



## Oral History of Joseph (Joe) C. Ross

Interviewed by:  
Craig Addison

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**Craig Addison:** Joe, can you talk about your background in the industry, your first involvement in the semiconductor industry.

**Joe Ross:** My first involvement in the semiconductor industry was in 1952 at Hughes Aircraft Company. At that time we were making point contact diodes. I was not in that particular operation. I was in the Industrial Relations department but I was assigned that division as part of my responsibility. I had that for two years and then the group that headed this Hughes activity started a company called Pacific Semiconductors, better known as PSI. And it was funded by Ramo-Wooldridge Corporation which later merged with Thompson Products, the financier of Ramo-Wooldridge, and it became TRW. That was in 1954. I was with them from 1954 to 1964. Then I went with Microwave Associates in Burlington, Massachusetts, and was with their semiconductor division making diodes for solid state phase shifters. Then I came out here [California] with Microwave Associates West and we started semiconductor activity there. I'm almost certain we bought the first vapor deposition system that Applied Materials ever sold. It was installed at 999 East Arques [Avenue, Sunnyvale]. The system was installed by Michael McNeilly and Walter Benzing. Anyway, later I was contacted about going to work for Micro Mask, which was a photomask company. I worked there from 1971 to 1992 as the CEO. We sold Micro Mask to Hoya Corporation of Japan in August of 1989 and I remained with Hoya Micro Mask until I retired in 1992.

**Addison:** OK, let's get some specifics. What was your background at Hughes and Pacific Semiconductor? Were you an engineer?

**Ross:** No, I was in the Industrial Relations department at Hughes, the wage and salary division, and I set up the entire wage and salary program for the semiconductor division. They liked the work I did so when they started PSI they asked me to go along as personnel manager, which I did. I became industrial relations manager then I became director of administration and took over the building and construction program and purchasing and related activities. Then I decided I'd like to get into the line operations. And the president, Harper North said, "You can't be in line operations, you're not an engineer." I said, "What do I have to do to get to line operations." He said, "Study electronics." So I took a couple of courses at Santa Monica City College and all of a sudden I'm an engineer. So they gave me a very small division to run. There was a new product called the micro diode and I did a very good job running that [at PSI]. So that's how I got into line management and manufacturing. That was about a million dollar line. At the time the company was doing about 25 million [in revenue] which was a lot of volume in those days. And there was a crisis in operations for the main group and next thing I knew I was running the whole operation. From there I went to Microwave Associates where I was assistant division manager in Burlington, Massachusetts. In March 1968, I was assigned to Microwave Associates West in Sunnyvale, California, where I was vice president and general manager.

**Addison:** What was the manufacturing line at PSI like in those days, was it mostly human assembly?

**Ross:** Oh yes, it was all hand operations. The only thing that was automated was sorting and testing. The rest of the operations were all hand operations, ladies with tweezers picking up little chips and putting them on a peg, and soldering them on, that sort of thing. It was all manual. In the early days...let's see, there was TI, Transitron and Pacific Semiconductors. We built our own equipment; the diffusion furnaces were built in house. We'd buy the components and assemble them. We built our own electronic

equipment to sort the product, both good and bad, whatever the characteristics were. It was fully integrated. [The equipment] industry had not even started in 1954. Everybody built their own equipment. Teradyne was one of the early ones in the test equipment business.

**Addison:** When you built your own equipment, were there any standards, a set of blueprints that everybody followed?

**Ross:** No, no. Everybody built their own, it was all proprietary. Our equipment group at PSI in the 1950s was the biggest part of the company because we were building all of our equipment...not building a lot of product at that point in time.

