HECHT: I’m Jeff Hecht, the author of *City of Light: The Story of Fiber Optics*, and I’m interviewing Michael Barnoski for the Optical Society of America’s History Project. Mike received the second John Tyndall Award in 1988 from the Optical Society of America and IEEE in recognition of his invention of devices and instruments instrumental to fiber optic technology and the leadership that he has exerted both in professional societies and in the industry in advancing optical communications technology. Mike received his doctorate from Cornell University in electrical engineering and has worked at major companies in the optics and fiber optics fields, including Hughes Research Labs, TRW and Polaroid. He founded PlessCor Optronics (PCO), which became a leading producer of optical to electronic and electronic to optical interface products. He is now president and CEO of nanoPrecision Products, which he founded in 2002. We’re here at CLEO in 2008 in San Jose where we just conducted a symposium in honor of Ted Maiman.

Mike, your training was in electronics. What got you interested in optics and fiber optics, and where did that lead you?

BARNOSKI: My training in electronics was primarily when I was studying for my bachelor’s degree. During that time I had decision to make. I had interest in the physical sciences. I took courses in electromagnetic theory, which I found fascinating. I also considered going into computer science because I really like math, and was also enamored by Boolean algebra. Eventually I chose to go into the physical sciences. So when I went to Cornell for a master’s degree, I specialized in microwave electronics, and the reason I did that was because I had
worked summers at Westinghouse microwave tube plant where I was introduced to Professor Lester Eastman at Cornell. He motivated me to go to Cornell University for my graduate work. I did my thesis in slow wave structures for applications to traveling-wave tubes. My PhD was in quantum mechanics math and solid state physics. I did Fourier transform spectroscopy of ferroelectric materials as my thesis topic.

When I left with a PhD in applied physics from Cornell, I went to Hughes Research Laboratories and got involved in numbers of projects, including lens less correlation imaging and studying ion implantation as it applies to bipolar microwave transistors. At about the time I finished that project, Corning researchers Bob Maurer, Don Keck, and Peter Schultz announced the 20 dB loss optical fiber. Being a microwave guy I found that very interesting, waveguides are waveguides. They're just bigger or smaller, and so the fiber was smaller than the millimeter wave pipe that was a competition at the time for long distance transmission of audio signals, certain voice signals and telephone signals. Just as I was finishing the project at Hughes Research in microwave bipolar transistors, in walks a Corning representative with the pieces of fiber in hand. The reason Corning was interested in Hughes is because, at the time, Hughes owned a cable television operator in Santa Monica. It also owned a cable equipment and cabling company in Phoenix or Tucson; I can't recall. I think it was Tucson. Hughes Aircraft also had a microwave division in El Segundo that manufactured portable communications equipment primarily focused on disaster recovery so that if something happened, like a flood, and the telephone or the communication system went down, Hughes would go in with these temporary microwave units and set up to reestablish communications until the landlines could be brought back online. So all that enamored Corning and led them to Hughes Research Laboratories. They said, “We want to get you guys involved.”
So I was asked to take on the project with a fellow by the name of Bart Bielawski who was, I think, the number two employee at what was then called Siecor, a joint venture of Siemens and Corning to cable optical fibers. The name Siecor was, relatively recently, changed to Corning Cable Systems when Corning purchased Siemens’ interest in the company. Siecor was located in a small town outside of Corning by the name of Horseheads, New York, and their offices were in an old Robert Hall clothing store. So Bart, I and another Corning individual whose name is on my lips but I can't bring it up immediately, and a fellow by the name of Joe Strauss from the Hughes microwave group did a twelve-month study of what it would take to bring optical fiber as the preferred transmission medium for cable TV. Frank Thiel, a researcher at Corning research labs, was the other Corning individual involved. So it was Frank, Bart, Joe and me.

After the twelve months, we concluded that it was definitely advantageous to use fiber, but it would have to be single-mode fiber, which at the time was something that many people thought was just not in the cards because the core was so small, the sources weren’t all that great, and the connectors were just not available. Single-mode fiber required single-mode lasers. We also concluded it would need wavelength division multiplexing. We laid out a complete system and did all the performance calculations, loss budgets, and all that. It turned out we were right. It just took 15 years for it to occur, and now it’s prevalent. So that’s how I got into fibers.

