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Michael R. Schilling

Michael R. Schilling: Chemical Analysis of Art at the Getty Conservation Institute

Getty Trust Oral History Project

Interviews conducted by
Roger Eardley-Pryor, Ph.D.
in 2019

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Michael R. Schilling in the Materials Characterization Laboratory of the Getty Conservation Institute Science department, standing by a pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS) instrument. (April 2019)

Abstract

Michael R. Schilling is a chemist and head of Materials Characterization at the Getty Conservation Institute (GCI), which focuses on the development of analytical methods for studying chemical materials used by artists and conservators. Schilling was born on December 4, 1957 in Los Angeles, where he has lived his entire life. He completed both his Bachelor's and Master's degrees in Chemistry at California State Polytechnic University, Pomona, in 1983 and 1990, respectively. Schilling, who began work in the GCI as an Assistant Scientist in 1983, has worked in every GCI location: in its Getty Villa laboratory, then in its Marina del Rey facility, and now in the GCI's Materials Characterization laboratory at the Getty Center where he is a Senior Scientist. Through the GCI, Schilling helped conserve the 3,200-year-old wall paintings in the Tomb of Queen Nefertari in Egypt as well as the Buddhist cave paintings of the Mogao Grottoes, a World Heritage Site in northwestern China. Schilling has since specialized in developing new research methodologies specific to the needs of art conservators with creative combinations of gas chromatography, mass spectrometry, and thermal analysis applications. Schilling's recent research activities in Materials Characterization involve a range of both traditional and contemporary art materials, including analysis of Asian lacquers, plastics (especially those used in Disney animation cels), and modern paints (especially those mixed by Dutch-American artist Willem de Kooning). A key element of Schilling's work includes improving analytical protocols and then teaching these procedures to leading scientists and art conservators from around the world in analytical workshops. In this interview, Schilling discusses all of these topics as well as the influence of key mentors and the importance of his Christian faith to his marriage and fatherhood of two children.

Table of Contents

Interview 1: April 18, 2019

01-00:00:02
Eardley-Pryor: I am Roger Eardley-Pryor from the Bancroft Library's Oral History Center at UC Berkeley. Today is Thursday, April 18 [2019]. I have the pleasure of speaking with Michael R. Schilling here at the Getty Center [in Los Angeles], for an oral history with you, Michael. To start things off, could you tell us the day that you were born, and a little bit about the family you were born into?

01-00:00:20
Schilling: I'd be happy to, Roger. I was born December 4, in 1957. I'm a native Angelino, so that means, for those of you not from LA [Los Angeles], that I've never strayed from the Los Angeles region, my whole life, actually. My parents are from Illinois, and my dad was a Navy veteran. He was in World War II, he fought in the Pacific War. He actually piloted one of those landing craft that brought the Marines and soldiers to the beach. So if ever there was a job that had a target on them, that was my dad's job.

So he did that in World War II. He met my mom on a leave, actually. They met at the naval shipyards in, I think it was—oh, gosh, where was it?

01-00:01:10
Eardley-Pryor: Here in LA?

01-00:01:12
Schilling: Maryland. Actually in Maryland.

01-00:01:12
Eardley-Pryor: Oh.

01-00:01:13
Schilling: My mom and her sister took a little vacation, and they left Illinois and they went to Maryland, and they met my dad there. And he had his Navy outfit on and his sailor's hat, and they fell in love.

01-00:01:29
Eardley-Pryor: And they're both from Illinois?

01-00:01:31
Schilling: They're both from Illinois, small towns in Illinois. My mom is from Dundee, and my dad is from Oswego.

01-00:01:38
Eardley-Pryor: And what are their names?

01-00:01:37
Schilling: Roy and Doris.

01-00:01:41
Eardley-Pryor: And Doris's maiden name was?

01-00:01:42
Schilling: Schumacher.

01-00:01:44
Eardley-Pryor: So Doris Schumacher and Roy Schilling meet in Maryland during the war.

01-00:01:48
Schilling: Yes. During the war, during a leave. So if ever there was fate, that's certainly one instance of fate, just meeting there, fell in love, and they married after the war, of course. And they were living in Illinois for a while. They were living fairly close to my mom's parents. The grandad on my mom's side was a butcher, and his wife was a homemaker. Boy, did they know how to cook and spoil us. We would come there for family reunions, it was wonderful—sausage, all this German food. With names with Schumacher and Schilling, you know you're going to get good German food. That was a life that they had in Illinois.

