Oral History with Dr. Lothar Jeromin, June 12, 2020
Interview by Benjamin Spohn for Hagley Museum and Library
Hologic oral histories project

Q: Okay, we're recording. Today is June 12th, 2020. I am sitting down with Dr. Lothar Jeromin, to talk about his career in the medical imaging industry. Industry or business? Is one word more correct than the other?

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A: Oh, they could be used interchangeably.

Q: Okay. So to start us off, maybe you could tell me a little bit about your early life and background. What got you into this field?

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A: Okay. I was born and raised in Germany. And studied engineering and physics. And when I graduated, I started—My first job was Phillips, a Dutch company, in a research lab in Hamburg, Germany. And I worked on electrostatic imaging, actually printing. In those days, that was in 1968, printers, computer printers were mainly impact printers. They made a lot of noise. You're probably too young to remember those. And weren't very fast.

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So Phillips said, "Oh, let's work on different concepts of imaging." And I worked on a concept called electrostatic printing. And the printing is done by taking a dialectic paper, depositing a charge on the paper, in the form of letters, and characters. And then applying a toning system, toning the charge. And then, fusing that image to the paper. And that was, we had a copy printed out.

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And Phillips did a lot of original research on this. But I got discouraged by the fact that it never ended up having any products in this field, although the concepts were demonstrated, were

exhibited, in internal conferences. So at the time, I had a friend who said, “Oh, you know, let's go to America I'd like to go and learn what the Americans are doing in this field of work.” And I said, “Yep, I'd like to do that.”

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I was married at the time. And my wife agreed. That was in 1968, my wife agreed to come along. And the plan was to stay a few years, learn the language better, and then I'd go back to Germany And Phillips actually held my position open. They said, “You can come back, and we'll give you the job back, or even a better job.” So two years.

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And in the meantime, I got a job at Xerox in Pasadena, California. And the company division was called Xerox Medical Systems. And Xerox wanted to develop an imaging system, an electrostatic imaging system based on selenium, which is—the concept is similar to photocopying, Xerox was the leader in photocopying, where a selenium drum is charged with a uniform charge. And then, the page to be copied is projected on the drum. And the charge dissipates where light hit it.

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And then the results [00:04:49] image is made visible through toning. And then the toned image on the drum is then transferred to paper. That's a copying process that revolutionized copying. So Xerox wanted to use the same concept, using selenium. But not exposing—The selenium was light, but it was x-rays. And x-rays have the same properties, discharging selenium, and generating a latent image. And using your body part, you form a latent image of whatever you're x-raying.

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And, well this is done on a flat plate, not on a drum. So Xerox made these flat plates, selenium [00:05:53] position process deposited on a flat aluminum plate. And that plate was charged, electrostatically. It was a Corona [?] device, and placed in a cassette. The cassette then was like

similar to a film cassette, was then x-rayed. And then the plate was run through a processor that would tone the latent image. And then, transfer that image onto that piece of paper that had a coating on it. And when heated, would fuse the image to the paper.

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I actually have some images of my wife's breast using this concept now. So that became a very, very successful product. And I was in charge of product development, generated a whole bunch of patents in this arena. But over time, Xerox felt, oh, we've been sued too many times for misdiagnosis. And people were blaming the machine for it. And it's sort of been a cancer detected, perhaps it wasn't detected. And whoever was at fault, remains to be seen. Sometimes the radiologist just didn't see it.

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Anyways, Xerox felt, you know, we're a deep pocket company. And we may be sued. They were never sued, but they were concerned about getting sued because of misdiagnosis related to the machine. The machine really worked flawlessly. So the company, Xerox Medical System was put up for sale in 1989. And there were many suitors. In the end, DuPont approached Xerox Medical Systems, and said, “Hey, we'd like to buy that division.” And I was part of the negotiations. And the intermingling, and talking to the DuPont scientists to explain the process.

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And DuPont said, “Yeah, this would fit right into our business model.” The division of DuPont was Medical Products at the time. It was a division of DuPont, Medical Products. And they were very successful in x-ray film, in the x-ray film business, making x-ray film and chemicals. But they said, “Oh, we could supplement this technology, film technology, conventional film technology was called zero radiography, okay. And zero radiography was the overarching name for anything that was—image was selenium plates.

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But then Xerox pretty much specialized in zero mammography. That's taking an image of the breast. And DuPont liked the idea. And the negotiations were done. And we were about to get acquired. And I was a key person in this negotiation, talking to their scientists, and especially Dr. Denny Lee, his name, I will mention later on, as we worked together.

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Anyway, in the 11th hour, DuPont discovered, doing due diligence, that Xerox had a cross-licensing agreement with several firms. So one of the firms was Kodak. So this cross-licensing agreement would have given other companies the know-how to build a machine similar to what we were selling at Xerox. And when DuPont found out about it, the deal was off. And that was in 1989. And they said, "Oh, we can't do it. We don't have the technology all along. We don't want to compete with companies like Kodak and other companies." [00:10:55] was one of the other companies too.

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So the deal was off. And then I was approached by one of the managers who was part of the negotiations. And he said, "Well, why didn't you come join DuPont?" And that was quite a decision we had to make. We were established in Southern California, wife and three children. And so we go to the east coast, to Delaware. And the manager said, "Oh, look. We didn't buy the company. But I think you can—If we take you on, we'll be as good as buying the whole company." And I wasn't sure whether that was correct. But I decided, talking to my wife, "Oh, let's do it. That's a challenge," that I could do something like this, like the challenge.