At that time, I believe Amnon Yariv and some of his students at Caltech got interested in what became known as integrated optics, and I don't recall what drove the interest. But anyway, he got interested in integrated optics, which was making and studying single-mode waveguides on the surface of various materials. So Amnon was a weekly—I believe weekly—visitor as a consultant to the Hughes Research Labs at the time. Since I was involved with the fiber activity, we started up an activity at the Research Labs in integrated optics. I was responsible for that. We
worked on numbers of things and built up a fairly strong capability in that area leading up to integrated optical spectrum analyzers used for analyzing microwave signals. One of the Hughes divisions picked that up from the labs. We developed the current technique for connecting optical fibers, which is two round cylinders with a hole drilled in the middle. Stick the fiber in and glue it in place, and then stick those cylinders, one for each fiber that you’re trying to interconnect, together into a spring clip, which is basically a split sleeve - that is, a cylinder with a slot down the side of it so it would act as a spring clip. If the diameter of the cylinder was concentric with the location of the fiber glued in the center hole, the spring would hold the two diameters and hence fibers in alignment. That design still survives today. The cylinders (ferrules) and split sleeves (adapters) are now mostly made out of ceramic. We machined them from metal.

So once I developed that capability at Hughes, I got involved with the Optical Society because I felt that it was important to participate in a professional organization to help grow the field and do my part. So I was involved from the very beginning. I started involvement when I was invited to give a talk at one of the first Williamsburg meetings. It may have been the second one or the first optical fiber meeting sponsored by OSA. I can't remember which.

HECHT: ’75 or ’77.

BARNOSKI: Yeah, it was ’75 actually when I gave the talk. That got me into the process, and I went on and became a member of the team of people that do technical paper reviews for the meetings. I was chairman of the technical paper review committee for one of the conferences. The meeting was in Washington DC, held in a very old hotel that was falling down. Actually
now I guess it’s been really restored. That was because the guys at Bell Labs—rightly so—wanted to be within a bus ride of wherever the meeting was, and that was the best place. Jarus Quinn, working with the committee, decided that was the best place so OSA took it. Anyway, after that, I think the next meeting was in San Francisco and I was the technical program chair for that meeting. I think it was the ’79 meeting.

In that period, both the Japanese and the Europeans had set up similar meetings to the Optical Fiber Communications Conference, including some on integrated optics. At the time, the integrated optics was a topical meeting. It was decided, and I was part of that process because I was invited by Jarus Quinn as was Bob Maurer, to participate in an international group that would decide how best to coordinate all these meetings so that there wasn't duplication and it was distributed well enough that people from all over the world could find one of them that they could go to. We ended up deciding, after numbers of meetings, to establish an international meeting occurring every three years that combined the work in fiber optic communications and integrated optics. It was named the international Integrated Optics Optical Communication Conference (IOOC), and it would rotate meeting location on a three-year cycle. So in the U.S. it would show up every three years; in Japan it would show up every three years, and the same thing in Europe. That went on for a while. The first one in the U.S. was in San Francisco, which would have been ’79, I guess.

HECHT: ’81.

BARNOSKI: ’81? Yeah, ’81. I was technical chair of that meeting. So that’s how I got involved.
HECHT: Yeah, that’s interesting. You’re talking about having been in basically microwave electronics and moving over to fiber. So were you really essentially transferring the high-speed electronics technology over to fiber from the millimeter waveguide, or there’s a lot more to it than that?

BARNOSKI: Well, on the transmission side, I mean it was a dielectric pipe, which is a waveguide, and the waveguides are waveguides. The difference was the size. Maxwell’s equations still apply. The whole principle of calculating what goes on—dispersion, loss, all that stuff—is just a matter of scale. On the sources and receivers, they were a little different because you needed to have a small, bright source for the small fibers. Even for the multi-mode at the time, it was still 50 microns, and that was pretty small at the time. Of course, on the other end, you needed to have something that converted the light back to electrical signal.