01-00:02:40
Eardley-Pryor: But you were born in LA. So how did they—

01-00:02:40
Schilling: Yeah, so my dad actually was here for a short time with my uncle during the war, kind of training, and they came to the West Coast. They realized, boy, the weather in LA is a whole lot better than the weather in Chicago, especially in the wintertime. So my dad always wanted to come here. But it was hard for them to make that decision, because it would mean my mom would be leaving her large family, seven siblings in her family. But it ended up then that his brother was married also at the time. So my dad and mom, and my uncle and aunt, decided to make the move to California in 1956.

01-00:03:22
Eardley-Pryor: So they moved out here with your Schilling uncle, your dad's brother.

01-00:03:28
Schilling: Yes. Yes.

01-00:03:29
Eardley-Pryor: So they had family to come with?

01-00:03:29
Schilling: His nickname was "Scoop." Yeah, Uncle Scoop and Aunt Lil. So Scoop and Lil and Roy and Doris took Route 66 from Illinois, and went through the Great Plain states. And my mom was a little concerned, just leaving home. As the terrain got more and more desolate, and you're going over the mountains and through the desert, boy, she's sitting there with her arms folded in the car, not talking to my dad at all. She really wasn't liking what she was seeing. But then eventually, at that time, LA wasn't the giant metropolis that it is now. So the cities and the suburbs were much smaller. You had to go a little bit farther towards LA until you finally got into what looked like civilization again. Once

she saw that and the greenery and things like that, then she relaxed a bit. So they made the move then in kind of the mid to late fifties. Then they—

01-00:04:28
Eardley-Pryor: You were born in '57, so shortly thereafter—

01-00:04:32
Schilling: Yes. Correct.

01-00:04:31
Eardley-Pryor: And do you have siblings?

01-00:04:32
Schilling: Yes, my two brothers. Older brother, John, middle brother, Dave. I'm the baby of the family. They both also served in the military. My brother, John, was actually drafted during the Vietnam War. And he served in Thailand, mainly. Then my brother, Dave, enlisted in the Air Force. He actually worked mainly in Guam, repairing B-52s. So he actually worked in Guam in the hot jungle climate, inside of the B-52, in the back section where they have what they call the "fire control system." That's basically a turret with machine guns mounted on it, .50 caliber machine guns. It's all controlled by the fire control officer. So it's really cool to visit him at Mather Air Force Base in the summer of 1977, the year that Star Wars came out.

So he took me to Mather Air Force Base in the evening when he was working, and he was then starting to train people on how to do these repairs on the fire control system. That was just such a thrill to be inside of a B-52. They're massive planes, enormous planes, tremendous capacity for stuff inside of them. So they had a huge wingspan. He told me that they're jet planes, built in the fifties, and they have so much fuel in the wing tanks that the wings are drooping. They're really close to the ground when they're full of fuel. And on the way back, then the wings get lighter, so they actually flex back up. It was just interesting to see that happening, B-52s kind of taking off and landing, and being under the runway. They're just incredibly loud, louder than anything I'd ever heard at the time.

01-00:06:21
Eardley-Pryor: That's wild!

01-00:06:21
Schilling: It's just awesome to see that. It must be the same feeling that people have watching the Tournament of Roses parade in Pasadena, and then the B-1 or the B-2 aircraft flies overhead. It kind of gives you the chills, just seeing what people have made and how awesome it is, and sounds and feels.

01-00:06:40
Eardley-Pryor: So you have a father who served in the military, in the Navy.

01-00:06:44
Schilling: In the Navy.

01-00:06:44
Eardley-Pryor: You have two brothers that served, both in Army and Air Force.

01-00:06:49
Schilling: Yes.

01-00:06:49
Eardley-Pryor: But you did not take that route.

01-00:06:49
Schilling: No. My dad really suggested—I'm a small animal, so he said, "You really shouldn't go into the military. You should get a real job." So I took his advice. That was good advice, yeah.

01-00:07:02
Eardley-Pryor: What are some of your earliest memories of this, being born—you were born in '57. What are some of your earliest memories from childhood, growing up in LA?

01-00:07:07
Schilling: Gosh, just being out in the backyard. I loved being out in the backyard digging holes and making mud puddles, and things like that, playing with cards, or just a whole different set of toys for kids back then that didn't involve batteries. So just getting out, flying kites. I loved flying kites with my friends. The cheapest kite was always the best kite; it went the farthest. Just trying to avoid trees and power lines in our neighborhood. We were really lucky, we lived in Temple City, that's where I grew up. My parents moved to the house that I grew up in after being in another house for about a year.