**Addison:** Can you tell me about the events that led to you joining TRW.

**Ross:** Ramo-Wooldridge Corporation was funded by Thomson Products. Ramo-Wooldridge then funded PSI. So we were a subsidiary of Ramo-Wooldridge. Thompson Products and Ramo-Wooldridge merged and became TRW Corporation. They existed as TRW until last year, and TRW was sold or merged...they are now part of Northrup. In TRW there was a cleavage in the company as to which direction the company should go. Should it go into computer transistors or into communications transistors. The director of R&D and the director of development were both Bell Labs people. Well, Bell Labs is in communications so the [PSI] president came down on the side of the technologists, rather than the operating and marketing people, and went to the communications transistors and Fairchild went to the computer transistors. The other companies went to the computer. So TRW never became a major factor in the semiconductor industry because of that decision, which was made probably about 1956 or '57.

**Addison:** After TRW you went to Microwave Associates. What was your role there?

**Ross:** I was assistant division manager.

**Addison:** Again, did they build their own equipment?

**Ross:** No. By 1964 you were able to buy equipment, particularly test equipment. But it was still pretty much a manual operation. Because in the microwave components, it was a fairly small, niche market compared with the computer market, so it was fairly small quantities.

**Addison:** That was on the East Coast?

**Ross:** Right, in Burlington, Massachusetts.

**Addison:** How did you end up on the west coast?

**Ross:** Microwave Associates bought Huggins Laboratories in Sunnyvale. It was a traveling wave tube amplifier company. But Microwave Associates wanted to start a semiconductor operation on the West Coast so they used Huggins Laboratories as a vehicle to start a semiconductor operation. Mason Clark, who went from Bell Labs to Pacific Semiconductor to HP Associates, came to Microwave West and was charged with starting up a semiconductor operation.

**Addison:** Was this during the period when a lot of industrial companies were getting into semiconductors?

**Ross:** No, the expansion had already occurred and MOS technology was just being developed. This was in 1968. I came back out here [California] in '68 to MA West and Mason Clark joined us out here in '68. After the MOS technology became viable there was a rash of startups. Intel started in January '68; they were the first MOS company.

**Addison:** How long did you stay at Microwave Associates in California?

**Ross:** From '68 to '71. It was three and a half years.

**Addison:** That was in semiconductors, not microwave components?

**Ross:** The primary products there were traveling wave tubes and traveling wave tube amplifiers for the Shrike missile program. We were just starting the semiconductor activity.

**Addison:** Back in that period -- and 1970 is when SEMI got started -- what companies were there that provided equipment for semiconductor manufacturing? Were there any or many?

**Ross:** Well, Teradyne for sure.

**Addison:** I guess Applied as well.

**Ross:** Applied was just started, I don't know what year Applied started. But I know they delivered this piece of equipment to us in the fall of '68 because I came out here in April.

**Addison:** Were you involved in the purchasing of the equipment?

**Ross:** No. Mason Clark was the manager of that activity. He bought what he wanted. He was setting up an operation from scratch so he determined what equipment he needed and we just signed off on it.

**Addison:** After Microwave Associates, then you went to Micro Mask?

**Ross:** I left Microwave Associates in June of '71 and joined Micro Mask in July '71.

**Addison:** It seems like a completely different industry; device to mask maker. How did you end up making that switch?

**Ross:** The patent attorney for TRW, a chap named Martin Horn and I, were good friends. And Marty's law firm represented Micro Mask and they were doing general law and patent work for them. When I came back to the west coast in '68, Marty called me and said that Micro Mask needed somebody with operations background on their board and would I be interested in being a board member of Micro Mask. And I said what does a board member do? So he said come on down to LA [Los Angeles] and I'll tell you about it. I was from LA originally, so he knew I was down there frequently. To make a long story short, I agreed to serve and they elected me to the board of Micro Mask in '68. And Micro Mask was immediately

a successful company...successful defined as profitable from the beginning and sales growth growing quite rapidly. But the founders had really no background in managing a business and they got out of control and lost it. And at that point in time I was approached by Hambrecht and Quist, who had an investment in Micro Mask...and [they] asked me if I'd be interested in becoming the CEO of Micro Mask to protect their investment, and take the company public. And I said. "Yeah, the opportunity to become a CEO, I'll take that." So that's how I ended up there.

