Mueller Berg, a Norwegian lady who lived in Brooklyn for 50 years, and worked on the waterfront ridding the waterfront of organized crime as a hiring supervisor at the Waterfront Commission. She was tough, but she loved her children and her grandchildren. We were constantly going into Brooklyn to see her, and she was constantly coming out to the Island to see us. She would be my hero.

Of all the heroes, Anna Christina Berg is the person that I see right over here all the time. My parents whole life seemed to be about two things, getting me to go to college, which no one in the family had ever done, and retiring. And they've achieved both their goals. They've gotten me to go to college and they've retired. Their sacrifice was so consistent and over such a long time I think a motivating force is to make sure that all their sacrifice and work was not in vain.

DSM: Well, they can't be altogether displeased.

RM: I don't think they're unhappy.

DSM: I've only got two more questions before I let David sit down and do his. What I'd like for you tell me about how you met your wife. The second thing is, you're a man of many interests, and outside of your work, what do you enjoy doing most?

RM: Robin Shotwell and I who have been married 18 years now, once lived in the same apartment complex. We had different apartments in this complex for five years before we met. This was in Palo Alto, California at Oak Creek Apartments, which is a rather conspicuous collection of apartments opposite the Stanford University Hospital by the Stanford Shopping Center. We both lived in this building, but she was a morning person and I am not a morning person. I'm an early afternoon person. So we never met. Our cars were in the garage together, but we never met. Then one weekend we both entered a tennis tournament at the club, and we met. This was on August 19, 1979, and both of us had just started a company. I had started 3Com in 1979, and she had just started a company in electronic publishing as a consultant. So we had that in common.

We got married on Groundhog Day, 1980 and now we have two children. One is Julia, who is ten now, and Max is nine. Nothing would make me happier than to have Julia and Max go to MIT, but I have been informed that having formed that thought, the likelihood of them going to MIT is now zero.

DSM: That's great! My last question is is there anything about your early life and upbringing, your friends and heroes, mentors, people that meant a lot to you, say, between the time you were born and the time you got out of MIT that I should have asked you about that you would like particularly to talk about?

RM: I mentioned my grandmother. I mentioned my parents. I mentioned Ron Rosenbaum -- he and I started friendly competition in eighth grade and we graduated in 1964 together and he turned out to be Valedictorian. I think he cheated! I came in a close second. He went to Yale and I went to MIT. He won all the awards in Russian and English and in Literature and all that stuff. His mother was an English teacher at the high school, which was where I lost, I think. I won all the awards in science and math and chemistry and physics.

What we discovered -- and this is an important lesson in life -- what we discovered at graduation was that all the awards in science and math had money associated with them, whereas the awards associated with the Humanities did not have any money.

DSM: Are you guys still in touch with each other?

RM: Rarely. Rarely. I see him every couple of years. He's in New York City.

DSM: Well, that's the end of my questions. Thanks very much. It was a real pleasure.

RM: Thank you.

DKA: I wanted to pick up at MIT. It's such an important school in the history of America, especially in your business. You were there in the 1960s. What was the environment like to be in electrical engineering with an interest in computing and things like that? How do you remember the environment at MIT?

RM: I remember it being very hard. Starting my sophomore year, I got a full-time job while I was at MIT. I don't know how I did this but I was working approximately full time and carrying a full time load and playing varsity sports at the same time. I don't remember a lot of that time, because I probably fell asleep. I think I'm proof that you can learn things while asleep in class.

DKA: What was your job?

RM: I was a computer programmer at Raytheon, starting in the fall of 1965. That happened because in 1964, I had been smart enough to take 6251, which was Introduction to Systems Programming. I had been told by my older fraternity brothers that if I did that, I could get a job in the summer at a much higher rate than being a lifeguard. They were right. I got a job in the fall at Raytheon and worked there for the next several years, approximately full time.

DKA: While going to school.

RM: While going to school, and playing squash and tennis and crew sometimes.

DKA: Gee, that's amazing.

RM: I don't know how I did it.

DKA: Doesn't sound like you had much chance to absorb the MIT spirit.

RM: No, I had a lot. It was very hard. MIT has this expression, "tech is hell," and it was. There was a lot of fierce competition. They had a freshman physics class for people who had 800 in mathematics on the SATs. So rather than advance place to take the second year of calculus, I decided to learn calculus the way MIT teaches it, as opposed to the way my high school taught it. It was a very good decision.

So I went to this special class where only geniuses like me would go who had 800, and there were a couple hundred people there. It was really deflating. Then we had the first math exam. I remember vividly, the perfect score on this math exam was 125. I got my paper back and I had received a 25. So I imagined that I was on my way out. Then I was told the class average was 17 so I rejoiced. Then I looked over at the guy sitting next to me, Schrapel was his name, and he had 125. So I learned quickly that tech was going to be hell with guys like this hanging around.

DKA: But you stayed with it. You obviously didn't let it defeat you.

RM: I flourished. I loved it. I got pretty good grades. A lot of people hated it, and I never did. It was the enthusiasm. Enthusiasm is my life's word, and I was enthusiastic about what I was doing, and so I think that really drove me. As you can tell, I am pretty happy about my MIT experience. This year I'm president of the MIT Alum Association. I'm a big booster of MIT.

DKA: Did you have a pretty good sense of what you wanted to do at that time, or were you open to a lot of possibilities?

RM: I was open. I took computers because I was advised that if I took it, I could make money in the summer. That's how my career has been guided basically, but it wasn't clear I would be an EE major.

When I went into the Undergraduate System Program, I became a Management major, "Course 15" as we call it at MIT. At that time the Vietnam War loomed, and my father kept saying, you can't graduate from MIT with a Management degree. It's the best engineering school in the world. So I stayed for a fifth year and I got two bachelors degrees -- one in electrical engineering and one in management.

The other thing that my fifth year did for me was, that during all the previous years I had worked full time, and during my fifth year I didn't. And I got something I always wanted to get, which is a perfect score on my cumulative average. At MIT it's a little unusual. 5.0 is perfect, as opposed to most schools which had a 4.0. I got a 5.0 during my senior year, proving that the two years of pass-fail were not a cover up for bad grades.