01-00:07:43
Eardley-Pryor: Also in Temple—

01-00:07:46
Schilling: I don't have any recognition, any recognition or remembrances of that first house. I was only a year old when we moved to the other house.

01-00:07:51
Eardley-Pryor: Were they both in Temple City?

01-00:07:52
Schilling: Yes. And very close to Scoop and Lil, who also settled there. But anyway—

01-00:08:00
Eardley-Pryor: Well, on that note, did Scoop and Lil have children?

01-00:08:02
Schilling: No. They were childless. They chose not to have kids. Lil was very involved in our church that we went to, First Lutheran Church in Temple City, she was on the Altar Guild. She was just a whirlwind woman. She's a tiny little woman, just a ball of energy. She had a really high voice, "Ooh, how are you? Ooh-whoo!" And she'd blow in and she'd spend some time with us, and then

blow out. She was like Hurricane Lil, but fun, just a fun woman. Scoop, totally different, more relaxed like my dad, and they just had fun hanging out together and talking sports, and things like that.

01-00:08:44
Eardley-Pryor: With this powerful experience during World War II, did he talk much about his service?

01-00:08:50
Schilling: Yes, he did. Actually, one of the things that he liked the most—he loved to read. Loved to read, veracious reader, who loved to read more books and things like that. It's funny, he was a parts man for industry; trucks and heavy equipment and things like that. One day, he said, "You know, I really wanted to be a doctor when I was a boy." But he had a hard life. It was a hard life growing up. His dad was a farmer. So when Pearl Harbor happened, he was happy to enlist in the Navy. But anyway, that's what he wanted to do with his life. And I never knew that. It was just not long before he passed that I learned that. That was interesting, to learn something about my dad at such a late time in my life, because I should have known that. I should have known that, really, when I was growing up. But loved to read. Had a great memory. And he loved watching war movies; war movies and Western movies.

01-00:09:51
Eardley-Pryor: And he was open about sharing his own experiences?

01-00:09:53
Schilling: Yes.

01-00:09:52
Eardley-Pryor: That's not common for a lot of veterans.

01-00:09:57
Schilling: No. And it must have been incredibly traumatic, absolutely traumatic. He didn't share too many of the details of being there, but he told me where he went, the ships he was on, and things like that.

01-00:10:08
Eardley-Pryor: Was that you were curious about as a young boy?

01-00:10:09
Schilling: Absolutely. I found it fascinating because it was just such a monumental time in our history of the world, certainly our country. And the men and women that served in the military at the time. It just shaped everything. Really, it shaped everything. And the post-war years were so shaped by what happened, and the outcome of World War II, and the dedication of the men and women who served, liked my dad and my uncle, and so many men in both families, actually, served there.

01-00:10:42
Eardley-Pryor: As you were growing up in Temple City, what were some of the—paint a picture for me of the neighborhood, the kind of annual cycle of events.

01-00:10:51
Schilling: Sure.

01-00:10:52
Eardley-Pryor: I imagine the Rose Parade being some sort of event that would draw people towards it.

01-00:10:56
Schilling: Yes.

01-00:10:57
Eardley-Pryor: Is that right?

01-00:10:56
Schilling: Yeah. Temple City is just a little bedroom community, maybe 30, 40,000 people.

01-00:11:02
Eardley-Pryor: Why do you think they settled there?

01-00:11:04
Schilling: That's a really good question. I think that's actually where Scoop and Lil settled. They picked that city for some reason. It was not really at the border of what would be considered LA, within commuting distance. LA developed the suburbs around it, because advertising to the war veterans and their families. Well, come to LA. Come live in one of these small towns that are only 30 minutes away, 20 minutes away by freeway. So those towns kept growing, adding more and more to the metropolitan area. And LA became this giant metropolitan area. Again, the commutes got longer and longer. Freeway traffic's got more and more congested. But I don't know, that's a really good question. I can't answer why they picked Temple City, of all places. But the San Gabriel Valley is where Temple City is, and it had a lot of citrus orchards there that were cut down to put in these bedroom communities. So I live in the San Fernando Valley now, west of the San Gabriel Valley. Same thing. Citrus orchards were there, and they were more or less cut down, and these bedroom communities went in in the fifties and sixties and seventies.