I went to Micro Mask in '71, had the operation turned around and going in about 90 days and it grew very rapidly. These sound like miniscule numbers compared with today, but it [grew from] about 2 and half to four to seven to 10 million [dollars in sales]. We took the company public in March of 1974. We were the first photomask company to be a publicly owned company. So that's the history of how I got there.

**Addison:** Who actually founded Micro Mask?

**Ross:** Robert Whiteside and Donald Holdhause.

**Addison:** What were they doing before?

**Ross:** They were running, either part or all of the photomask activity at National Semiconductor. I think Don was running the production of the photomask line, using high resolution material with the emulsion plates. And I don't know what Bob's role was at National to tell you the truth. Bob was the president and Don was vice president of engineering [at Micro Mask].

**Addison:** I guess at that time mask making was mostly an in-house activity. Was Micro Mask one of the first independent mask shops?

**Ross:** Micro Mask was the third. I think Qualitron in Connecticut was the first. And MicroFab, which was Drexler Technology, was second. I think Micro Mask was third. And there was one down in Southern California also called Transmask.

**Addison:** At that time did the Nationals and TIs want to get rid of their mask making, or was it something they wanted to keep?

**Ross:** No, the market [for Micro Mask] wasn't the established companies like TI and National. The market was for startups like Intel and AMD and Cypress and companies like that that elected not to put capital into the photomask business...which persisted until Intel built their own mask facility. That must have been about 1990, the approximate date.

**Addison:** You said Micro Mask started off profitably and was successful, and then ran into trouble. From your perception, what caused the troubles?

**Ross:** Lack of internal control. They didn't go into a loss position, they just got to about break even but all the profit went away. I have my favorite story. Shortly after I was there one of the supervisors walked into the accounting office and said, "I want to give so and so a raise." And the bookkeeper said, "How much." And he said, "Oh about 15 cents an hour." The bookkeeper said, "Well you're going to have to give me

something in writing.” So he reached over to the table and picked up a napkin and wrote on it, and that was the authorization for the raise [laughs]. That’s my classic story of how out of control they were.

**Addison:** How did you turn things around?

**Ross:** The first thing I did was to hire a controller...to get financial control of the operation. And then we instilled some discipline and planning into the activity. Put in an operating plan, just basic business principles.

**Addison:** What happened to Don and Bob, did they stay on?

**Ross:** They both stayed on. Don stayed on until he retired a couple of years ago. And Bob left, I think it was in the mid-80s.

**Addison:** How did Hambrecht and Quist become involved? Did they have a shareholding from day one?

**Ross:** Let’s see...some of this was before I was involved. Joe Chulick was on the Micro Mask board, and I don’t know how he got on the board, but he worked for Hambrecht and Quist. And when we bought our first photo repeater...we needed \$90,000 and we didn’t have it. I was still on the board then, I wasn’t an employee. We didn’t have cash to buy this new state of the art photorepeater. When I think back, it was \$90,000 and we didn’t have [that kind of money]. That’s pocket change today. Hambrecht and Quist put up \$100,000 and got, as I recall, 10 percent of the equity in the company.

**Addison:** Was it difficult to get money for that kind of business at that time?

**Ross:** Yes and no. We went public on March 6, 1974, and we were the last IPO of that year. It was similar to the dot com bust here recently when all the IPO money dried up. We just made it under the wire. We came in at 12 [dollars per share] and by September we were in a recession and the stock was at 1 and a half. When I retired they had cake and coffee for me up there and I said, “Well guys, after 20 years and 17 recessions, I’m out of here.” There weren’t that many but they were frequent. It’s a cyclical business. It came back up. The 1974 [recession] was the worst of the worst up to that time. I remember driving to work saying, “Why am I going to work? What am I going to do when I get there?” You were just helpless. People were just not buying, sending stuff back that was phony returns. They didn’t want to pay for it so they found some flaw and sent it back. You had to make a decision whether you were going to hold them to the fire for the short term or whether to eat the stuff and maintain a client for the long term. Those were rough days, but there have been others rougher since, including the most recent.