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So we moved. And Xerox—I mean DuPont was generous, and the package, and selling our house, and paying for all the moving expenses. And I set up shop then, all by myself, and first in the Glasgow [?] facility, where I had a small little office. And in the early days, like in the early 1990s, my entire focus was on which technology should we pursue. DuPont wanted to go from film to a digital imaging system.

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And, as you know, Kodak kind of missed the boat. They stuck with conventional photographic film, didn't switch over to digital early enough. But DuPont said, “We've got to have a digital system to replace our conventional film system.” And I was given big budget, and I could pretty much do what I wanted. So the first half of the year or so was spent, went from universities and companies to see what they were doing, in terms of digital x-ray images, imaging. At the time, there was only one digital x-ray imaging system available. And that was the storage phosphor system by Fuji, Fujifilm Corporation

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And it was a system where a storage phosphor was inside a cassette. The x-rays were captured by the storage phosphor. And then it captured the image latently in the storage phosphor. And that storage phosphor then was later read out by a laser scanner, and the image was formed that way. That's the—It was very famous and really happy market capture at the time, in the early 1990s and '90, '91.

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But the big drawback was, it involved light scattering When the image was read out, the laser excited the storage phosphor, and the light emitted would be captured by photodiode array, that caused this scattering and blaring [?] of the image. The images were quite good and comparable to film. But I thought it should be able to do better than doing what's called an indirect method of converting x-rays to light first, and then reading out the light.

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So, since I had the background of selenium, actually had some selenium plates in my luggage when we moved from—in my moving van, when we moved from California to Delaware, I said, “Let's decide to just go ahead. And—And, after having looked around, and haven't found anything better, at different research facilities and universities, let's try selenium.” So selenium has these photoconductive properties, which I mentioned earlier. And in order to use selenium,

you would have to—how do we read out the latent charge. So we patented the idea of depositing the selenium on an amorphous silicone transistor array, Centrum [?] transistor array.

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And that's when I began to scale up, hired more people. Are you interested in who—the names who joined the original development team? Or is this not important?

Q: Sure, yeah.

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A: So it was Dr. Denny Lee. He had been at DuPont for years. Then there was Dr. Lawrence Chung. He was a former Xerox guy. There was technicians, George Robinson, and another technician, Cornell Williams. So the five of us began to actually prototype the concept of depositing selenium on a Centrum transistor array. Now how do we get those Centrum transistor arrays? That was the key issue.

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I had connections in Japan, was friends and researchers Actually, they were all dentists, but they had connections in Japan. And Japan, to get a hearing, you need to get somebody to introduce you. So we approached a company called Hosiden [?] in Kobe, Japan, asking them to build us small little plates, maybe three by three inches. And to start the development of this x-ray conversion device. And what distinguishes this technology from the storage phosphor was called a direct conversion.

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And later on, I coined a term, direct radiography, where the image is captured in the selenium. The charged image then is spread out by the Centrum transistor array. And similar to, you know, a reading out a photodiode array. And then the image is captured. So it's direct radiography, the term kind of stuck. And these transistor— Centrum transistor arrays were the basis, at the time, for flat panel television systems. So rather than sending a signal in to show an image on a flat

panel television set, we just did the opposite. We would take this flat panel and generate an image in it, and then read it out. You understand the concept?

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So the company, Hosiden, was interested. But they asked to develop small little prototypes. They asked for a million dollar development cost. And I had the money, we had the money in the budget. But I said, “Oh, it's too much.” So we began negotiating. And in the end, they built us prototypes for half that. And these prototypes were—Well, in the meantime, we moved to the experimental station, where we set up shop in Building 357, and set up a little evaporation [00:20:07] selenium on these panels. And then, actually leaving them out, and generating x-ray with this. And this was—this was really a breakthrough. Nobody had done this before. This was our invention.

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And there were times when selenium, at the experimental station, was considered dangerous. And so we had to get the Environmental Protection Agency in, because we had to—when you evaporate, and then evaporative [?] product [?], you generate vapor that you have to exhaust out of the chimney. Well, we got the chimney built. And eventually, this passed the inspection. So we were doing our own evaporation coatings at the experimental station.

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And then the issue was, now we have a 3x3 inch panel. How do we scale it up, for an 8x10 for example, so it will actually capture larger images? And we went through different methods. In the beginning we said, we're going to use like tiles. We tiled several pieces together, and formed a larger panel, using smaller tiles. It worked. But it got very complicated. And so we approached other firms in Japan and in Taiwan and in China, oh and Korea, South Korea. And we found a firm in South Korea willing to make us these 8x10 panels. And eventually, we made them 14x17 from chest radiographs. We made a larger, a larger detector.

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And then we said, oh, we won't be able to do this kind of coating ourselves. So we approached a company in Canada called Noranda [?]. And they were willing, for a price naturally, to do the coating on these larger panels. And that worked. And we eventually built a 14x17 panel for chest radiographs. And we tried this device out in Philadelphia. And what's the university name, the hospital there?

Q: St. Joseph's?

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A: No, no, no. I can't think of the name right now, it's been so long ago. It's one of the major, major places, major hospitals in Philadelphia. I can't think of the name. I'm drawing a blank. Okay. So the doctor, the doctor really liked it. And he did a lot of experimental work, and published a lot in the field.