One of the interesting things I founded with Bob Maurer was a one-week short course on optical fiber communication at the University of Santa Barbara. Through the years, it went on every summer for 20 years almost, many people lectured, including Don Keck, Stu Personick, and Ivan Kaminow, Jim Goell, Amon Yariv, Henry Kressel and others. The course notes ended up in a text book published by Academic Press. It was a best seller with two editions published. One of the interesting things for me that came out of that course was that there were the electrical engineers who were the communications guys, and then there were the physics optics guys. The two didn't talk to each other very well. The engineers couldn't understand how optical power and current were equivalent, so you had to go through and explain that to them, which was kind of interesting. But it was an indication that those two worlds needed to mingle, and over the years
they have, obviously. So from the point of view of all the other devices—the couplers and the wavelength division multiplexers—all that stuff transports from microwave electronics - it’s all very, very similar. You know, it’s different but the base is the same. So that’s how I got involved. A lot of the people in the industry came out of the microwave world, in my opinion.

HECHT: Was there a lot of electronics expertise within Hughes at this point?

BARNOSKI: Well, Hughes had an enormous amount of electronics expertise. As a matter of fact, one of the things that we did early on—and it was in the ’70s—one of the divisions came to the laboratory. It was the Avionics Electronics Division, and they were testing what they call a fly-by-wire system for flight controls. Instead of the hydraulics systems for controlling the various aerodynamic surfaces, they were using motors driven by electrical control signals. They came to the lab saying that they would like to take advantage of the fact that the glass fiber wasn't responsive to electromagnetic interference. It was lighter and all these things that were purported at the time…you know - the advantages. So they asked if we could get involved, and so we did. We ended up building a system where we used bundles of optical fibers to transport the optical signals. At the time it was not possible to get a single fiber in a form that was protected well enough that it wouldn't break - or at least they were not readily available - as well as required small LED’s and photodiodes. As a matter of fact, it was kind of interesting because when they first came to the laboratory (as I mentioned, they wanted to get us involved), they had these pieces of fiber on the table in a plastic tube because it was in a bundle. You’d finger it a little bit and all of a sudden there were three or four pieces and you’d say, “Hmm.”
So in any event, we took the bundle, which had about 50 or 60 fibers in a plastic tube, and we built the system. So the question I had in my mind was, “How do we get the light in and out?” So a prevalent connector at the time of electrical cables was called the BNC connector, so I just went down to the machine shop and drilled it out and stuck an LED in one of them and a photodiode in the other. We stuck the bundle into the BNC and glued it in place and then connected one end to the BNC with the LED, the other end to the BNC with the photodiode, and we flew it. Don Keck made the network star coupler at the Corning labs. We actually flew it over upstate New York out of Cal-Aero out of the Buffalo Airport. It was an experimental aircraft that could do all kinds of things, including move its center of gravity out the side of the plane, so you could go sideways, up, down. It had two cockpits and pilots, one experimental and one conventional. So we flew this system and fully tested it, and I was on board with a parachute and the whole thing. [Chuckles] So they were very much involved in electronics and supported the effort completely.

As a consequence, we ended up coordinating all the divisions of the aircraft company’s interest in photonics. We built a microwave spectrum analyzer using integrated optic devices, basically geodesic lenses and an acoustic array that deflected the optical beam. We did that, and then we had the flight control system. The connectors that I mentioned, the cylinders which are now called ferrules and split sleeves, now called adapters, were picked up by the Hughes Connecting Devices Division in Irvine, and they actually marketed fiber connectors. That division still sells them. It’s now a part of Delphi, but it still sells them.