**Addison:** What did you do to survive that downturn? Reduce staff?

**Ross:** Yes. Fortunately I always ran with a very low overhead operation. So we basically reduced the direct labor part of the workforce. We didn’t have a lot of overhead and fortunately it was a very short recession. It hit in July/August and was over by April/May of ‘75. It was only a six month cycle. You just had to get your costs under control. But we always had our costs under control anyway. I had a very flat organization. Few supervisors, few managers, mostly direct labor.

**Addison:** What was competitive landscape like coming out of that recession?

**Ross:** Going public was probably one of the biggest business mistakes I've ever made at Micro Mask. Because when we went public we had to report the financial results. I think there were four or five photomask companies. At the peak of competition there were about 17 photomask companies. I believe that has now shrunk to two companies, Photronics and DuPont Photomasks. I don't think there are other smaller ones because the capital investment required is too great. We had a peak of about 17 competitors, all independent.

**Addison:** Who were you most worried about?

**Ross:** In the early days I wasn't really worried about anybody because when I went to meet my competitors, the CEOs, I found out that they were all distracted, worried about other things rather than the photomask business. I did that very early on and came back up to Sunnyvale after my tour and I said, "We have a free run at this market because so and so is out trying to go public on the cheap, he's spending all his time trying to sell stock." Another guy, he was worried about what kind of wine cellar he was going to have and how big it was going to be. So I found, from a dedication to the business, that it was pretty easy...it was one of the reasons we were able to grow the way we did in the early years. Then it became tougher because more people came in and...some of them went out of business, but another started up.

The other thing, it became very capital intensive, which is ultimately why we sold the company. When you start out you have the \$90,000 photorepeater, then you went up to more expensive photorepeaters. Then you went up to the electron beam system and we put the first electron beam system into production in the United States at Micro Mask. That was a million dollars and then about four years later the next e-beam system cost \$4.5 million. I understand now they are \$15 to \$20 million.

**Addison:** Where there any major technology changes that impacted your business?

**Ross:** Not really. You got more sophisticated photorepeaters, but the big technology change was when you went to e-beam. And we went to e-beam early on. We put the system in and delivered the first commercial product off that. We were always technology leaders at Micro Mask. We kept up with or ahead of the game.

**Addison:** What impact did the Japanese have on your business?

**Ross:** The Japanese companies stayed in Japan until pretty late. Then we had some competition from them, but not a lot. There was an aversion to buying photomasks from Japanese suppliers. In fact, we lost any opportunity to do business at Micron Technology when we sold out to Hoya in 1989. Cypress [Semiconductor] wouldn't do business with us. This was never stated. But we understood what was going on. In fact I had counseled the Japanese...they wanted to change the name of the company from Micro Mask to Hoya Micro Mask. That's the only decision I ever slow rolled them on because I didn't think it was the thing to do. Because I felt that in time people forget who owns what anyway. As long as it stayed Micro Mask, after a couple of years of turnover and people forgetting...but they insisted on changing it to Hoya and that hurt the situation.

I'll tell you where the Japanese really did influence the photomask business, and that was in manufacturing the photo plates. The Japanese, particularly Hoya, were building the best product, lowest number of defects on a plate. Hoya had the highest quality plate. We were trying to compete with them but we couldn't buy Japanese equipment. We tried to buy Japanese equipment and they wouldn't sell it to us. They said the Japanese government wouldn't clear it [for sale to the U.S.] We ultimately had to buy Leybold Heraeus. But that didn't work. It worked but still didn't measure up to the quality of the Japanese system. Then when I got involved in Hoya, here we were a \$25 million photomask business trying to compete with a \$700 million Japanese company. It was no wonder we lost. So they [the Japanese] cornered the market until DuPont got into the business. And Dupont devoted...I wouldn't even want to know how many millions they poured into [the photo plate] business. They were at it for about five or six years before they had their own product. Now I understand the Dupont product is probably as good as Hoya's. [Editor's Note: DuPont Photomask was purchased by Toppan Printing Co. of Japan in 2005]