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And then, then DuPont, you know DuPont Medical Products, they decided, they really don't want to be in this business. So they put this division up for sale. And it was purchased by an investment company. And this investment company renamed – from Texas – this investment company renamed this division Sterling Diagnostic Imaging. I think that happened in 1996. But you may want to check with Jim Culley about the dates. I'm not 100 percent sure.

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So they had big plans, and scaled up production. And we were buildings these devices. We built up a manufacturing plant. And that went back to Glasgow. The folks at the experimental stations said, “Hey, you're no longer in R&D. You're past R&D. We really don't want you anymore.” So we talked to Glasgow, set up shop in Glasgow. You know the Glasgow facility? Anyway, not important.

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So Glasgow. And in the meantime, Miranda was kind of holding us a little bit captive. And so we had—they were the only supplier of selenium panels deposited on this Centrum transistor array. So I looked around for an alternative vendor. And I had connections in Germany, and went there, and hooked up with a company in Bitburg, where they brew very good beer. And the company was AEG. And they started to do the coatings for us. And I'm not too sure whether this was during Sterling's time, or whether Sterling had, in the meantime, sold the division to Hologic. Now that should bring, you know, a [00:26:16] for Hologic for a long time, during that.

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And so we found a vendor in Germany. And in the end, they did really quality work. The key was building [00:26:32] evaporations with minimal defects. Because you don't want a defect on an x-ray image, and explain to the patient, “Oh, there was a defect. We couldn't really read the image.” So doing defect-free coating was extremely important. They did a good job. In the end, Hologic actually bought the entire equipment from this company in Germany, and moved it to Glasgow, and set up a selenium evaporation coating facility in the Glasgow facility. And this is where they continue to do the coatings now.

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So the marketing folks thought, okay. General radiography is called, you know, chest x-rays and all that. You know, there's too much competition. Other companies had, in the meantime, done a better job doing the storage phosphors, giving them better spatial resolution. So Hologic decided, we want to use the advantage of direct radiography, where it's most critical. And that's in mammography. In mammography, you have to have very high spatial resolution to see microcalcifications in the image.

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So Hologic then concentrated on mammographic imaging. And we were able to do pixel-size, we ended up at 90 micron. So the spatial resolution was higher than what the competitors could do. And, as you know, right now, this Hologic device is the extent of the industry, I think in

marketing terms, I think Hologic is 60 percent of the market share. Jim Culley knows more about that.

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So I retired from Hologic in 19—no, in 2000—let's see, when was it? 2006, I believe. But I've been keeping an eye on the improvements they've made. They have turned this device into a tomographic device, where images are taken—images of the breast are taken from different angles. And then the image is reconstructed into a three-dimensional image. And this is extremely important for mammography, because in any projection image, x-ray projection image, you're imaging the entire thickness onto one plane. So you're obscuring potentially very valuable information. In mammography that's important that you can actually read it out a slice at a time, like a one-centimeter slice at a time.

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And this is what produces a very low false [?] positive image. That means the doctor thinks there is something there, but then do a biopsy, it turns out there's really nothing there, nothing suspicious. So when you reduce the false positive rate, the recalls, the number of recalls are reduced. And biopsies are diminished. And, you know, women dread biopsies and having to wait for the results of the biopsy. So that's a big advantage of three-dimensional imaging of the breast. And that is just made possible by this direct radiography detector.

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So I've been watching Hologic's other forays, like they are going into—or have gone into specimen radiography, where let's say, a tissue that's been taken out of the breast could be malignant. Or anyway, the doctor isn't sure whether there was cancer there. So they would take some tissue out of the breast, and then x-ray it at a very high spatial resolution. And then, they can make a distinction, yeah, this was cancer or wasn't cancer.

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And what else are they doing? Jim knows a lot more about it. I've been away too long from Hologic now. And that pretty much ends my involvement.

Q: Hopefully I could ask some follow-up questions Is that all right?

A: Sure, yes.

Q: So with your time with Xerox, can you compare and contrast a little bit what the differences and similarities between the work culture at Xerox versus the work culture at DuPont?

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A: Oh, absolutely. That was a—That's a great question to ask, because we were kind of the mavericks. Xerox was headquartered in Rochester. And this division was formed in California. And people in Rochester always said, “These are the crazy guys start down in California. They're doing their own thing. They want to be left alone.” And we had a really great relationship among the employees, because there was a very casual atmosphere.

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When I end at DuPont, I just couldn't understand that in the research—and I was a PhD myself—they would have two classes basically of citizens. They would have the non-PhDs and the PhDs. And there was such a divide that the non-PhDs would not even be invited to meetings. Or they wouldn't take a picture where they had these two folks, two different classes in one picture. I mean it was ridiculous. And I kind of worked against that culture. And I think I was pretty successful making the DuPont culture more the way I was used to, Xerox culture. But there were a lot of obstacles.

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And oh, by the way, when we came out with this idea to replace film at DuPont, there was a lot of resistance from the people who spent their entire career trying to develop a better x-ray film. And I don't want to mention any names, but these people actually went up the ladder, the

corporate ladder, to the Chairman of the Board, and said, “Don't wast your money on this digital x-ray imaging system.” But the management was not persuaded by the objections of the scientists, the film types, who didn't want to see their technology kind of go down. And they could have stiff resistance.