01-00:12:25
Eardley-Pryor: Were the citrus orchards around Temple City and the San Gabriel Valley, were they there in your childhood?

01-00:12:32
Schilling: Yes. Many houses actually had citrus trees in their yards, which was kind of nice, because they were wonderful trees. Delicious fruit. But I lived in a house that was in the center of the block. So if that's the block, our house was kind of here. For some reason, they put the house in the center, and we had this

unusually long driveway, and the house was kind of in front of us, off to the right, looking out our front window. So that driveway was a great place to ride bikes and run around, and start kites flying in the air. So I had this great, long run that would be long enough to get the kite up in the air, just in my own driveway. So it was just fun to hang out in my garage with my friends, and go over to their house and climb trees and fly kites, and all of that stuff. So I loved it. It was just a great time.

01-00:13:27
Eardley-Pryor: It sounds like an idyllic childhood.

01-00:13:27
Schilling: Yeah, simpler time, for sure.

01-00:13:30
Eardley-Pryor: Were you close with your brothers at a young age?

01-00:13:35
Schilling: I was much younger than they were, so there was quite a number of years between me and my next older brother, Dave. So, not so much. We weren't as close, just because they were already moving on to the military or high school, and things like that. Once a guy gets in high school, he doesn't want to hang around with his little brother. But definitely, we would play catch or football, baseball, things like that. My brother and my dad were coach and manager of my Little League team, so that was nice. That was nice to hang out and do that with them. I played second base for a number of years, I played in center field, I was a catcher, even though I am a small animal. I was catcher for a season, and that was fun. Baseball was just in our blood. It was definitely in the Schilling blood. We watched the Dodgers, and yeah, we were passionate baseball fans and sports fans.

01-00:14:32
Eardley-Pryor: Was your dad a Cubs fan? Or a Sox fan?

01-00:14:35
Schilling: My dad really did like the Cubs, he really did like the Bears, absolutely. So that year that the Bears won the Super Bowl, my parents always hosted a Super Bowl party at their house. I just remember that year, the "Super Bowl Shuffle" was the song that William the Refrigerator Perry did, and the music video. So that was big. They'd always have chili and things like that. It was just a great time having that Super Bowl party at my parents' house.

01-00:15:00
Eardley-Pryor: That's great. What are some of your early memories of other events that were happening, perhaps nationally, in the early sixties? Did any of that filter down to you as a young, young boy?

01-00:15:12
Schilling: Sure. Let me add one thing, because I forgot to add one cool thing about our family.

01-00:15:16
Eardley-Pryor: Please.

01-00:15:18
Schilling: We had tortoises. They'd just wander in the yard. It's a desert, LA is a desert, and desert tortoises were people's pets for a long time. So we had a couple of tortoises, Rosey and Truman. We named them after Roosevelt and Truman. We got the genders wrong, both times. It was really funny. We thought Rosey was a female, Rosey turned out to be a male. We found that out when we brought another male over to mate—didn't work out. They started to battle. The person who brought the other male over turned Rosey upside down and said, "Well, this is a male, this is not a female." Okay, Rosey Grier, the football player. We never changed Rosey's name. Truman, we thought, was female—turned out to be a male also. So we just couldn't get it right. Anyway, having turtles was really fun. Or tortoises, sorry. Having tortoises was really fun. They would dig holes and they would hibernate. It was just fun to see that life cycle. One day, they would just start digging holes along the fence at the edge of our property. And they would be in there for months.

01-00:16:23
Eardley-Pryor: It sounds like you had a real relationship with nature and the surrounding environment.

01-00:16:28
Schilling: Oh, I loved nature. Absolutely. Now it's really captivating just to see nature, and to see the beauty of nature, the complexity of nature, to be part of it, to be part of the natural world. The old adage, "stop and smell the roses" is something that people really don't do enough. We have a really wonderful grounds crew here at the Getty Center—they do a magnificent job in maintaining the grounds, to have a mix of kind of manicured and natural, so you have a bit of both at the Getty Center. And there is one walkway leading between Central Security and where the Trust offices are. Up above that area, the plaza level where the tram comes in and the visitors come and go, there are jasmine flowers and lavender flowers. This is almost the time of year that the jasmines start to bloom. And that odor cascades down from the plaza level, one floor below. And when you're walking between Central Security and our east building, where the Getty Conservation Institute is, you can really smell that smell, if you're paying attention. So when we have visitors and I'm bringing them into our building, I say, [sniffs] "Can you smell that?" Then they're [sniffs]—"Oh yeah, what is that? It's beautiful." Right? I always point that out to people, because there's just so much natural beauty here, and just in LA in general. It's just a beautiful place to be. Just being connected to nature is just something that I think a lot of people in LA feel, because nature is accessible so many more months of the year here than where my parents grew up, where they have an actual winter, and things look brown and dead during the winter. Yeah, that natural connection is just really part of who I am. I just love walking and enjoying it.