Now there's an interesting story there. I took the best course at MIT, which in those days was 605, Linear Systems Theory. I was by far the best course, and I worked really, really hard on it and loved any minute of it. I don't know, maybe I was the best student in the class or one of the best, and on my grade report, I got an "A." So I had to go to the university and tell them that I couldn't accept the "A." I had to take a "pass." And they said, "Why not? A is better than "pass." And I said, "Yes, but an "A" all by itself, surrounded by P's, means that you probably got B's and C's in these other classes." So I had to talk them out of giving me the "A" in 605.

DKA: And then you went on to graduate work at Harvard.

RM: Yes.

DKA: What was the rationale behind that?

RM: I had been at MIT for five years, and it was time to go to graduate school. I applied everywhere and several places at Harvard had accepted me. Harvard is a pretty prestigious institution, and I had spent five years at MIT. I was getting advice that it might be good to broaden my portfolio. Plus Harvard, to get a Ph.D., you didn't need to do a Master's thesis, but you did at MIT. That appealed to me. So I went to Harvard just for diversity. Plus, my then wife had a job at MIT, and she couldn't leave.

The other funny story about that is I received a letter inviting me to apply to Stanford. I never gave it a second thought, because if you look carefully at Stanford's logo, it says "Leland Stanford, Jr. University" and I was pretty sure I didn't want to go to a junior university. That tells you how much I knew about California at that time.

DKA: I guess you learned differently later. What was your thesis work on?

RM: My undergraduate thesis was with Marvin Minsky. It wasn't a very good thesis, but it was a senior thesis on the information processing capabilities of a neuron model. I saw Minsky twice, the day he agreed to be my advisor, and the day I turned in my thesis.

DKA: Did he like it?

RM: He accepted it. That was the important thing.

DKA: What did you focus on at Harvard?

RM: I was originally accepted into a joint program at the business school and the applied mathematics department. It was called "Decision and Control," and it was about operations research, mathematical models, which were very important later to me. After a year there, I decided that I wanted to get the Ph.D., so I got the almost automatic Master's Degree they give if you take all the courses for a year.

They made me pay extra to get the diploma, which very upset me. They said, "Well, you got the degree. If you want the diploma, you have to pay us like \$500 or something." I'm very bitter about Harvard, and that may have been the beginning. But later, I got my Ph.D. there on packet communication on the ARPANET.

DKA: And that's when you were working on the Project Mac?

RM: Yes, I tried to do my graduate work at Harvard as an employee of Harvard. It was typical that a graduate student would get a job with a professor. But Harvard and I did not get along and I think it stemmed from the fact that I was MIT through and through. I was an engineer through and through, and I'm probably not remembering this correctly, but Harvard really didn't like that. Of course, I'm not easy to get along with anyway, so maybe I shouldn't blame Harvard. But anyway, I found a job at MIT doing research. I was a member of the research staff at Project Mac, and they asked me to do the same thing that I was hoping to do at Harvard, which was to work on the ARPA computer network.

DKA: How had you found out about that?

RM: When you're a graduate student, you know you have to write a thesis some day. So you start asking around, and in those days the money was flowing to build the ARPA network, which had been started in 1969, which is when I arrived at Harvard. So the indications were that the fruitful area is to go work on the ARPANET.

DKA: That must have been an exciting project. It was certainly a formative project in American technology. How do you remember that atmosphere and the people working on the ARPANET at that time?

RM: What I really liked was MIT was willing to give me enormous responsibility, responsibility that Harvard was not willing to give me. They said, "Okay, you took digital electronics at MIT. You build the hardware to put our computer PDP 10, PDP 6 later, PDP 10, put it on the ARPANET for us."

I had taken all the digital electronics courses at MIT, so I set about building it. It was quite over my head, but I eventually built it and made it work. That sort of began my career as a builder of high-speed network interfaces, although the ARPANET interface was not high-speed by modern standards.

DKA: I was wondering if that really was your introduction to truly working with networks in a practical fashion?

RM: It also began at Project Mac, building that ARPANET interface for the PDP 610. I worked for JCR Licklider who was head of the lab, and for Al Vezza who was his "make everything happen" kind of guy. Al and I immediately bonded. I just did whatever Al said to do, and it worked out.

DKA: Were you pretty much alone, or was it a team approach?

RM: I was building the hardware pretty much myself. I did some of the software, but I was working with a guy named Bob Bressler, who is now at Sun, and he did the higher-level protocols. So that was two and a half years of putting MIT on the ARPANET and working on some of the ARPANET early protocols.

DKA: Did I understand that while you were at Cambridge, you also were trying to set up your own company, or experimenting with being an entrepreneur?

RM: Yes, I ran through three companies during this period. I started a company called Management Systems Consulting. That existed about a year. We did consulting on linear programming. We wrote linear programs.

Then three of us founded a company called Data Concepts Design. We wrote manuals and computer programs for a time-sharing service in Boston. In both cases the principals went to graduate school and moved on.

Then I got involved in a software development company called Professional Data Services, Inc., which was to be software for lawyers, and that just fizzled away. IT never really went anywhere. I invested several months writing programs that never went anywhere.

DKA: Was this normal for graduate students? It seems like you just were really bent on being an entrepreneur and being in business for yourself. What drove you to do that?

RM: There were a lot of role models around. MIT is a place where people start companies, and I guess I just fell into that pattern, as I did later in Silicon Valley.

My father actually started a company once. This is a union man working in the aerospace division. He was a technician and had been there a long time. He started a company called BAM Electronics, Bailey, Abramson and Metcalf, repairing television sets in Bayshore. This company lasted a year or two, before it finally fell apart. I can't imagine that that drove me to be an entrepreneur, especially since it was an unsuccessful event, but I do have to remember that my father, the union man, actually did start a company.

DKA: It seemed like your interests already were a mix of technology, business and management. Did you feel that urge throughout school? I'm trying to get a sense of what was it that captured your interest to evolve in that direction.

RM: Well, the fun was building things. You can build hardware. You can build software. You can build companies. It seems to be the same thing approximately.

DKA: Did it bother you that they didn't work?

RM: Well, two of them worked. We just abandoned them by moving on. One of them just frittered away. No, it didn't at all. I guess they weren't serious companies. They weren't planned to be big and serious.

After I left Raytheon, I worked for a consulting company called Charles W. Adams Associates. That was a very important company in those days. I worked there for two and a half years, as I recall, and it was a very fruitful time. This is while I was an undergraduate. Then I noticed the billing rate that they were charging the government for my time, and compared that to my salary at the time, and I thought maybe I should start my own company. I think that was the simple logic of the situation.