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But they would say, “Never going to work. Been there/done that. Will not work.” And they made their voices known. I don't think went to the CEO of DuPont, but especially went to the top management in the Medical Products Division. But the fellow, at the time, I don't remember his name, he was kind of very supportive, because he said, “Hey. I have this idea, have this idea.” And he drew it on the back of a napkin. We'd have a panel, you know, an x-ray capturing device with a cable coming out. [laughter] And it would—And then the cable goes to a computer, and there is your image.

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And so he thought it was his idea. I mean anybody can come up with ideas once you have shown the concept. But making it actually work, that was our expertise. And the folks that I mentioned first, we were a really strong group and were able to pull it off against a lot of resistance from the film scientists. I mean they spent 30-40 years developing x-ray film. But they could only make it incrementally better. They couldn't make the switch from indirect conversion to direct conversion without the light scattering that's involved in the indirect conversion. Yep, that was a good question.

Q: So at the time, can you explain why the switch from film to digital was such an important changeover to make?

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A: Oh, okay. There were other industries where—like in nondestructive [?] testing, for example, uses x-rays for—actually [00:37:04] turbine blades, you know, for aircraft engines. There were other industries where things went digital. And film was kind of lagging. Look at the

digital cameras at the time. They came out about that time. And as I mentioned earlier, Kodak missed the boat. And so conventional photography went digital. So x-ray was going to get digital. There was no stopping it. So that's why DuPont said, "We've got to be in the digital x-ray imaging field." Yep. That's the way it was.

Q: So it seems like DuPont had, at least at some point, the idea to try to be at the forefront of the field. Do you have any insight into why they decided to sell off that business then?

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A: We were wondering that. Because when I was hired in, I said, "Oh, this is a position for life, you know. DuPont is good to their employees. And once hired, you're in there, and don't have to worry about getting laid off, or getting sold." They just didn't – the management, I don't think, just saw the potential of this new technology. Just didn't see the potential. And I don't know who called the shots, but they sold it to Sterling. And Sterling Medical Imaging or Diagnostic Imaging, they made a great catch, because they turned it around, sold it to Hologic, where it was a big markup.

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And it was an investment company. They had no interest in holding this technology and exploiting it, marketing it, building it, marketing these detectors. They were just a company, a turnaround company, buying and buying something that had potential. And they saw the potential. And then selling it later. They were very successful at it. That was their business model. So why DuPont didn't stick with it, couldn't tell you.

Q: So relatedly, to comparing Xerox to DuPont, can you compare DuPont to Hologic?

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A: DuPont, you know, it's a [00:39:51] company. And certain things are done a certain way. Hologic was a startup. I mean it wasn't that old. And I knew the management well, Jay Stein and he was one of the cofounders. They were more entrepreneurial. They would look at opportunities

and say, “Yep, this fits our business model.” And they were—They had only one product, and that was, at the time, measuring the bone densitometry, measuring the bone density in human bones, to see whether a person is subject to osteoporosis and bone breakage. That was their only product.

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And they said, “Oh, we are a one-product company. Let's see what else we can add to our product portfolio.” And so they were very keen in acquiring this technology. And in the beginning, they were [00:41:01] relationships were more like I was used to in Xerox in California. They were the management, they were the top managers—the founders would sit in meetings with us, discussing pros and cons, and how we could improve. But they went on—the founders went on business trips with me and the other folks to help find new suppliers. And that was just a great way to run a business.

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At DuPont it was more, you know, you move up the chain of command. And if you're not the right person, you couldn't go. And it was—we were pretty stymied by the way DuPont was organized. We also had to carry a heavy load, because when we were part of research, we had to—we were actually renting space in the experimental station. The Medical Products Division was renting space. And scientists, we had several of their scientists. And I just couldn't believe how much they charged us. They charged us $200,000 a man [?] year, for a scientist. And the business, medical products, had to fund this. But we had plenty of money. People saw the opportunity. And we were well funded.

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And one of the things I could say is, we were known, this group was known to be ahead of schedule in the old budget. We were known for that at one point in time. In spite of the opposition from the film people. So Hologic was—Well, Hologic top management was really involved in the decisions. DuPont, we never saw anything like that.

Q: It seems like that was both a product of different management styles, and as well as Hologic being a smaller, younger company?

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A: Yep, I think that's—DuPont entrenched, you know, that's the way one does business. Hologic was a startup, one-product company. They said, "We need another product." And now it's the standard of the industry, in digital mammography. So when you know someone that needs mammograms done, well the older women all need it. So make sure they go someplace where Hologic machines are used.

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When my wife came, we were still living in—Yeah, we were still living in Delaware And she needed a mammogram done. So I called up the imaging lab. And I said, "How do you do mammograms?" "Well, we use film." I said, "No, we won't do this. We will find some imaging lab that has Hologic direct radiography system." And so when somebody's asking you, make sure they go someplace where they use Hologic machines. I told you earlier, because of the better outcome, lower false positives, and that means fewer recalls or biopsies.

Q: I'm just checking my notes. You said something very briefly about having been involved with dental imaging as well. Where does that fit in?