01-00:18:30
Eardley-Pryor: Did your family go on vacation to areas around LA? Or did you go visit different parts? Or was it really located mostly in Temple City?

01-00:18:34
Schilling: Mostly local trips and things like that. Then again, going to see our relatives, to make the big trip.

01-00:18:42
Eardley-Pryor: Oh, and you'd head back to Illinois?

01-00:18:43
Schilling: Yeah. So that was fun.

01-00:18:44
Eardley-Pryor: That was a big trek. How would you get there?

01-00:18:44
Schilling: By car.

01-00:18:47
Eardley-Pryor: You'd drive across the country?

01-00:18:48
Schilling: We would go the opposite direction that my parents took to come out to Temple City. So it was always fun to go through. Wyoming, they allowed fireworks year-round, so you could buy fireworks and shoot them off. I love fireworks. That's how I'm a chemist, you know? All chemists, if you scratch just a little bit, they love fireworks. They love pops and smells and things like that. But you asked about the sixties, and the war era.

01-00:19:13
Eardley-Pryor: Yeah.

01-00:19:15
Schilling: And boy, oh boy, was that on a high school boy's mind, because I graduated from high school in '76, so then when I started in '72, '73, the draft was going on. "Wow," we were wondering, "would we get drafted?" As much as I wouldn't want to serve, because I had other aspirations, it was certainly an option, you know? Size was no guarantee of not being in the military, that's for sure. I didn't have any physical defects.

01-00:19:46
Eardley-Pryor: And your brother had been drafted.

01-00:19:46
Schilling: He got drafted, after being married for just a short time. Didn't see that coming, and it just changed his life completely, yeah.

01-00:19:56
Eardley-Pryor: Wow. Are there—

01-00:19:57
Schilling: And that was a turbulent time. I mean, the music really reflected the turbulence, all the changes. I was never part of that movement, you know? I was always kind of the straight-laced nerd of the family, and I've word bifocals since fourth grade, so I always looked the part, at least. If nerds have glasses, then I'm a nerd. But that was never part of who I was, growing up. But it's odd, now that I'm older, and I have streaming music service, access to that, which is the best thing for a music lover like myself. Now I really enjoy that music a little bit more, just the sound of it and the edginess of it, and things like that. It's fun to kind of appreciate it now, decades after the events that inspired it. Oh, the events were terrible, what we saw on TV. I mean as turbulent as the times are now, pales in comparison to what was happening in that time. The country was just in turmoil.

01-00:21:01
Eardley-Pryor: Do you remember seeing some of these events? I mean, things on television at home?

01-00:21:02
Schilling: Absolutely. Just seeing beatings in the South—oh, it was horrible. It just gives me the chills, thinking about it. It was just horrible times. The fire hoses being used against protestors, and black people. And it was just wrong. And we all knew it. There wasn't the endless news cycles the way there are now, where you can kind of—it washes over you, and you just turn off, right? It's just background chatter. Then, it meant something. You've never seen things like that before on TV. It was just frightening. It was just frightening that we were—sorry.

01-00:21:42
Eardley-Pryor: Mm-hmm.

01-00:21:44
Schilling: It's frightening to think that we were capable of doing that to each other. It's just wrong.

01-00:21:52
Eardley-Pryor: You had mentioned that your Aunt Lil was deeply involved in her church, her local church.

01-00:21:57
Schilling: Yes.

01-00:21:55
Eardley-Pryor: Was that something that was important for your family, as well, at a young age?

01-00:22:00
Schilling: Yes, all of us went to church. That was a great family thing to do on Sundays. I had my pastor, Reinhold Schultz, he was a wonderful pastor. Everybody loved the man. He confirmed me, confirmation means that you can go through

a catechism class. That was a group in the Lutheran Church, so it meant that I could take communion for the first time, as an eighth grader. So I went to a parochial school between fourth and eighth grade, just a great experience, a hundred people in the whole school. You knew everybody. You know, the older students helped out the younger students, and it was just fun. It was just fun to be there. So Pastor Schultz was just great. And I just really respected him. He had a good understanding for the Bible, good passion for the Bible. Passion is really what makes people. Successful people, they're almost always passionate. It's just so hard to make that happen in someone, if it's not natural.