DKA: Did you pick up experiences there that would serve you later?

RM: You mean from Charles Adams?

DKA: Yes and from different things that you tried earlier in your life.

RM: What I learned at Charles W. Adams Associates is don't spend three years getting one year's experience. I spent two and a half years programming the Univac M460 computer, and it was basically a dead end, because there weren't any of those. I should have been learning the program, the IBM 360 or the PDP 6 at that time. I switched to the PDP 6 in 1966. That was a more promising commercially oriented computer program. Then at MIT in 1970, '71 and '72, it was PDP 10s that I was facile at.

DKA: You were doing that at the machine language level, at the FORTRAN or a little bit of everything?

RM: I worked at that border between hardware and software. So that was in machine language, assembly language, we called it.

DKA: And then I guess in 1972 is when you went to Xerox PARC, right?

RM: I had a big event I'm sure you'll want to know about, which is in 1972. I was going to get my Ph.D. from Harvard. So I went on the lecture circuit for potential upcoming Ph.D. graduates, and I managed to travel all over, and because the ARPANET was a hot research area, even more so than in 1970, I was in demand. I got nine job offers, but I didn't get the one I wanted.

DKA: Which was?

RM: MIT did not invite me to be an assistant professor, and I was broken-hearted. So I was forced to accept a job at the Xerox Palo Alto Research Center, where I would be paid 30 percent more. I would have no students to hassle with. I would have an infinite capital budget. I would live in Palo Alto where the sun always shines. It was a really hard decision to make!

DKA: But you would have taken the MIT job any day?

RM: Any day. I would have stayed. That's clear. Who knows what would have happened had I stayed at MIT. Then a horrible thing happened in May of 1972, which is I went to defend my thesis at Harvard and they rejected it. So I called up Xerox. I said, "I have a problem here with my thesis so I'm going to have to work on it some more." And Bob Taylor there who's one of the gods of Xerox PARC as far as I'm concerned -- Bob Taylor said, "Why don't you come anyway and finish your thesis while you're out here?" So I did. It was very generous of him.

So Harvard rejected my thesis for two reasons, a real reason and a not real reason. It wasn't theoretical enough in its initial draft, which I had submitted. It was basically a recounting of how the ARPANET worked, how my hardware worked, how the software worked and how the protocols worked, which I had built, but it didn't have a grand theoretical idea. So the instruction was, go do something that's a breakthrough in theory. So I got myself a new thesis advisor, Jeff Buesen. Wherever you are, Jeff, thanks. Jeff sat down with me and his first words were, "What are we going to do to get you out of here?" So I started looking for something theoretical.

As it turns out, I continued to work for ARPA from Xerox. I became what we call an ARPANET facilitator, and on one of the trips back to Washington, I was at Steve Crocker's house. He was an ARPA program manager, and I was jet lagged and trying to get to sleep. There's a little dispute about how this exactly happened, but I ended up reading a copy of Congressional proceedings from 1970. There was a paper by Norm Abramson, a professor at the University of Hawaii, describing the operations of the Aloha Network, another packet network but not the ARPA network. Thanks to my education at MIT I understood the mathematics, which were very simple thank goodness.

I not only understood them, I disagreed with them. The assumptions that he was making for tractability seemed unrealistic. He assumed the network had an infinite number of users, which isn't a very realistic assumption. He assumed that a user of the network would go on typing input even when there was no output coming back, which was another assumption I didn't like. So I remodeled the ALOHAnetwork, made that a chapter in my thesis. Then while I was doing that, I noticed that this ALOHAnetwork was unstable. It was famously unstable, and I saw a way to make it stable. It was a very simple way, which used my probability and statistics background at MIT. So I added this probabilistic algorithm that helped solve the problem how computers on a cable would take turns sending data without a lot of wasted time, saying your turn, your turn, your turn. They would just go.

Then I submitted this thesis with this analysis of the ALOHAnetwork with the stability discovery in it, and that was found to be acceptable to Harvard. So I got my Ph.D. in June of 1973, which is about the time that Ethernet was invented. While at Xerox PARC I was given the job of building the network for the Xerox PARC personal computers that we were involved in building. I was the networking guy, so I took the ALOHAnetwork and the ARPANET, and on May 22, 1973, wrote this memo which would later become the Ethernet. In fact, I called it the Ethernet in that memo.

It borrowed the technique which Abramson described as one of randomized retransmissions. That is, when you had something to send on this shared channel, you would just send it when you had it, and then you would wait to see if it got through. If it didn't get through, presumably it had collided in the channel with somebody else's transmission, so you would send it again. But you wouldn't send it again right away, because the other sender would probably be doing the same thing. So you waited a random amount of time, the assumption being that the two contending stations would choose different random times and thereby take turns.

So I adopted that idea, and then added to it a few important improvements like not transmitting if you could hear somebody else transmitting, putting it on cable at 3 million bits per second instead of over the air at 4800 bits per second, one channel instead of two with two addresses instead of one, making it a LAN instead of a packet radio network, and we called it Ethernet.

DKA: What was different about that compared to how other people were trying to solve network problems at that time? Was it really a new approach?

RM: The prior work, the best of it was by Dave Farber at the University of California at Irvine. He was building a ring network in which the contending stations would send a token around in a circle, and when the token arrived it was their turn to send. That's how he solved the problem of whose turn it was to send.

In fact, I wrote in the Ethernet paper that it was wise for us to consider the Ethernet method. Since he was already experimenting with the ring method, we didn't have to do that. So we it turns out these two approaches competed for a very long time, into the '80's, before the Ethernet finally won.

The thing about the Ethernet that was different is that it had mathematics at its core, and it assumed it was distributed computing, that there was lots of personal computers around, and there was no need for a central node to tell them whose turn it was. So it was just this cable which we called the ether, and then the machines would connect to the ether, and there was no central control. They would just send and receive packets into the ether.

DKA: So it seemed like it was almost unbounded in terms of how it could be expanded, other than the network traffic being on it.

RM: You could almost fill the cable with traffic if you wanted, although at three megabits per second at the time, it was considered really, really fast. So it would be kind of hard to fill it.

By the way, it was in about June of 1973 that I hooked up with David Boggs, who was a graduate student at Stanford. He and I worked on Ethernet together for two years. I would call us the co-inventors of it.