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A: Oh. I mean that was from Xerox. They said, "Okay, we can make the selenium plates small enough that it fits into a mouth. We put it in a cassette, and then do the x-ray image. And tone it, and then transfer it to paper." and this was a tremendous product. It worked. And this is how I got to know the folks in Japan, Dr. Kashima [?], Isamu [?] Kashima. He was a professor at a dental school. And so I helped him actually write a paper on—it was called "Intra-Oral Dental Radiography." And in Japan, it's like this. If you've done somebody a favor, I mean they bend over backwards to help you out. And when I approached him—I was looking for a vendor for

these amorphous silicone plates, the [00:46:29] arrays, he said, “I can help you. My whole staff will be at your disposal.”

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So we traveled all around Japan and found this company, Hosiden. So Xerox had a foray into intra-oral dental radiography. But it's like this. We offered the machine, and it had many sold for $5,000 dollars. We did marketing, research. All the dentists will buy something for $5,000 dollars, which will really speed up his office. He can get more patients through, because dental images are instantly available.

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And we used to call dentists that would have these little films, dip them in a development tank, and a fixer tank. We would call them [00:47:27] a dentist. And we said, “You don't need to be a [00:47:30] dentist anymore. You can use the Xerox's intra-oral dental radiography.” But once we did marketing research, yep, $5,000 is a good number. People will buy it. And once we approached the dentists, said, “Okay, here it is. Here's the invoice.” “No, I don't want it anymore. $5,000 is too much. I have to buy my Mercedes here next week. And I don't want to buy this machine.” So it was a technology marvel, but a marketing flop. So Xerox got out of it.

Q: So what happened after that, when you—I'm sorry. I'm tripping over my words. What happens after you develop a product that should have been successful, but then wasn't?

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A: What happens? Well, companies give it a try, try to market it. It doesn't sell. It's abandoned. Look at the automotive industry, the Edsel. I mean oh, a fantastic car. And once it came out, people looked at it. Was ugly, didn't like it. And Ford abandoned it. It's pretty typical. And the investment was just written off. But Xerox, at the time, maybe Xerox [00:49:07] was flush. We had these systems were selling. These imaging systems were selling well. It's called the 125 System. And it's the 125, the number is the address of the street we were located on, 125 Gonito [?] Street, in Pasadena. So the management boss said, “Oh, we'll just name it 125 System.”

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So I'm sure other companies have tried things, and found out great technology, but developed, offered it as a product, and didn't sell. Well, they'd pull the plug.

Q: So you'd also said that you and your team were responsible for making things work.

A: Yeah

Q: What'd you mean by that?

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A: Oh, we have an idea. Then we'd sit together. And in the beginning, I mean we did everything manually, like developing the electronics to read out the image. And, little by little, we saw the progress and said, “Oh, we were very encouraged.” We showed our progress to management. They said, “Oh yeah, that looks very good.” We keep funding. I was responsible for all the budgeting and planning and all this. But my preferred job is really, my preferred location is in the laboratory, actually, making things work, with our hands.

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That's the team that I had, these five people I mentioned, everybody was in the lab. We didn't have people, you know, sitting there and writing. Sure, we had to write reports, but they were all kind of lab-oriented guys. None of them were like the theoretical scientists. And like Dr. Long Jing [?] I mean he was a Harvard graduate, PhD from Harvard. Denny Lee was from University of Texas. And these guys were, you know, the backbone, trying new ideas. We always needed to know the theory behind it. And all of us together felt, yep, theory—in theory, it should work. So let's build it and try it out. That's how we worked.

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We didn't over-analyze anything. We said, “Okay, the best way to find out will it work, build it, and try it.” And that was our model. And other companies, they—I call that paralysis by analysis. They analyzed and analyzed and analyzed. And in the end, they missed the boat. So hands-on. When I hired these folks, I made sure they were the hands-on kind of guys.

Q: So if your favorite part of your job was the hands-on part, what was your least favorite part?

[00:52:56]

A: Oh yeah, good question. Sitting in meetings, and having to give presentations to management, you know, where we are, and where we're going to be going, building five-year plans, which I thought was kind of nonsense. So sitting in meetings. And basically, I always thought that that was a wasted meeting, waste of our time. And so those were the least favorable parts. And I'm not the only one. I'm sure most people that like the hands-on kind of approach don't like to go to meetings.

Q: So, of all of the different products that you worked on, does one stand out as being a favorite, or a bigger challenge than all the others?

[00:54:01]

A: Oh yeah. And this is direct radiography, that concept. Because we started from scratch, and we didn't really know whether this would work. But we just persisted. First, you know, building a small prototype, and then scaling up. And that's how we used. And the scale-up often was more complex, because the availability of this silicone array, the Centrum transistor array, didn't keep pace. But now, you know, you look at a TV, 70 inch, right, is pretty common. In the beginning, how big was a TV, a flat-panel TV? Maybe it was eight inches, and they began to scale and scale. And, as they scaled up, we were able to scale up, because they were able to build those panels [00:55:03] size.

[00:55:07]

But there was a time when we couldn't just get the right size. So we had to take two, and grind the edges carefully, and then butt them together, and hoping—not seeing a seam. But there was always a seam, you know, when you talk about microns, like they were pixel size, generally [00:55:31] 40 microns. And so we had a whole bunch of software guys trying to kind of hide the seam in software. And it worked. And the panels became big enough, we were able to purchase the full size from one vendor. That was a big breakthrough for us. So we were happy to find a plate that met our size requirements. Any more questions?