**HECHT:** Okay. What kind of an environment was Hughes to work in at that point?
**BARNOSKI:** It was an unbelievable environment. I mean in that company at that time, you could find a world expert in anything. It was just amazing. There was one guy I’ll never forget. He only had some high school training, but he was one of the brightest guys I ever met. He would integrate by breaking up the graph into little blocks and then add up the areas of these blocks. This guy was amazing. The company was like that. It had a reputation: If it can't be done, give it to Hughes; they’ll figure it out. And they did for the most part. So it was a premier organization. It was interesting also in that the research lab grounded the people in the following sense: to be successful from the organization’s point of view, if you were going to be a manager, you had to bring in enough government contracts—and the only customer the aircraft company had was the government. You had to bring in enough government contracts to feed at least half of the people in your group. That was kind of the rule of thumb, and it brought you down to reality. People didn't go drifting off. We did some very esoteric stuff competitive with pure research organizations, but we had that grounding. I think that is good for innovation, good for development of people. It doesn't let you just drift. You know, it makes you responsible to a customer, and that's good.

**HECHT:** So you were doing a lot of military work at Hughes?

**BARNOSKI:** Yeah, we did a lot of government contracts. That was the whole game. An aircraft company was a government contractor, and they didn't do anything else.

**HECHT:** So the military at this point was looking at military fiber optics systems such as the aircraft flight system that you described?
BARNOSKI: Yes, that, and we were looking at the fiber-guided missiles. So we got into the strength of fiber and coatings because Hughes had the lock on wire-guided missiles at the time. There were the avionics systems. There were these microwave spectrum analyzers. They were interested in microwave analysis. You know, they did some very interesting things.

I have one recollection. There was a fellow by the name of Rosen. His brother was the head of a venture firm that founded Compaq. Anyway—I can't remember his first name. I think it was Hal. Hal Rosen. He called me up one day—he and two others who are the fathers of the concept of synchronous satellites. So he called me up one day and he said, “Come on down here. I want to talk to you.” So I went down there. It was in El Segundo. He said, “I want to put a fiber down to the bottom of the ocean and melt rocks. Come back in a week and tell me whether I can do that.” [Laughs] So I did and went back to him, and I said, “Well, the trouble is, Hal, you’re going to melt the fiber before you melt the rock,” and so that ended that. But that was the kind of a place that was. I mean they were just pushing in every direction. We were involved in undersea tow systems for towed arrays for detecting the presence of ships, so that was involved with fiber. So it was very active with all the divisions.

HECHT: Yeah. How did you get into management there? Were you early on?

BARNOSKI: I just drifted into it, I guess. When I got there, I was a member of the technical staff, as was any incoming PhD-level guy. I became a senior member of the technical staff, and then I had to bid on contracts and I started winning, so I couldn't do all the work. So I had
people under me, and then one thing led to another and next thing you know, I’ve got 40 people working for me in the lab.

HECHT: Okay. How long did you stay at Hughes?

BARNOSKI: I arrived there in April of 1969 and left in May of 1979, so I was there ten years. I went from Hughes to TRW because a fellow by the name of Ted Maiman who I had met at a party. He started talking to me about what he was doing, and at the time, Ted was the vice president for new ventures for the commercial portion of TRW called TRW Electronics. It was the commercial portion of TRW on the West Coast. They owned a lot of companies, various kinds of companies: electronics companies, point of sale equipment, device companies, etc. They had a company by the name of Vidar up in the Bay Area, which made large telecom switches, you know, that kind of thing. Ted, under the guidance of Si Ramo, was brought into the company to extract the technology being developed from the government side of TRW for commercialization. The first one he did was a roaring success. It was marketing analog digital converters chip sets developed by military application. They made a company out of it. TRW had developed a chip that could do A to D conversion and D to A, and commercialized them. That was a roaring success. The company just took off like a shot.

So anyway, Ted talked me into coming there to set them up in photonics. So I developed an organization that was called the Technology Research Center (TRC) that reported directly to Ted. It was primarily thrusts were digital communications, optical communications, and information science. I was there four years from ’79 to about ’83. There was a major reorganization of TRW around 2003 that merged two organizations, aerospace and defense and
the commercial group TRW Electronics. At the time, I said, “Well, I’ve already done the aerospace and defense thing. I don't want to do this all over again,” because the reason I got interested in joining Ted, one of the reasons was it was in the commercial sector and I had no experience in that at all. I found it interesting to participate in that.