01-00:23:07
Eardley-Pryor: Did you have a passion for Christianity as a young man?

01-00:23:06
Schilling: Yes, absolutely. Faith is just something that is just part of who I am. I've expressed it differently over the years, you know. We'd go to college, the tendency is to fall away from it, but came back once Cherrie and I got together. And again, what you learn in church varies, depending on what church you go to, the giftedness of the pastor, and again, the passion of the pastor, so the last five or six years, the church that we're at—just wonderful teaching. Just off the charts in terms of quality, genuineness. Real care for people, and real care for the fact that we're all connected to each other, we're all connected. And if you're a Christian, you're connected in a deeper way than even if you're a family member. So that's just a wonderful thing that gives you great comfort. And it makes me want to tell people that I actually go to church. It's not that popular to tell people that. Some people hide it, I don't because the church has something for everybody, if you find the right church.

I just saw things yesterday about one of the presidential candidates who's gay, and just shameful things that Christians were doing—I don't identify with those people at all. Yeah, I don't understand that. That's not what Christ was about. That's not what you read in the Bible. So anyway, I'll get off my soapbox about that.

01-00:24:45
Eardley-Pryor: No, this is a good soapbox to be on, because it's helping share your perspective on things and where you came from. So even at a young age, this was a space and interest of yours.

01-00:24:57
Schilling: Absolutely. It made sense. It made sense to me, it was explained well. And again, you mentioned nature—God made nature, we're part of nature. We're all connected. We're connected in mysterious ways. Even though I'm a scientist, I like mystery. I don't mind things being unexplained. I don't mind appreciating things that just look wonderful, you know? And they're inspiring. And they're moving. Like the astronauts; hearing the stories of the astronauts who go into space and they see the earth for the first time from that perspective. It's almost a spiritual experience for them, I think, just seeing how

precious the earth is. And we're all part of that, you know, that biosphere. And it's just an amazing planet. It's just an amazing diversity of creative energy, you know?

01-00:25:59
Eardley-Pryor: Do you have memories of when those photographs that are coming back, from '68 through '72, and those first images of Earth from space. Do you have memories, or your feelings of seeing that?

01-00:26:10
Schilling: Oh, it blew me away! That we could do that as a civilization, that we could go that distance and get those images back to us. I just get chills. It's an emotional experience just thinking about that. All the things that were happening in the sixties, that was a wonderful counterpoint to all the mayhem and chaos and awfulness. Seeing what people could do if you just united. And I loved the fact it was just for mankind, humanity. That's just a great feeling. And the Voyager probe and where we were technologically at the time, and it went out, I could imagine that someday, much like the first Star Trek movie with William Shatner, and Voyager was sent back to earth with this grand structure built around it. I could see that happening someday, that some intelligent species that God created will send that back to us, and say, "Here we are, and this is what we can do." Yeah, I love that.

01-00:27:19
Eardley-Pryor: You mentioned a memory of Star Wars in '77 and Star Trek—were those things that were on your radar then? Were you a science fiction fan as a young man?

01-00:27:25
Schilling: I love Sci-Fi, yeah. I still do. My wife and I enjoy watching things like the X-Files, and Sci-Fi stuff. It's just fun to let your mind wander and imagine possibilities, to go places that are outside what seems like the normal boundaries of our experience. And I love that. "2001" [A Space Odyssey] was, what, '68, I guess it came out? That was really breathtaking. We were just discussing it the other day in the lab; the technology that was needed to create the scene where the pen was flying through the spacecraft. And the flight attendant came and grabbed it out of the air and put it back in the person's pocket. I loved that technology.

But when Star Wars came out, the weird thing about Star Wars was the lines of people who wanted to see it. So I happened to be in Sacramento with my brother; I was spending a few weeks with him. "We've got to go see that movie!" I've never stood in a longer line to see a movie. But we were both completely blown away with what we saw, the technology to create it, and the fun in the movie. It was just a fun experience. And I loved it. We just were amazed at what we saw. Again, it's still fun to watch.

01-00:28:45
Eardley-Pryor: Why do you think it was such a blockbuster?