Q: Of course. Were you personally involved in any of the marketing for any imaging devices?

[00:56:25]

A: Oh yeah. I was still under DuPont, when we had the first working detector. And we exhibited it at the RSNA conference, the Radiological Society of North America conference in Chicago. And we had big booths, I mean huge. And I was answering questions to potential customers. And they kind of said, “Oh, you guys are faking it.” So I said, “Here's what we're going to do.” We could not do any x-rays. We couldn't do any x-rays on the floor.

[side remarks]

[pause]

[00:57:28]

A: New device. Said, “Oh, you have all these images stored, and you're just going to display it here. They are already in your computer. And you're just displaying it here on the wall, you know, on large [00:57:42] play.” And they said, “Oh, this is not real,” because people just thought, “Hey, these things don't exist.” But we had it. So yes, here was my idea. So we went to a local hospital in Chicago, and into the x-ray department, and set up our detector in the x-ray department. And then, we beamed the picture over to the floor, the RSNA.

[00:58:17]

And so they said, “Oh, you know, these images are prerecorded also.” So I said, “Okay.” I asked somebody on the floor, “What do you want me to put on the—What do you want me to x-ray?” And he said, “Okay, x-ray somebody's watch, wristwatch.” And so they would also have a video of what was happening in the examining room, in the x-ray room. So we put pens and watches and anything they had, they had lying around in the x-ray department. And then we x-rayed those. And the image would then beam over to the floor.

[00:59:04]
And the audience would see the items that they said, “You put this in this upper right hand corner. Put the watch over here, there.” And that's when we made believers out of the audience. And that was kind of a fun project. So I was heavily involved. Didn't miss an RSNA in 20 years. I was also at the RSNA with Xerox, so I knew how the Radiological Society of North America worked.

[00:59:33]
But typically, I think they—I think worldwide, probably 50,000 radiologists come to this conference, the largest conference in the world, to exhibit x-ray imaging devices. So I was involved in being actually on the floor, in the booths, answering questions That was my contribution to marketing. Other than that, I didn't really do anything. You call that marketing, then I did some marketing.

Q: And then, in the pursuit of all this, did you ever have to deal with the government or insurance companies?

[01:00:24]
A: Oh sure. The government. I mean to get something like this approved for patients, you have to do all kinds of—The FDA, you have to satisfy the FDA requirements. And you have to have experts say, “Yeah, this is good. This works. The images are better than we've ever seen before.” And then you apply for the FDA clearance. And, you know, it takes some time. We had the right—I mean, you know, when you deal with the FDA, there's a lot of paperwork involved to

first explain the technology. Then you show the marketing data. Not the marketing data at that time, but the experimental work.

[01:01:17]
And we tried to get volunteers, which role was to volunteer for these mammograms and chest x-rays. And then we put all this together, and submit it to the FDA. And then you wait. They have questions. Answer the questions And in the end, when you get that FDA clearance, that's a big day in the life of our company. Like drugs nowadays. I mean if somebody comes out with a coronavirus—what is it--

Q: --vaccine?

[01:02:10]
A: --vaccine, yeah, coronavirus vaccine. I mean, you know, the stock market is going to get a bump. And the world will say, “Finally!” But how do you get that? You know, they do, right now, on the vaccine, they do a fast track. They show up in the test periods and all this, which I think is a good idea. So once the FDA says yes, and the whole world is basically waiting for—The FDA is kind of the world leader in approving medical devices, drugs, and so on. If the FDA says, “This is approved,” all the other countries say, “Yep, the FDA says so. Must be good.” So the FDA is very influential in getting the product out the door.

[01:03:06]
So once we get the FDA, we had a party, FDA approval. But that was under Hologic. And I helped write this Dr. Jing, we wrote together, we wrote the FDA papers. So yep, that was a big deal.

Q: So maybe I should have asked this earlier, since it's such an overarching, you know, the overarching subject of everything that we've been talking about today. But why mammography in particular, as sort of your subfield?

[01:04:04]

A: Well, I came from the mammography field [audio breakup] [01:04:09]. That was, in the early days of mammography, this is something that's important. Mammograms were done on industrial film. An industrial films require fairly high dose. And in mammography, we always consider the cost-benefit question Is it beneficial to do mammograms? Or does the x-ray, high x-ray dose actually induce mutations in the breast, leading to cancer?

[01:04:49]

So that was always a big question. When Xerox came out with the 125 System in mammography, the dose was almost one-tenth, only, of the dose at the time for industrial film. Then the film people, they didn't slumber. They said, “Okay, we're going to be using an image intensifying screen, a phosphor screen. X-rays [01:05:22] on the phosphor screen. And the phosphor screen emits light. And that light is captured by the film.” So that helped reduce the dose also, tremendously.

[01:05:33]

So in the end, these intensifying screens, and Xerox panels, they had about the same dose. So my background has been mainly in mammography. So when I came to DuPont, we were told, “Oh, just let's not [01:06:00] on mammography. Let's just do the detector that can do everything.” And so we actually, our first detector was a 14x17 inch for chest radiographs, which we tested at the hospital in Philadelphia. I know the name now, Thomas Jefferson.

Q: Oh, okay.