When they merged the two together, I said, “Well, I’ve done this at Hughes and I’ve done it here.” We had a lot of contracts. We had commercial contracts. Why am I doing this? I’d kind of like to do this for me, not for someone else. So I was at one of the meetings—I don't remember which one—and I was talking to Chuck Lucy and Dave Duke, both with Corning. I said, “I’m kind of thinking about doing this,” and they said, “Well, so are we. Why don't we join forces?” So that’s how I got involved with Corning in establishing a company which was first called PlessCor Optronics.

I left TRW and became a consultant to Corning while we searched the world for a partner because Corning joint ventures if it is out of their expertise. That was their mode of operation and I think pretty much still is. We went to talk to all the obvious potential partners, and the one that seemed best because of the technologies they had at the research lab was Plessey. Plessey had a world-class lab at Caswell in England, and the chairman of Plessey was a very dynamic guy.

I’ll never forget how we closed the deal. We had been talking to them for some time, but there was a dinner held at the Savoy Hotel in London where the chairman drove the wine steward crazy because he kept asking for a good bottle of claret. I think it went at least five rounds, and by this time the wine steward was red faced and the bottle was probably $500 or more by the time this ended. In any event, we sat down for dinner, and I sat next to him. He said, “What do you want?” That was exactly how he said it. So I said, “I want $6 million of yours and be your...
partner.” He said, “You got it.” That was it. That's the deal. So from there on, we worked it all out and it became PlessCor Optronics. They were a good partner.

Then when they became a subject of a hostile takeover by GEC of England, the arrangement was that Corning had 40% ownership of the company, Plessey had 40% ownership of the company, and the management had 20%, and it was undiluted. So whatever it took, the founding team and the options would be at 20%. So Plessey came to us and said, “We want to buy Corning out,” and Corning did the same thing, and we didn't have any idea who GEC of England was. Since we didn't know who they were, we just decided to go with Corning. So Corning bought out Plessey, and then a year or so later, IBM made a major investment in the company and we became known as PCO. When I left at the end of ’90, we were number two to ATT in modules. So we were the second-highest module supplier in the world. ATT was first; they had 22% of the market. We had about 19, something in that order percent, and then Sumitomo was down around 16%.

So after that, I sold my shares and became a consultant to the chairman of Polaroid, and I did that for five years. It was half-time, but it was actually probably three quarters of my time. My wife and I became bicoastal for that period of time. That was a lot of fun.

**HECHT:** Was that in the Edwin Land era?

**BARNOSKI:** No. Edwin Land had already passed on. It was an era where they were trying to cope with the fact that film was being threatened by digital imaging and what to do about it. So I was brought in to help them address that problem. It was a very good experience for me. I was there until the chairman who hired me retired, and then, you know, so goes the chairman; so goes
the chairman’s barber. So I left after that, and then I got involved at this company that I’m currently the president of.

HECHT: You went then from development of technology into manufacturing. What was involved with those whole transitions because you were involved in starting in the very early days of fiber optics developing new technologies, and then taking the technology out to the point where it could be used commercially, thus helping build the fiber optic networks of the 1980s.

BARNOSKI: Yes, I was involved in the transition from just pure technology to actually applying it to manufacture things. At PCO, we had a capability of making our own indium gallium arsenide phosphide chips, lasers and LEDs and photodiodes. So we had that device manufacturing business, which is a very capital intensive portion of the business. We also had a hybrid electronics business, which is basically these transceiver modules or hybrid electronics, so we had the hybrid assembly business. We were also making line cards for primarily for the Korean telecom, and also we sold them to China as well. Then we had an electronic box business. We had a very high performance video link, and we were promoting that for transmission of high performance TV signals, very high-end TV signals from one place to the other. So I learned a lot about manufacturing in that process and about the economics of devices versus equipment and what it takes to make laser diodes. When they’re on the wafer, they have certain value. Once you break them up into individual chips their costs start to go through the roof because you start fingering them, and when you start touching anything in high-volume manufacturing, the cost goes through the roof. So it was very good experience. We did very
well. We got the company up to about $16 plus million in sales. We were profitable, and we did that in the period of 1984 to 1988. It was an experience that I enjoyed very much.