01-00:28:48
Schilling: The technology was something that people had never seen, it was a fun story, and it was like a Western in space, basically—the good guys, the bad buys, really obvious stereotypes with color of their costumes, and things like that. And the actors and actresses were fantastic. They were kind of relatable, fun, a little cheesy, and really just fast paced. So it all worked. The soundtrack was amazing, by John Williams. Yeah. People had never seen anything like it. I can't imagine that experience ever being repeated, where the technologies are so different. But maybe with VR [virtual reality], maybe one day with VR and AR.

01-00:29:32
Eardley-Pryor: What's AR?

01-00:29:34
Schilling: Augmented reality. Pokémon Go, or whatever, catching Pikachu in the lab—I've never done that; not that we'll admit to. But yeah, we just at a staff meeting yesterday, we were talking about how could we use virtual reality, augmented reality, in our own work, to get our own work out to a wider audience in a more meaningful way, where all of the depth of knowledge that's contained in our analytical reports, all the endless terabytes of files and printouts and things like that—how can we make that accessible to museum visitors, or people interested in cultural heritage research? So that'll be an interesting frontier, when that's really tapped into properly.

01-00:30:21
Eardley-Pryor: That's really cool to have those conversations, even, about it. Take me to your schooling. What were some of your memories, was it public schooling, private schooling?

01-00:30:30
Schilling: Yeah, it was a mix of both. I started out in a public school, and enjoyed that. I guess the best thing that happened to me in public school was that it was mandatory for every kid to get an eye exam, so that's when I found out, in fourth grade, that's why I couldn't see the chalkboard so well. And it was really funny, the one really vivid memory I have of being a child was leaving the optometrist's office wearing my first set of bifocals, and being able to read signs on the buildings across the street that I didn't even know existed. And it was just, yeah, it was jaw-dropping. Wow, all the details out there, and it's been a mystery to me all these years.

01-00:31:15
Eardley-Pryor: It's like opening up another level of reality for you.

01-00:31:19
Schilling: Exactly, yeah. Totally different level of reality. Just new sensors at work.

01-00:31:22
Eardley-Pryor: Which, in some ways, you do through your chemical analysis as well.

01-00:31:25
Schilling: Absolutely. Absolutely. Scientists just have extended senses in the equipment that we use.

01-00:31:32
Eardley-Pryor: So you said it was a mix of public and private?

01-00:31:35
Schilling: Yeah, public and private. So my parents just decided, figured I would get more in-depth schooling and instruction at a smaller, private school. So the church that we went to had a parochial school attached to it, like I said, about a hundred kids, or a little more than that. So I went there from fourth to eighth grade. I just loved being there, and the science and music, really loved music. The organist of the church taught music class for us; he was a fifth and sixth grade teacher, Mr. Baden. And he had a hearing aid, so we always joked that Mr. Baden would turn his hearing aid down when he would play the organ for the church service. That was fun. But he taught music classes, and so I really enjoy music. I still do. Music is in my head constantly. At work, I always think of a song that goes with some occasion. We had just had a workshop for Korean and Japanese researchers a couple of weeks ago, and of course on the last day I had to get out my iPhone and start playing K-pop and J-pop songs. And boy, were they laughing. They really got a kick out of it. So definitely, there's a soundtrack to my career that's evolving.

01-00:32:55
Eardley-Pryor: That's great.

01-00:32:56
Schilling: But anyway, so that was up through eighth grade. Then I went to the public high school, Temple City High School.

01-00:33:01
Eardley-Pryor: How was that transition?

01-00:33:03
Schilling: That was an incredibly difficult transition to make, because you go from a graduating class of twelve or fourteen people to five, six, seven hundred per graduating class. And it was really tough. That first year was tough. Hung out with the nerds, got hazed a little bit by the seniors—that was okay. That's, the price of entry. But then really, once I got into chemistry in my sophomore year, that's when I really started to know what I wanted to do. I always knew that I liked math and science—couldn't tell you which one I liked the most. But once I got into chemistry in high school, Mr. Thaller, Floyd J. Thaller, was the teacher—wonderful man. Just a really great teacher. He had a way of explaining everything in a way that everyone could really understand. Quirky man. He liked wearing bowties in an era when all of the teachers were wearing straight ties. He wore his bowties. And what's more, he made special bowties for different holidays. So he had a green one for St. Patty's Day, with

little shamrocks. He had holly sprigs for Christmas. But the best tie was his April Fool's tie.

01-00:34:22
Eardley-Pryor: Why?

01-00:34:24
Schilling: It was a straight tie.

01-00:34:27
Eardley-Pryor: Perfect!