[01:06:25]

A: Yeah, Thomas Jefferson. Yep, we went there and did a lot of studies on chest x-rays. But chest x-rays don't have the demand for high spatial resolution. You know, if you ever get a launch [?] out of the ribs or so, you're not looking for tiny objects in the chest. But, so this direct radiography, direct conversion was really better suited, and really have no competition in film for mammography, because of the direct conversion method. So that's why Hologic then decided,

forget about the chest x-rays. They're good enough. Film is doing well. And all the storage phosphor with Fuji is doing well. We really don't want to compete with them in that field. But we have this advantage of direct, the direct conversion, giving us the advantage in mammography. And that's why they decided mammography only. And that was the end of building these larger panels. So that was a good, I think it was a good decision. They used the advantage of this technology in the right application.

Q: Are there any other valid uses for that technology in screening? Like could it actually be effectively turned to other things as well, if you had to?

[01:08:01]

A: Yeah, I mentioned earlier, the specimen radiography, where you take a biopsy tissue and x-ray it, that's another product that Hologic is selling now. And that's done with what's called a micro-focused x-ray tube. In radiography, the focus part of the x-rays, where the x-rays are coming from, the focus part, is also crucial in the spatial resolution of the final image. So if you use a micro-focused part, of maybe even 50 microns, and then do actually a projection radiograph, and you can enlarge these images, the images are fantastic.

[01:08:58]

And this is a product, now, I believe that Hologic is selling. I know they're selling it, but I don't know enough about it. So we already worked—I already worked on this—I said, this could work for also nondestructive testing. I mentioned the turbine blades for airplane engines. They need to be inspected. If there's any flaw in their cast, and if there's any bubble in it, or any flaw in it, it won't pass. So they are all x-rayed.

[01:09:43]

And we had a company that used our system to inspect turbine blades. So that's really only two things that I can think of, where direct radiography has been being used. So mammography, specimen radiography, and nondestructive testing.

Q: So what would you say is the part of your career that you're the most proud of? And would you do anything different, given the chance?

[01:10:37]

A: No, I spent my entire professional career in imaging, x-ray imaging. And when you see an idea, you have actually developing and turning into a product, that is very, very rewarding and satisfactory in anybody's career, to actually—Well, let me tell you a little anecdote. Xerox, once I left, we still were in contact, with folks in Xerox. And they said, "Okay, we're going to have a reunion. And anybody that left Xerox who wanted to come back for a reunion." And a woman approached me and said—I had been away maybe five years. Said, "Do you remember me?" I said, "I know who you are. You were the head of accounting."

[01:11:38]

And Xerox, at the time, offered every woman free mammograms in the company. And mammograms were not covered by insurances at the time. That was in the, I would say, mid '70s or so. And she said, "Do you remember me?" "Yeah." "So do you remember when all the women were given free mammograms?" I said, "Yep." "You know, I had breast cancer at the time. And it was not palpable." Meaning she was nonsymptomatic. But the mammogram showed the breast cancer. And she was operated on, and was healed. And she said, "You guys saved my life." And that, when you hear something like this, I wonder how many lives we saved, you know, in mammography, through mammography. So that's extremely rewarding.

[01:12:48]

I wish everyone who's working on something novel, that they have the same feeling, and just get the same reward. That's a tremendous reward, when somebody says, "Yeah, you probably saved my life." And I said, "It wasn't me, it was the whole team." I was the manager of product development at the time at Xerox in Pasadena. So this, which product, definitely we did direct radiography developed—started at DuPont. And then, affected by Hologic. That was my highlight of my career.

Q: So you wouldn't do anything differently if given the chance?

[01:13:48]

A: Well, you know, you mean another profession? Something different in this field? I mean I admire the guys that invented like MRI or magnetic resonance imaging. You know, I admire guys like that develop CT, computerized tomography. Any imaging device, or even ultrasound, these guys have done a lot to save people's lives. So I would like to—I probably wouldn't—When I looked for a job first in the US, I got an offer from General Dynamics in the Finger Lakes Region, testing some military devices. I wasn't—You know, that wouldn't have satisfied me as well, as much.

Q: So you wouldn't change it?

[01:14:57]

A: No, I wouldn't change it. Nope.

Q: That sounds like the mark of a good career.

[01:15:02]

A: Yep. You know, I see my wife does the mammograms. And she told one of the doctors, once, "Oh, you know, my husband developed a detector in this." And he said, "Oh, I'd like to meet him." I mean I never went to meet him. But they were all very happy about the performance of the machine. So now my daughter is old enough to get mammograms. And I said, "Where did you make your appointment? Did you make sure they have the Hologic system?" She said, "Yeah, dad, I know. I know. I know what's best." So that's tremendous satisfaction in somebody's career.

Q: So is there anything that I haven't asked you, that you really wish I had, or that you wanted to talk about?

[01:16:13]

A: I would say the way we dealt with the Koreans and Japanese. You know, Dr. Denny Lee, he was a—you know, he knew—He was born in China. And he gave me a lot of tips how to speak, how to deal in Asia. And I mentioned to you that we approached this company, Hosiden. And they wanted one million dollars to develop a small prototype. And I had the money in the budget, but I felt, man, if this were my own money, I wouldn't want to spend this much.

[01:17:05]

So we sat down, and said, "Denny, how can we reduce this to half a million?" And he said, "You know, when somebody with Asian background makes an offer, and then they just simply reduce the offer, then you might get the idea that they were gouging you, okay. And that's a bad thing to do in the Asian culture. So why don't we just ask for less, you know, a few prototypes in numbers. Like we had agreed to do, like 40 plates. Why don't we just ask for 20. That's enough for us." And, sure enough, his wise counsel worked. And we were able to get the 24 for half a million. So I learned a lot along the way, how to deal in a culture that I wasn't familiar with.