HECHT: Yeah. Your Tyndall Award was for a rather broad category of activities. I guess it also applies somewhat from hands-on development to managing.

BARNOSKI: Yeah, you’re right. My Tyndall Award was written in a broad way, but it was dominated by the Optical Time Domain Reflectometer (OTDR), as I was the first to publish the use of Raman backscattering to analyze light propagated in the fiber. As with anything that eventually makes it to the end, there were three people in the world, unbeknownst to any of the three of us working on OTDRs simultaneously. Stu Personick at Bell Labs was one, and a friend of mine also involved in the courses that I mentioned at UCSB, and a fellow at Siemens in Munich. The three of us simultaneously were working on it. I happened to be the first to publish. I didn't know they were working on it until after I published it, and then it became apparent. That I think was the dominant reason. But I was active with these societies at that time, as I had mentioned. I was very active with the Optical Society, and Jarus asked me to represent the Optical Society at the International Optics Congress. So I was involved in that sense, and so they wrote it up the way they wrote it. Ted and Jim Goell were the proponents of my getting that award. They were the ones who actually submitted the application. Jim established ITT in the fiber optics business. I didn't know anything about it.

HECHT: Before the optical time domain reflectometer, was there really no good way of measuring what was going on within the fiber?
BARNOSKI: You had to access both cable ends to measure transmission. You stick light in one end and go down to the other end and measure it. The OTDR allowed you to look from only one end, and it was a controversy at the time. “Oh, it’s not exactly right because you’re not exciting all the modes in the right way.” “Yeah”, but look, here’s the data. What did you measure?” “Oh, I got 2.” “So did I.” But they’re right. It wasn't exactly right, but it was so close it was fine.

HECHT: Was the major impact for field use as well?

BARNOSKI: Yeah. The major impact of the OTDR at the time was in the lab, but then it became… You know, people picked up on it and Hewlett Packard came to see me as did Tektronix. They all wanted to commercialize it, which they did.

HECHT: And then that became very important in servicing once fiber got out in the field.

BARNOSKI: Yeah. The OTDR is a very common instrument today. Unfortunately, I didn't patent it because—well, I did patent it. I actually submitted an application, and true to Hughes’s approach, “Well, this isn’t something we’re interested in, so we’re not going to patent it. But it is patentable.” That was what they told me, so I didn't pursue it. I should have taken it on my own because they allowed you to do that. If they decided they weren’t going to patent, you could have it. But I didn't do anything about it.
HECHT: Did anyone else patent it?

BARNOSKI: Not to my knowledge.

HECHT: That’s very interesting. What achievements are you particularly proud of looking back over the years? The OTDR was a major instrument that you developed. Are there other particular devices or perhaps a particular role that you served in the industry?

BARNOSKI: Whatever achievements I’m most proud of, on the technical side I am proud of the work I did on the microwave bipolar transistor because it was the first ever of a complete transistor built that way. I wrote several papers. I for probably two years was sending out reprints, and so that indicated that it was being looked at. So that gave me satisfaction. I was very, very proud of doing the OTDR. I did patent the fiber-to-fiber coupler at Hughes. But more than that, I think what I really am very proud of is having found and supported the people in various groups that I’ve managed through my career. It’s all about the people. That’s what makes it possible to do these unbelievable things, so I’m very proud of the fact that I was able to put these teams together and they stayed together. I take great pleasure in that. And I’m in the process of doing that again. I hope I have the success in that regard that I’ve had in the past.

HECHT: Were there particular people in addition to the people like Ted Maiman who you’ve mentioned that you would also mention as particularly outstanding that you worked with?
BARNOSKI: Well, yeah. Ted was one of the outstanding people for sure. But Don Keck and I wrote proposals together when I was at Hughes and he was at Corning, and of course he was involved in the short course. I really admire Dave Duke, and he gave me a lot of support. He’s the one who led Corning’s investment into PCO. And Les Gunderson, who was the head of the lab there at the time, or part of the lab, was also very helpful. So I’ve been fortunate to be able to work with a lot of people who were very, very good at what they did. That helped me with my own career.