DKA: What was the atmosphere at Xerox PARC like?

RM: It was great. We flew first class everywhere. It was a Xerox policy. I remember liking that. We were working on the paperless office of the future, an ironic goal. One of the things we did in 1974 was build the first laser printer, which ended the paperless office of the future. The primary initial motivation for the Ethernet was to connect the Alto personal computers to this laser printer that we were planning to build, and it was so big and fast that it couldn't use old methods of communication.

DKA: How did it compare there to your work at MIT in terms of how people worked together and teamwork and structure and things of that sort?

RM: Well, pretty much the same I would say. There were a lot of excellent people. Xerox is very flat. There wasn't a research management hierarchy. Similar to MIT, the "scientists" there had to build everything. It was a strange kind of science, where we built things instead of theorized about them.

One of the first things we built was this laser printer, and when I arrived, a guy named Charles Simonyi, who now works at Microsoft, he handed the networking to me and went over to work on this text editor that used a big bit mat display and a thing called "mouse." Through selecting and adding and deleting, he built an editor called Bravo. So I'm delighted to say that I offloaded Charles so that he could do what has come to be called "Microsoft Word," the Mackintosh and then Word.

So everyone was building things. We built this system where you could produce beautiful document fonts. There was a little while there where every page had about 20 different fonts on them, and they looked a little bit like ransom notes. Eventually we got sophisticated, and I claim that this has sort of helped boost PARC's overall reputation, because we had the best looking papers in the industry printed out of that laser printer from our PCs. That sort of made our research look better than everybody else's.

DKA: I have a Xerox Alto on exhibit in Information Age. There it sits with a laser printer, bit map graphics, the mouse, networking, it's an amazing body of innovation happening all at once in this one place. It's hard to think of a place where more innovation was stirring around than what was happening there.

RM: Well, this was my advantage in business. By having the honor of working at Xerox Research -- and I was in research really for four years, and then engineering for four more years -- I was able to live in the future. So I saw what would happen ten years from now, because I was surrounded with it.

Then when I went into business, started 3Com in 1979, I sort of knew what to do, because I knew what it was going to look like. It was going to take us a long time to commercially deliver what already existed at Xerox Research, and that was very clarifying. I just knew where we were going with all this, because I had had the privilege of working there.

DKA: It's an interesting thing about Xerox, particularly for this time period is it has the reputation for having all the great ideas but not being able to deliver them commercially. Is that a deserved reputation?

RM: Well, yes and no. In the end it turned out Xerox was a copier company, and a recently monopolistic one. It didn't know how to compete, basically. It had been leveraging its copier patents for some years. And then they made a fairly serious mistake. They put us in charge of bringing these products to market, which is in retrospect foolish, because none of us had ever done that before. But the thinking was it was easier to teach how to commercialize products to us geniuses than it would be to teach the people who already worked at Xerox how to take our great ideas and turn them into products.

Actually, there is evidence on both sides. Every once in a while we would throw an idea over the wall and it would get mutilated by the rest of Xerox. So we gave up on that. So many of my colleagues blame the Xerox culture for the failure to exploit many of those ideas. I think we are partially to blame since we were basically researchers pretending to be product engineers and marketers and all of that. That is why I eventually left Xerox.

DKA: Was it the "Star" that you were trying to develop as a commercial system?

RM: Yes.

DKA: And sell to customers like DOD and...

RM: Well, when I say "we" now I'm referring to the large group of us who worked there. We took the Alto, a group of us, and got it into the White House. That wasn't particularly my job. Then the rest of us started building what we thought would be commercial versions of the Alto, which were ultimately called the Xerox Star, which was a sort of direct forerunner of the Lisa, which is sort of a direct forerunner of the Mackintosh, which is sort of a direct forerunner of Windows.

DKA: So the ideas were there but were they just too expensive?

RM: The Star came in too expensive.

DKA: That was the major problem from your perspective?

RM: I would have to look more closely, but that was a problem. Plus Xerox didn't have any idea how to introduce a computer product into a competitive market. This would have been in 1980-81. Apple was already a couple years old and selling PCs for much less than the Star. So it was a combination of the product being a little wrong, and a little too high-end.

The thing we didn't understand, I think, was adequacy. We didn't understand what was adequate to serve the market, and the Star was really pushed too far as a perfection machine.

DKA: You could afford to design it but not build a new market for it.

RM: We built it too expensive, assuming the market would want all the things that it did. We were wrong. When I left the Xerox second time, this time from the Star project, the Star was further from being introduced than when I had joined Xerox the first time. So I basically spent two or three years not advancing that cause much in terms of hitting the market.

DKA: So that was frustrating.

RM: Very.

DKA: Was it the frustration that sent you out to do your own company, or was it a sense that you had an opportunity that you could develop on your own?

RM: No, it wasn't a sense of opportunity. It was I was an engineering manager. My boss was an engineering manager. His boss was an engineering manager. I think there were one or two more of those, and I could see that a lot of the problems we were having didn't involve engineering. They were in marketing and manufacturing. So I asked Xerox if they would get me into a situation where I could still be an engineering manager, but I wanted to know some people in sales and marketing and manufacturing. I wanted them to be colleagues, and Xerox just was not organized to do that. So I left for the second time on good terms, "to pursue entrepreneurial ambitions," was the actual phrase in my letter, but I had no idea where those ambitions would lead.

DKA: So you just walked out the door without knowing what was next?

RM: I was a little smarter than that. I walked out the door and became a consultant at MIT. I went back to MIT as a consultant in the then "Laboratory for Computer Science," which was Project Mac renamed. I consulted there for the first five months of 1979 and then founded 3Com in June of '79. Then it was on a completely different roller coaster, which is building a Silicon Valley company.

DKA: What made you think you could commercialize this idea?

RM: 3Com was founded on the general idea that the pace of progress in computing was limited by incompatibility. So by carefully choosing standards this company would greatly enhance the compatibility among machines, and thereby prosper with its customers. The standards that we chose were Unix, TCPIP for the Internet and Ethernet -- well, two out of three isn't bad. We were right twice and Ethernet was the big home run for us.

DKA: Who owned the patents and the rights to that, did you?

RM: The patents were in my name. There were four patents with different inventors in my name, and Boggs' name, and Lampson's name, and Thacker's name, and St. John's name. There were a few other names, I forget, but they were Xerox-owned because they had been bought and paid for by Xerox, as they should have been.