**Addison:** What were the events that led up to Hoya's acquisition of Micro Mask?

**Ross:** We had decided Micro Mask could not survive long term as an independent company; that the capital intensity of the business was such that you had to have deep pockets to compete. Not only that, but the photomask business was so competitive that you really couldn't get a good return on your investment. So we agreed we were going to sell the company. So we looked, and looked. We had an investment banker who contacted companies. We couldn't find any U.S. companies that wanted to buy Micro Mask. So we did approach Japanese companies, and the first time Hoya said no. I think this exercise started in 1987...then Hoya approached us in 1989. They had decided to expand their business into three areas: Europe, the U.S. and Japan. They already had an operation in Europe. So they asked us to sell. So we negotiated a deal and did it. I knew all the Hoya managers, right up to the top -- Suzuki, the president, because we'd become what you'd called friendly competitors. They liked me and I like them, so we did a deal.

**Addison:** Was Hoya selling into the U.S. in a big way?

**Ross:** They were selling photo plates and using Micro Mask as an entry into the photomask business.

**Addison:** In 1989, had DuPont Photomasks started already?

**Ross:** Dupont had bought Bill Formby's company -- I can't remember the name. DuPont was already in the photomask business, but not the photo plate business. Micro Mask was in the photo plate business also. I had bought a company called EMC in 1974. And at the time we had the photomask business we were a Kodak distributor for the high resolution photo plate business that Kodak manufactured. And we were manufacturing the hard surface plates down in Southern California [at EMC]. It was what I called the three legged stool. It was a good strategy and it worked. But then the high resolution business went by the board because the technology went to chrome. We had a good little operation down there at EMC but Hoya killed us on quality over the long haul.

**Addison:** Were there any objections raised by the U.S. over the Hoya purchase?

**Ross:** No. It was too small a deal for anybody to worry about. It was only a \$25 million deal.

**Addison:** But Micron and Cypress stopped buying from you?

**Ross:** Yes. We got it from one of our competitors who'd worked for us. Tim Durham and Bill Formby...we were friendly competitors. This business is so incestuous. Tim tipped us off; don't bother spending any money going up to Micron, they're not going to buy from you since you sold out to Hoya. He was right. Have you ever been up to Micron? The first time I went up there I looked and said, "What's that?" They said, "That's the flagpole." I've never seen a flagpole that big in my life. The sucker must have been 100 feet high, and a half acre flag. They are real patriots up there. This was at the height of the trade war [between the U.S. and Japan]...before we leapfrogged them with the integrated circuits.

**Addison:** Let's talk about SEMI. Do you recall who introduced you to SEMI?

**Ross:** It might have been Bob Johnson. He was on the Micro Mask board. He was with Kasper Instruments [and] he got me active on the SEMI board.

**Addison:** When did you become a director of SEMI?

**Ross:** I think it was '78.

**Addison:** And you served as SEMI president in '83.

**Ross:** '83, yes.

**Addison:** During your time hands on at SEMI what do you think the group achieved, and how was it perceived in the industry?

**Ross:** When I got on the board of SEMI, they had two employees in the office, Pat Westly and Mary Law. The directors were literally unpaid employees. We worked. We didn't just go to meetings. We managed the trade shows, managed the monthly activities...it was a working job, a part time job in fact. It was a dedicated group of guys. The show grew and grew, the activities grew and the number of members grew to the point where we needed a full time executive director. And Phil Gregory was nearing retirement from Raytheon, and since he'd been in the thing since it began, he was a natural. And Phil did a great job of managing SEMI and building it up.

**Addison:** That was a full time, paid job, not volunteer?

**Ross:** Yes, he was full time paid. We were part time, unpaid. And some of us put in more time than others. The guys who were local did more. Larry Hansen and I, and Phil, were essentially the executive committee because the other directors were out of town...in Boston, LA. And we built the show up to the point where we did SEMICON East, we did SEMICON Southwest. Then we built [a building] at the [San Mateo] fairgrounds.