HECHT: We mentioned earlier your involvement with OFC. How has that played a role in your development and the development of the field?

BARNOSKI: Yeah, I was involved with OFC from the very beginning. I think it gave me visibility into what others were doing because I would sit in these paper review meetings. I would sit in these planning meetings, and you know, you got to know people from Bell Labs and RCA and various universities and the government. It allowed you to get a perspective of the industry, and it also gave me some visibility personally so they knew me. I think that had some impact on how I developed.

HECHT: Were there any interesting stories you’d have going back over the years of things you were involved or projects that worked very well or didn't work very well?

HECHT: Were there any stories you have that are particularly interesting from over the years or particularly fun or some great achievement or minor fiasco?
**BARNOSKI:** One was my experience with the chairman of Plessey, where he probably had made up his mind already when we got to the dinner, but nonetheless, he could have said no and he didn't. The way he did it was kind of dramatic, which I thought was kind of interesting.

There’s another story about one of the lecturers in the Santa Barbara course—I won't mention his name—but Don Keck and I were sitting in the audience because Don was going to speak next. This fellow was up at the podium or at the blackboard, and we think he had a heart attack. But he never lost a beat. Then after the meeting, he said, “My arm hurts,” and all this. “You’ve got to get to the hospital!” “No, I’ll be all right.” He’s alive today, and Don and I were just flabbergasted. So I guess teaching does that to you, I suppose, you know. [Chuckles] You know, I’d have to think about any other stories or funny things that happened that you just don't expect. But none come to mind right at the moment other than those two.

**HECHT:** Was there much continuity at Hughes going back to the days of Ted Maiman’s invention of the laser? Hughes had been involved with laser technology for a long time.

**BARNOSKI:** Yes, there is continuity at Hughes with regard to the laser technology. My introduction to laser technology personally occurred in the summer of 1962, I believe. I was an undergraduate student at the University of Dayton, and in the summer, I worked for the University of Dayton Research Institute. I worked for a fellow by the name of Rambowski was a scientist that was brought over in the team with Wernher von Braun. Rambowski smoked a pipe with a cigar a stuck in it. His project, which was I guess Air Force funded, was to build a ruby laser and then do some ranging experiments where you’d fire the laser off to a distance and hit
something that reflected the beam back and then measure the time of flight and the distance. The experiment that he asked me to do was to assemble the laser, and so I said, “This is all there is? I mean this little thing? This helical tube and the cylinder and this stick of ruby,” and he said, “Well, we’re going to do this indoors.” The longest distance he could find indoors at the time was the diagonal across the University of Dayton basketball arena. But the longest distance was if you were at the very top row of the arena. So the biggest problem I had in assembling this laser system was lugging the power supply up to the top row of the arena. It was gigantic. But the laser was just this elegant thing.

Interestingly enough, when I started at the Research Labs, the first thing I got asked to do was go rummage through the drawers and reassemble one of the ruby lasers that were lying around because we want to do some holography with it. Ted’s influence at that lab was there through the time I was there. I mean people talked about it. Charlie Osawa talked about it. He and I wrote a paper together. Don Devore and Irnee D’Haenens, of course, often talked about Ted. I was a very good friend with Ernie. We played basketball together at noon in the back of the lab. So Ted’s influence was there. I mean it was just felt. I had numbers of laboratories in my group, numbers of rooms in my group that were labs, and one of them, it turned out, was the same room that Ted and Ernie were in when they actually fired the first capacitor discharge and saw the first the line narrowing.

HECHT: What were you doing in it then? Do you remember?