DKA: So you had a deal with Xerox to set up this company? I don't really know the corporate history of 3Com.

RM: Oh, no. No. I left Xerox with no prospects at all for those patents. But in February of '79, I was consulting for Gordon Bell at DEC. He took me into his office and said he really liked Ethernet, and would I help build an Ethernet-like network for DEC that wouldn't run afoul of Xerox's patents. And I refused to do that. I didn't feel comfortable turning around that quickly on my former employer. But we had a better idea. In that meeting we decided, "Why don't we just ask Xerox to cooperate?" Xerox was using DEC computers in their printers, and DEC was going to be using Xerox printers for its data processing systems, so it made sense that they would be compatible. So I served as the marriage broker that introduced my old friends at Xerox and my new friends at DEC together.

I also brought in Intel later, in March of 1979. Intel was out looking for an application for a new chip technology, and I introduced them to DEC and Xerox. By June of '79, it was clear that DEC, Intel and Xerox were going to cooperate on an industry standard for Ethernet. That is why I founded 3Com, to leverage off of that standard, which I was sure would create many business opportunities.

DKA: And is that where your funding came from, those three partners?

RM: Oh, no, no. The first year and a half the company was funded by consulting revenue from principally DEC, General Electric and Exxon, some of the biggest companies in the world. Then after DEC, Intel and Xerox announced their specification for the standard Ethernet, we had a business plan that we then shopped into the Silicon Valley venture capital process, and became a classic Silicon Valley venture capital funded startup.

DKA: You say "we." There was you, and who else was involved in it?

RM: Well, there's a lot of funny detail there, but I was the first employee and Greg Shaw, who's now at Microsoft, I might add, was the second employee. Then Howard Charney who's now at Cisco was quite prominent, and Ron Crain, who had worked on Ethernet with me at Xerox, joined us. A very significant event was the joining of Bill Krause from HP in April of '81. This was after we closed our first venture capital round, and Krause he knew where to run a big company, which is where we were headed.

DKA: Bob, you had been involved in a lot of different organizations by the time you set up 3Com. What did you want it to run like? What culture did you want it to have?

RM: In the very early days we didn't think about having a culture, but we began to form thoughts that resembled that. Very early on we decided that every employee would have stock in the company. One of our early dreams was that the offices would be within walking distance of shops, restaurants, and the Southern Pacific Railway. Then we recruited Bill Krause to join us, which was a big coup, from HP. Then all that nonsense was over because we became an HP-culture company.

Part of Bill's value to the company is he brought a flock of HP people who knew how you were supposed to run a company. You're supposed to have marketing managers, and sales managers, and engineers, and products. It was a whole structure and a culture that Bill brought to us, which worked. I consider 3Com an HP company to this day, although I haven't been there recently.

It was funny, some years later Bill thought that we needed a written culture. And I said, "Why do you think we need a written culture?" He said, "Well, HP has one." I said, "Yes but HP is a multi-billion-dollar company. We're just scraping by. When HP was our size, did they have a written culture, or did they only write it recently?"

So we took several cracks at a written culture, but basically our culture was Bill Hewlett and Dave Packard's culture, which is a very wholesome, I like to say "boy scout" culture - clean living and hard work and respect for the individual and performance appraisals regularly. Just play it right down the middle, no short cuts.

DKA: Not a lot of hierarchy?

RM: Some, but management by walking around. It was funny sometimes to watch Bill, because Bill would act on these ideas. Bill had a calendar in his pocket. Whenever you had a meeting with him, the goal was to get him to write something down on his calendar on his "to do" list. But he rarely did that, because he's a good delegator. So during most of his meetings you couldn't get him to write anything on HIS "to do" list. You ended up with everything on YOUR "to do" list. He knew that you were supposed to manage by walking around, because that was a Bill and Dave kind of idea. So you'd watch Bill out in the cubicles, managing by walking around. It was hilarious, really, because he knew he was supposed to do it. It's very much Bill that if he knows he's supposed to do something, he does it. And there's no stopping him.

DKA: And what role did you take on in running the company? How did you play your work out?

RM: For the first six months I was probably the only employee. Then during the early years it was a consulting company, and I was the Chairman, President and CEO. Then when Bill came, he became President and COO, and I became Chairman and CEO. That lasted about a year. It was a hiccup in the history of the company, and the board felt it would be better for Bill to take over as CEO. Then as a measure of their desperation they gave me the job as head of sales and marketing. When they gun you as founder CEO, it is classic behavior to get all red in the face and storm out the door with words about vulture capitalists, blah, blah, blah.

And I don't know what exactly happened, but I decided that would be stupid. I was going to be better than that. I stuck around to be head of sales and marketing, which I then did with great enthusiasm. I got the company up to about \$1 million a month in revenue before we recruited a real head of sales and marketing, who knew how to do it. In the early days, the secret was credibility and personal selling. I had a lot of credibility, being the inventor of the stuff, and personal selling, I had a knack for, but as soon as we got to \$1 million a month, it became sales compensation and contracts and distribution channels and things which I had no expertise in. So we got a new head of sales and marketing.

DKA: Sounds like you weren't too interested in those either. Was the innovation the part that really interested you?

RM: Oh, no. I loved sales and marketing. I loved it. I used to keep track of our orders, estimating what they would be each month. I would call on people and change the probabilities. I had sheets where I would write the name of the customer, the amount of the potential purchase, the probability of closing it that month, the probability of closing it in two months, the probability of closing it in three months. Then I would sum these columns and report to Bill what the forecast was on sales and marketing. He'd look at these pieces of paper and say, "Okay, if you say so." I think this is a pretty classic method of estimating and I loved it because I had a number to work with.

It was a funny thing. My goal was to get that number to be higher than that number, and I learned a very important lesson there that MIT didn't teach me, which is that MIT people tend to think that if you do something excellently, the world will beat a path to your door. Perhaps you've heard that before. What I learned is a lot of people won't buy your products unless you ask them to. And you have to ask them in the right way, and you have to give them the right tools to make the favorable decision, and you have to keep after them. Many MIT people look down on sales people as green slime, and I learned to appreciate sales people, who are quite a different form of life than engineers. I love sales people. I learned to appreciate them. So I was a very enthusiastic head of sales and marketing.