Q: Did that come up a lot then?

[01:18:27]

A: It came up a couple times, maybe three times, where we—But then we had the manufacturing manager. He would do the negotiations. And I guess he wasn't maybe as sensitive as I was for all the big money we were spending. And he was taking the lead at that time, negotiating prices for prototypes and products. I didn't get much involved in it anymore.

Q: Here's one written down one I haven't asked. Were you ever involved in any philanthropic organizations related to your work?

[01:19:24]

A: Yeah. That's a good question You are probably familiar, maybe you weren't, the earthquake, the Kobe earthquake in Japan. That must have been maybe 1995. anyway, there was major

destruction. Thousands of people killed. And we had to—I had a trip scheduled shortly after the earthquake. And the company, Hosiden at the time, they sustained some damage to their production line. And a production line of the Centrum transistor array, precision matters. I mean this has got to be—every piece of equipment has to be perfectly calibrated and so on.

[01:20:17]
But they managed to get back up running quickly. And so I delayed my trip, maybe a week or so. But I asked my current boss at the time, "What do you think? Can we help, not the company, but people in the organization who have sustained losses, with a cash gift?" And that was Debbie DuBois at the time, my manager. And she said, "Sure." I don't know where she got the money, but I took a $10,000 dollar check with me. And I tell you, that was a token, money, but it was very much appreciated, just the thought that we would be concerned about losses they sustained in the population in Kobe.

[01:21:16]
And so, but personally, I go on, with the church, I go on trips to do hands-on work in Costa Rica, building a school in Mexico, building clinics and so on. Yeah, I build—That's my personal conviction. I do some of my skills. I'm very good with my hands. And kind of a handyman. And I had a trip planned to South Africa this summer to work in an orphanage in South Africa, Johannesburg. But COVID-19 put an end to that. And hopefully we can do it next year.

Q: Fingers crossed.

A: Pardon?

Q: I said fingers crossed you can.

[01:22:20]
A: Fingers crossed, yeah, yeah. Had everything lined up already, tickets bought, but it didn't work out. And I'm sure they're disappointed that we didn't come. It was 10 people here.

Q: So with the construction of clinics, is that just construction? Or do you help them set up their own imaging equipment?

[01:22:49]
A: No, no, no, that's just building, construction. Mixing concrete, and directing the building. [laughter] Yeah. The medical part, no.

Q: So do you have any other thoughts you'd like to share? I think we're at a good stopping point for today. I've worked my way through my list and gotten everything that I had on there, that I wanted to hear about.

[01:23:36]
A: I probably, I've omitted to mention certain names. But I didn't want to go in that kind of detail, you know, who did what and when. So hopefully, nobody takes offense to that. I don't know who will actually listen to this recording. You're not going to put it on YouTube or anywhere.

Q: No, no. I mean it will be in our digital archives, but it won't be like that—It will be online, but it won't be widely distributed like that.

[01:24:15]
A: Okay. Yeah. So the time at the experimental station was really one of the highlights in this development, because the campus-like atmosphere was very conducive to fostering ideas, and the many like-minded folks that we could bounce ideas off. But then the culture there was—you know, I mentioned to you earlier, was two class citizens in this culture. And I didn't like that, that they would make such a distinction between the highly educated folks and not so educated folks.

[01:25:19]

I would think things have changed. That was in early '90s. I'm sure things have changed. And all the two parts splitting up, and merging, and all this. And I'm sure that things have changed. You are a DuPont employee?

Q: No. Hagley is an independent research library. We're not associated with the company DuPont. We're more associated with the actual members of the family.

[01:26:00]
A: Oh, okay. Okay. So you're doing this for prosperity, huh, posterity I mean? I have a good friend who was the—at Hagley, he was the manager for buildings and grounds, Mike Downs. He's no longer there. So he worked there for 20 years. I've been to Hagley many times. And I always admire the way they build the powder of buildings, where they ground the powder, one wall, towards the—Brandywine was not even there. So if there was an explosion, it would blow out the back. You're familiar with that, right?

Q: Oh yeah, yeah, that's our logo, is one of those powder mills in profile.

[01:27:02]
A: Yep. And then, no electrostatic sparks avoided by wearing shoes with nails, studded nails. But still, lots of people got killed, right, in those days.

Q: Yeah, they did. I mean when you consider how long they operated there, the number sure seems pretty low. But there still was very much human loss.

[01:27:33]
A: But DuPont took good care of the survivors. And they took care of the families of those who were lost, the father or yeah, that was great. DuPont no longer does that. I mean it's all business. Not a family business anymore.

Q: All right.

[01:28:10]

A: So I'm going to look at the release form and get it back to you today.

Q: Okay, great. Any final thoughts before I turn off the recording?

[01:28:22]

A: Oh, it was good seeing you. And you asked good questions. And I hope I answered them to your satisfaction.

Q: Absolutely. Thank you for taking time to speak with me.

A: Yep. And when you see Jim Culley next, say hi. We are corresponding. And I haven't seen Jim in probably a year or two.

Q: I will.

A: Yep.

Q: All right.

END OF INTERVIEW