BARNOSKI: Yes, I do. We actually were experimenting using a CO₂ laser to melt the end of the fiber so it would ball up into the form of a lens to look at the coupling efficiencies. It would
result in improvement in coupling efficiencies, and we also to used it to make fiber-to-fiber
couplers for beam splitters. We actually had an Air Force contract out of Hansom Field in the
Boston area to deliver a bunch of these couplers so they could put together a breadboard of a
fiber network, and that work was in that room.

**HECHT:** Mike, you went through a period when fiber technology developed very rapidly from
the multi-mode systems. In fact, you mentioned the early bundled transmission through to
single-mode operation at 1300 and 1550. What was that like to go through such rapid transition
in the field?

**BARNOSKI:** I did experience this transition from fiber systems that were built with bundles of
50, 60 fibers in a plastic tube to high performance single-mode 1300 and 1550 systems. That
occurred in the period from the mid ’70s to the early ’80s and then beyond, of course. It was
actually amazing because the fiber had a minimum loss at 1300. It had a minimum dispersion at
1550. When the whole thing started, if my recollection is correct, indium gallium arsenide
phosphide was not a prevalent material. Gallium arsenide was bad enough; to have to deal with
that was even worse. It was not a prevalent material, and there were people who thought that
you were going to have all kinds of defect problems that would limit life and all that business to
deal with. But lo and behold, along that material system came, and it was 1300 nm lasers.
Detectors came right out and matched the fiber loss, and then when it had to go to 1550, the
same material system was used and it worked. So you went from this situation where you had a
gallium arsenide large LED facing a bundle of 60 fibers and silicon detector on the other end to
In that transition, I do have a story about Dave Duke and Corning.

He and I were in New York City having dinner together, and he told me this story about his being at MCI. One of the executives at MCI, I think George Roberts, said they wanted to employ all single-mode in their network. So Dave made a call back to his supervisor. They had a conversation about it, and that went well, so Dave made a commitment at MCI. Then when he got back to the laboratories and they told him, those guys went nuts. They said, “You did what?” Then there was this big hoopla about whether they were going to be able to convert from multi-mode to single-mode and whether it would work and all that stuff. But lo and behold, it worked. The convergence of all these technologies by serendipity just happened. So if any one of them weren’t there: if you didn't have the laser, you didn't have the detector, you didn't have the fiber loss and it was someplace else where there wasn't the source, it wouldn’t have happened. But they all melded together, and lo and behold, we now have these elaborate fiber systems.

**HECHT:** What was it like to ride that change? It seems like every week there was something new or every month.

**BARNOSKI:** The dynamics of the technology in that era was enormous, and it was very exciting to be part of it because it went from lasers to distributed feedback lasers to fiber systems using single-mode so you could do all these coherent micro-wave-ish kind of components on a chip. It was a very exciting time.
HECHT: Did it affect you as you were setting up PlessCor, or by that point had the transition actually finished?

BARNOSKI: The dynamics of the technology definitely affected how we set up PlessCor. One, it was clear to me that there was a need for the melding, being able to interface with the electronic world with the world of optics, namely the fiber, and that needed to be done in a way that matched where you use the fiber minimum loss and minimum dispersion. So I had experience at TRW in setting up indium gallium arsenide phosphide capabilities. I had that experience, and so when we went to PCO, it was natural to set up the liquid phase epitaxy and MOCVD epitaxy and grow the appropriate materials. But it was dynamic. When we first landed a big contract from Northern Telecom at PCO, it was in a hybrid gold-coated dual in-line module, which when I would go visit Northern Telecom, I would call it a gold brick intentionally because they were pushing to get more and more volume, which means you had to have cost reduction. But the package itself was just enormously expensive. So we eventually convinced them to go to a design that didn't use the metal package. We actually had a flex-circuit that we rolled up like a cigar and stuck it in a plastic package and basically displaced our gold brick. But that was a good thing because the volume went way up and that volume allowed us to bring cost down while maintaining profitability at lower selling price. Our profitable sales went up as a result.

HECHT: All right. Mike, I want to thank you very much for telling us your story. It’s been very interesting.
BARNOSKI: Well, thank you for inviting me. I’m honored to be interviewed. Thank you.

[End of recording]