DKA: What were the struggles for 3Com as it came into being and shot up toward success?

RM: Our first hiccup was we mistimed the standardization of Ethernet. We were off by about six months, which was fatal to my reign as CEO. But it was not, fortunately, fatal to the company. We started burning cash because of this delay, but then Ethernet finally did sort of catch on as a standard and our fortunes improved. That was the first major hiccup.

DKA: So you were just out there too early.

RM: Yes but not too early, so we recovered from that. As soon as Bill took over as CEO he put us on a written survival plan, where all the executives took 10 percent pay cuts, and all the managers took 5 percent pay cuts, and everybody else took no pay cuts, and there was no more vacation, and so on. I was head of sales and marketing, so I took a guy out of production engineering and I sent him to be a West Coast regional sales manager. That was a bad decision however it had a good outcome. He really did well. We took an underutilized product marketing manager, Dave Coulson, and we gave him Central United States, and the rest of the world. We gave him the rest of the world because he had an English accent. We gave Mike Halaburka the Western Region. It was my job to work with this group and hire regional managers beneath them and meet our quotas. And just by doing that we doubled sales in a month, because we had feet on the street. In order to get people to buy your product, you have to ask them. You can't just sit there waiting for them to come.

DKA: So it was first, getting through the standardization; second, getting sales out and making it happen.

RM: So I had this very nice house in Boston and I would frequently invite MIT people there, including many undergraduates and entrepreneurs and engineers, and they'd look at this house, which is really spiffy, and they formed this notion that I live in this house because I invented Ethernet. Not really because, for example, the patents were owned by Xerox. I lived in that house because I ran sales and marketing for two years in the early days of 3Com. It wasn't that I invented it. It's that I sold it. That's how I got the money to buy the beautiful house in Boston. Engineers don't want to hear this. They hallucinate that if they just have a really good idea in their room that night, that they'll be set forever having the royalties roll in. As far as I can tell, the world doesn't work that way. Not often, anyway.

DKA: So it was selling and then billing the customers, and once the product got standardized and the customer base was in place, did it sort of become smoother sailing for the company?

RM: No, the opposite. In 1982, the engineers in the company hit upon a technological advance, the first Ethernet chip, which they worked on with a semiconductor company in partnership. We took Ethernet and were able to put it on a small card about this big, instead of about this big, so that it would in fact plug into a personal computer, in particular, an IBM personal computer, which had just been shipped in August of 1981. So in September of 1982, we started shipping Ethernet for the IBM personal computer. Instead of smooth sailing, we ended up on a rocket ship. Suddenly the orders started coming in at an accelerating rate. We were growing 50 percent sequentially per quarter. One quarter, we grew 85 percent, every three months we grew 85 percent. It was great fun.

We couldn't make the stuff fast enough. People wanted it. Everyone should have that experience in life, hitting pay dirt, because the company started really growing. That 85 percent quarter, by the way, we almost broke the company then because we didn't have the infrastructure, and we were abusing customers and shipping junk and not supporting it well, because we were growing so fast. I remember Bill coming into one meeting where we were very upset about this, and Bill says, "We're never going to grow 85 percent in one quarter again." To which my retort was, "Bill, the problem isn't that we grew 85 percent. The problem is that you planned to grow 15 percent. If you had planned to grow 85, everything would be fine."

And the evidence I had that I was right was that Compaq had gone from zero to \$100 million in its first year. You really could grow rapidly if you planned to do it. Bill had a conservative streak, so he tended to forecast conservatively, and that quarter blew it away.

DKA: Were you able to catch up and keep going?

RM: Yes, Bill had brought in good people, and so we had strong enough people to build the infrastructure necessary to serve the larger customer base. An important lesson there to learn is that in big companies, the people grow more quickly than the company. So their career path is upward as they advance up the hierarchy. But in a small company, the company grows faster than the people. Which means you have to go out and get people who are much bigger than the job you're asking them to take, so that the job will grow into them. And occasionally, you'll have to let someone go when their limits have been exceeded.

Now Dave DePew, who I mentioned earlier, was a good case. He was this production engineer who took the entire Western Region and was very successful. So his next job was head of the Northeastern Region. Then his next job was head of the Washington Regional Area, a smaller area still. Then his next job after that was head of OEM sales, that is, sales to other computer companies in the Washington area. So if you looked at that from a big company point of view, poor Dave was getting slashed and burned with each notch of the company. In fact, his compensation and his job responsibility were going up. It's just that he was not really qualified to be, at that time, the regional manager of a much larger company. So the company was outgrowing him, and he was virtually sliding down the ladder, but he was doing very well.

DKA: And down the ladder to more money and more sales.

RM: So the companies grow faster than the people, and you had to build that into your recruiting plans.

DKA: So it was quite a ride at 3Com.

RM: Great ride! I was there officially for eleven years, but if you count the year beforehand and the year afterward, it would be thirteen years during which I was affiliated with it.

DKA: And were you ready to leave and do something else when you...

RM: I left three years too late. I should have left sooner.

DKA: Why do you say that?

RM: In the late 1980s, Bill and I led the company to sort of this awkward site. They call it going sideways, meaning your revenues go flat and your profits go down. In the ensuing trauma in which Bill popped up to be chairman and we got a new CEO, I bucked to become CEO at that point, and a different person was chosen, so I retired in 1990 at that point.

DKA: And decided you would do some writing.

RM: Ultimately I decided to be a pundit, a technology pundit.

DKA: Why? You could start another company. You could go teach. You had lots of options.

RM: The reason I'm not interested in starting another company, although you should never say "never," is 3Com almost killed me. So I didn't want to do that again. I'd been there, done that. It was very hard work and tore me in a lot of directions. It was really just hard. It wasn't whoop de do, for thirteen years. It was a lot of misery and suffering and I'd been to every Ramada Inn in western civilization. Ramadas are good inns but I've been to all of them, and I've listened to all the bands that they have in the cocktail lounge late at night. I've been there, done all that. I didn't want to do it again. So I considered two alternatives. One was to do private science, in the tradition of the 19th Century English, just do science on my own.

DKA: Be a general scientist?

RM: And I tried to talk my very good friend and colleague and former boss, David Liddle to do this with me, that we would do private science together. The other alternative was to become a journalist, which is what I ultimately did. It was when Liddle refused to be a private scientist with me that I became a journalist. Then it turns out Paul Allen approached David, and made him head of Paul Allen's private science, the Interval Research Company in Palo Alto. So David is doing the private science that I tried to promote him into. Apparently I didn't have enough money to interest him.