The first time that I can remember anybody talking about a worldwide SEMI was at a planning meeting up in Cape Cod. At that board meeting Chuck Drexel proposed that the board consider a worldwide SEMI;

Japan, Europe and the U.S. And to be very candid, he got shot down. That's a polite way of putting it. But that was the first time that SEMI being worldwide was conceptualized.

**Addison:** Was there anything about Chuck that would have prompted him to say that. Did he have offices overseas, for example?

**Ross:** He just had the foresight, I guess. Anyway, it got "poo-pooed". And that must have been before I became president because the year I became president we discussed seriously opening the Japan office. And when we had SEMICON Japan -- that would have been in October '83 -- I was authorized by the board to say that we would be opening a Japan office. I know I made that speech in Tokyo in '83.

**Addison:** From the time Chuck proposed SEMI going global to the time of the opening of the Japanese office, what changed to get people to agree to that?

**Ross:** Bill Reed became president in 1983. I hired Bill. I headed the search committee and it was my job to replace Phil [Gregory]. And it was a few years of Bill's administration that began seeing this type of plan come to fruition. By that time...we had [shows in] Boston, San Francisco, Texas, Europe and Japan. Sometime during Bill's management we expanded to other places such as Southeast Asia.

**Addison:** Where there any special highlights from your term as SEMI president?

**Ross:** My term as president was unfortunately devoted primarily to getting an executive director. When Phil [Gregory] was going to retire in '82, we hired another person -- I prefer not to use names -- and it didn't work out. So most of my term was spent finding somebody to run SEMI. If I recall I hired Bill [Reed] around May of 1983 and the rest of that year was spent getting him on board and working with him. Frankly, I think he gave his life for SEMI because he just traveled too much. Bill was the same age as I am and he was in his '70s and he was still flitting around the world, "red eyes" and this and that and the other. I know how tired I got when I was his age. When I traveled I was tired. I think he just gave himself up. This is a personal opinion. Several of us did all we could to get him to slow down and retire but he loved what he did. He died a happy man.

**Addison:** Looking at the SEMICON shows, did they change during the time you were involved?

**Ross:** The shows started out very, very small at the Fairgrounds in San Mateo. Then it grew and grew and grew and next thing you know we needed a new 100,000 square foot building. And then grew and grew and grew, next thing we know we were in the Moscone Center, and then in the Moscone Center and the San Jose convention center. It was very informal. Everybody knew everybody. It was fun. Now it's work.

**Addison:** What was the feeling of the industry at that time, breaking new ground?

**Ross:** I never felt that way. I just felt that the industry was growing and the chip industry itself was growing, the equipment industry was growing. It was exciting to be part of this experience. I go back to PSI days and I remember, we were in a planning session one day and Warren Hayes, who was vice president of operations, said, "I can see this industry some day being a billion dollar industry." Well in

1958-59, we couldn't even imagine what a billion dollars was. And Warren had the foresight to see it as a billion dollar industry, and now it's what, how many billion...Warren passed away last year, but he lived long enough to see his forecast be very conservative.

But it was exciting. New things coming along. In the '50s and '60s we had a new product every six weeks to two months. Your product was superseded. And the classic example was the Philco Ford experience. They had all these old line Eastern manufacturing people who said, "We have to automate this process." And they had a transistor called MADT, I don't know what the initials stood for...so they spent all this money automating the line to build the MADT transistor and by the time they got the line running the device was obsolete.

**Addison:** People are now talking about mask sets for 90-nanometer approaching one million dollars. Back in those days, were customers complaining about the high cost of masks?

**Ross:** Sure, sure. When I left, \$1,500 a layer was a high price. So that made a mask set \$15,000 to \$18,000 for a 10 to 12 layer set. As I understand it now, the last number I heard was \$15,000 a layer. But I'm sure that the cost of making them is a lot higher because the equipment is more expensive and the specifications are more stringent.

**Addison:** After you retired from Micro Mask did you leave the industry?

**Ross:** About four years later I bought a photography business and we sold that out just as this recession was beginning. I'm fully retired now.

END OF INTERVIEW