DKA: And mostly you've focused on writing about networks and thinking about networks. How's it been being a commentator?

RM: Well, I lucked out and I ultimately fell into the International Data Group, which is a very large publishing company, about a billion dollars in revenue a year now. It's owned almost entirely by Pat McGovern, MIT class of '59. Pat approached me when I was living in Cambridge, England as a visiting fellow in the computer laboratory. Pat approached me about being the publisher of InfoWorld. It has improved, but at the time it was in the top five publications in computing. I thought it would be cool to start at the top of the publishing industry. I became publisher, CEO of InfoWorld for two and a half years, and then started writing a column in InfoWorld. Then when we moved to Maine, I stopped being CEO of InfoWorld, and focused entirely on punditry, which means I don't sell ads anymore. I just write. I write, speak, and organize conferences.

DKA: And you seem to have focused particularly on the Internet, in recent years.

RM: Yes. The Internet is my beat, and I think that's a pretty good choice. I don't think the Internet's going to stop being an interesting subject any time soon. So it could conceivably be my beat forever.

DKA: And why? What's interesting to you about it?

RM: It's the biggest thing since the wheel. It's a major event in the history of the world. It's the information age upon us, and it needs helps. A lot needs doing. As a pundit it's my job to help get the Internet to flourish and reach whatever potential it has by being a critic. I tend to criticize people who are slowing the Internet down, and praise people who are speeding it up and doing the right thing.

DKA: What are the biggest threats these days, do you think?

RM: The number one threat to the Internet now is the telephone monopolies, the local exchange carriers. Not MCI, I might add, because MCI is a long-distance carrier, and has competition, but the local exchange carriers are monopolies. There are 1,200 or so in the US, but they don't compete with each other. And that monopoly is why we have to use dial-up telephone modems today, which is a really horrible way to access the Internet.

DKA: So you think if there was true competition, that would go away quickly?

RM: Yes. There are many alternatives to dial-up telephone modems, and we need to get freedom of choice among competing alternatives. Just like we have in Silicon Valley this fierce competition among technologies, we need to instill that same fervor for cutthroat competition in the telecommunications industry. The telcos are quite entrenched as a political force. That's turning out to be very hard to do.

DKA: Are you concerned about the flow of content on the Internet? Is that going the way you'd like, or would you love to see that go in a different way?

RM: I have no complaints about that.

DKA: Have there been concerns about whether there's going to be too much commercial content, too much squeezing out, maybe, some of the other kinds of content that's out there, but other people say it won't happen?

RM: The Internet doesn't allow any kind of content to squeeze out the other. The beauty of the Internet is that it's a million channels, so you can have as many channels as you want. Now some of those channels are pretty horrific, and having children who are 9 and 10, I just don't want them to see pornography. Call me old-fashioned, but that's the way I am.

So I'm interested in what's happening in that area. I think that's going to go pretty well, though. The most important kind of content on the Internet is community content that is not editorial content produced by writers, editors, artists, for the readers, and not advertising, which is by the advertisers for the readers, but community content which is by the readers for the readers. That's by far the most important content.

So dealing with that content, encouraging it, managing it, culling it, packaging it, leveraging it, filtering it, is the real exciting challenge ahead of us.

DKA: Are you concerned about the role of government with the Internet? Is the government playing the right role today, do you think?

RM: I'm anti-government, and that's the first bit. So generally speaking I would like to keep the government out of it. Now that doesn't mean completely, but if you wake me up in the middle of the night and you ask me, "What do you think about the government and the Internet?" I would say, "Stay out!"

Of course, there are some places where it needs to intervene, but minimally so. I'm amused by the people who constantly remind us how the government built the Internet, and that's true. The government played a very important role in stimulating the growth of the Internet through the financing of research in universities, like MIT for example. And the expenditure of research monies at universities; MIT, Stanford, Carnegie, Berkeley, there are many of them, that is the best spent money, because not only does it develop new technology, but it yields people to carry that technology into the marketplace. So that was and is a proper role. But to say that the ARPANET was built by the government ignores 3Com and Sun and Cisco and a thousand other companies that have, for a long time, been building the Internet, and doing so in fierce competition. So generally speaking, I'm fearful whenever the government takes an interest in the Internet.

DKA: Is the Internet developing throughout the world as you think it ought? You talk about the American government, but what about the role of governments and private enterprise in other countries?

RM: For now the Internet is growing outside of the US faster than in the US, but it has a long way to go. And whatever my complaints are about the monopolization of telecommunications in the United States, it's ten times worse outside. I've been everywhere, and it's pretty horrific. I like to put it this way. Back when we were forming the Soviet Union, we had another brilliant idea, which was to create telephone monopolies. And both experiments have pretty much worked out the same. The Soviet Union has done us the favor of deconstructing, but the telephone monopolies are still there, and their great strength lies in the fact that they are able to channel their monopoly profits into campaign contributions. So they have us in a vice grip, and more so outside the US.

The Internet is the major factor of production in the information age. It is an extremely important economic good, and to have it under the auspices of an outmoded, intransigent, political organization threatens these countries. As I quipped when I was in Hong Kong, "Mainland China is less of a threat to Hong Kong than Hong Kong Telephone is, because the information age is coming, and if your communication assets are in the hands of monopolists, you're going to fall behind." And you see that in places like, especially France, Germany, and many places elsewhere.

DKA: And do people listen to what you have to say? Are they resistant to it, as you promulgate this message internationally?

RM: I'm a bit of a broken record on this. I don't really know how to sell ideas this big in a political context. I'm not a politician, so I don't really know how to. So what I do is I just write my columns and I rail and try to make suggestions about how to improve the situation, and hope that those ideas will be picked up by people who do know how to grab the levers of political power. Maybe I should get more sophisticated, but right now I'm just a simple country engineer, railing against the telephone monopolies.

DKA: As you look toward the development of the Internet in the next decade or so, how would you paint the way it will be in 2010 if it will be the way you will want it to be throughout the world?

RM: Well, assuming we solve the telco problem, and assuming we get the government right, I believe there is a long-term trend away from government and toward markets as the arbiters of power and resource allocation. Then I would envision a highly competitive electronic market place, highly commercial. I don't think "commercial" is a bad word.

Thanks to competition, I see the Internet spreading rapidly. So my idea about how to solve the "have" and "have not" problem is to let competition reign and drive those prices down, down, down, which is what happens when you have competition. I would see the Internet evolved to the point where it becomes a major substitute for transportation, so that that horrible time we spend driving to work or that even worse time we spend flying to various Ramada Inns around the world can be eliminated through meetings in cyberspace. I would like to see that.

DKA: And you feel that the cost will be low enough so that even underdeveloped countries can grab a hold of it or maybe use it as a vehicle for their own economic growth?

RM: It's a very complicated question but I would say that I'm pretty confident that the net effect, so to speak, of the Internet will be positive on everybody. The so-called "developing nations," the barriers to their access to our markets, to the developing world's markets, will be lower and so I expect it to work out just fine. I have a hard time making that argument in detail and so I'm anxious to have it fleshed out.

DKA: Is there anything that scares you about looking forward?

RM: Well, there are asteroids from outer space. When I was growing up we never worried about asteroids but now I'm worried sick, every day, we're going to find one of these.

DKA: At least everybody will know about it fast, because of the Internet.

RM: Yes, well I'm hoping to see my children graduate from college. It would be horrible if I didn't. So I have to take better care of myself. No, I'm basically optimistic and more than anything, enthusiastic.

DKA: You've had a remarkable career through some of the leading institutions of American science and technology. MIT, Harvard, Park, starting your own company...

RM: Stanford.....

DKA: And Stanford, if you were to advise young people thinking about going after a scientific career and looking forward to being innovators like you have been, what kind of advice would you give them?

RM: Do your homework. Go to bed early. My mom made me do all those things -- find a way to like what you do. I've had a big advantage over many of my cohorts, which is that I've generally always been excited and interested in everything. And many of them have had the problem that they never knew what they were going to do when they grew up. I've never had that problem. So I think if you commit yourself to finding everything to be interesting, as soon as you can, that will bode well.

I can see it in my kids. There's a tendency for them to tune out when something's boring, and I try to sell them on the fact it's not really boring. It's really quite interesting when you look at it a certain way. That's the pitch I give. So being uncertain about the future is no way to be. You need to work hard at getting certain about the future, as hard as that is, because life's easier that way. It helped me a lot knowing that I was going to go to MIT since fourth grade. I didn't have to worry about going anywhere else. That's a joke.

DKA: It wasn't altogether a bad choice. Anything else we should talk about before we close this up?

RM: Why do you get an award like this? What are you supposed to do afterwards, what's the point of it?

I suppose the point of it is to do what we're doing now, which is to sort of explain what works. So that people coming along can see what works, and they don't have to try the stupid things. I've heard this thing about failure being a learning experience, but you learn much more from success than you learn from failure. It's a real shortcut to be surrounded by people who know how to be successful, and I've benefited from that. I've also benefited from my parents' naive view of the melting pot, and the whole story about America, which they believe through and through and taught me to believe.

DKA: You're a pretty good example of it.

RM: I think I am, and I think what I'm saying is, that's the way to be. Don't be as cynical as many of us have become, remain enthusiastic. It's really sad sometimes to watch what happens, but I think the way to win is to be enthusiastic, to be interested.

DKA: Well, you're a pretty good example of the fact that innovation is not just good ideas. There are a lot of aspects to being a successful innovator, you talked about the marketing, you talked about career moves.....

RM: Well, that's another fallacy of thought. I've heard this many times -- deciding whether to be deep or broad --should I focus on one thing, and know a lot about it, or should I learn a lot of things about a lot of things? And what I've found, there's no trade-off at all. You can do both. You have the time. You do have the time to both go deep and broad, and both of them are an advantage.

So in my case, I went deep on the networking technology, but I had the benefit of being broad in sort of a managerial communications. I can communicate. I have the vaguest notion of how to manage a company. So enough of this trade-off stuff between deep and broad. You'll be much happier if you go both ways -- go deep, go broad at the same time.

DKA: You also seem to be to be very adept at taking advantage of the opportunities that came your way, whether you knew they were coming your direction or not. So it's hard to imagine you could have expected to land up in something like Project Mac, but when you were there, you didn't just pass through without being affected by it.

RM: That's really true. Opportunities come along. I've made some mistakes, like I spent two and a half years programming the Univac M460. That was an error. I did learn a few things from it, but I should have been programming something else.

I frittered away some time writing this lawyers' software, which was to no avail. So there are mistakes there, but don't spend five years getting three years' experience. You have to learn when to move on. And as I said, I stayed at 3Com too long. It's very hard to see yourself accurately, very hard, and I work very hard at trying to get an accurate view of myself. I watch myself on television. I'm always looking for what is happening here objectively. But it's very hard, and it's why you need help from friends, to tell you where you're going wrong and what you're doing.

For example, the board of directors of 3Com, twice in its history, once in 1982 and once in 1990, did not choose me to be CEO. I'm okay with that, because I built that board of directors. I recruited those directors, and their principal job was to choose the best CEO at the time. Although I didn't really like it either time, I had worked hard to be sure that that process was going to work well, and it did. And history will record that Bill Krause was a damned good choice in 1982, and Eric Benhamou was a damned good choice in 1990. So that worked.

DKA: So being a good innovator is not just knowing what your ideas are, but knowing who you are.

RM: And knowing what you're good at, and what you're not, and when you're being obnoxious. It's very hard to know. People have been telling me for years that I'm moody. I've never felt myself being moody, but repeatedly through my whole career people say, "You're moody, and we don't like it." So I'm going, hmmm, I must be moody. I'm going to have to watch that. But I don't know what to do because I can't see myself being moody. But I know I'm moody, because too many people have told me I'm moody, so it must be true.

DKA: But you certainly use the enthusiasm side of that to latch on to ideas and carry them to completion at critical phases.

RM: Someone famous once said that the only thing you need to be happy in life is something to be enthusiastic about, and that is my rock bottom. My boat's called "Enthusiasm" for this reason. Enthusiasm has a double meaning. It has the normal meaning of enthusiasm, excitement about something, but it also means, "having God within," which is very important when you're at sea. You want to have God on your side.

DKA: It seems to me that's a good place to leave this interview. Thank you so much for your time and insights.

RM: Thank you.