01-00:34:31
Schilling: Absolutely perfect.

01-00:34:33
Eardley-Pryor: So Mr. Thaller was the chemistry teacher.

01-00:34:35
Schilling: Yes.

01-00:34:36
Eardley-Pryor: And he opened up your interest in chemistry?

01-00:34:39
Schilling: Yes. He just explained it well, and that's when I got my first chemistry set, put it out in the garage. That was fun. I could make my own pops and smokes and things like that in the garage.

01-00:34:49
Eardley-Pryor: What did your parents think?

01-00:34:53
Schilling: I don't know how much they knew. I'm sure they saw the smoke marks and things like that, and didn't say anything. As long as I didn't do any damage, I think they were okay with me getting crazy in the garage. That was just a great time. Just to really learn chemistry, and to be in a lab. I loved being in a lab. That's where I was made to be. Just working with the equipment, seeing things happen.

01-00:35:17
Eardley-Pryor: What are some of your memories of the high school lab? Tell me what that was like.

01-00:35:20
Schilling: Oh, color changes. One cool thing that Mr. Thaller did at Christmas time was, he made something called the "electrochemical Christmas tree." It's a really simple reaction. He took a sheet of cooper and he cut it into the shape of a Christmas tree. So he made a triangle with a little trunk, and then he cut slots for the branches. He bent the slots so now the pieces were bent at different angles, like that. So that's the Christmas tree. He made a little base for it. He

put that into the beaker, so copper is a nice copper color. Then he added a color to the solution of silver nitrate. And so when he put the tree into that beaker of silver nitrate, the reaction takes place where copper is replacing silver and solution, and it's precipitating silver crystals that ended up growing on the copper tree. So it started to decorate itself naturally by this chemical reaction. So it was just really wonderful to watch that grow over the series of an hour or so, as the silver kept depositing. And the colorless solution then became blue, because copper and solution makes the solution blue. So it was a beautiful blue tree, with these silvery crystals. And that was just a great experiment to teach electrochemical replacement, that reaction. So it's a fun reaction to study. And, you can write it up in the lab and write out the equation. But to see it happening, to make it happen, there's something grand about that, that just fits with me and my personality. It's just doing the experiments.

So when I was a junior, I assisted him as a lab assistant in his lab, and that was great to work with the students, to give them a little bit of advice. Whatever I remembered from the last year, I could pass that on to the kids, and that was fun. That was fun to teach them a little bit, and to assist.

01-00:37:26
Eardley-Pryor: Did you go to Mr. Thaller to say, "I want to be a part of the lab?"

01-00:37:24
Schilling: Absolutely. At the end of my sophomore year, I said, "Do you have a lab assistant opening, or anything?" "Sure." So that was fun. That was fun to be a lab assistant. I don't know, maybe that's when my love for teaching really started, back then, was just helping out. I like to see people succeed, you know? And if there's something I can do to make that happen, it's great, and it's just satisfying. And it's part of why I'm here.

01-00:38:00
Eardley-Pryor: So you graduated high school in '76.

01-00:38:01
Schilling: Yeah.

01-00:38:03
Eardley-Pryor: As you're coming towards the end of graduation, what were your thoughts about next steps?

01-00:38:07
Schilling: Oh, I knew I wanted to be a chemist. Didn't have a lot of money, I had to earn my way through college, just different part-time jobs in retail. So as much as I'd like to go to a large, expensive university, that wasn't in the cards for me. But California at the time, we were really blessed to have a very low-cost, high-quality university system. So the state college system was wonderful. For $70 a quarter, I could go to Cal Poly Pomona, or California State Polytechnic University Pomona, affectionately known as "Cal Poly." And it's much shorter to write on a resume, if you write "Cal Poly" instead of "California State

Polytechnic University Pomona." But $70 to go there. Chemistry books were twenty bucks. Now they're hundreds of dollars. Parking was $10 and $20, so it was just dirt cheap to go there on a minimum wage job. Boy, has that changed. The funding stream is different. The dollar amounts are different to go to Cal Poly Pomona today, but the quality of the education is still high. And the motto is, "Learn by Doing." And that again resonates with me, because you really do learn something when you're doing it yourself. You prove to yourself that you can do it.

01-00:39:27
Eardley-Pryor: Had you thought about other opportunities, other university options?

01-00:39:28
Schilling: I did. I thought Loyola was a good school, and LaVerne, University of Chicago is a wonderful school. Again—

01-00:39:38
Eardley-Pryor: Oh, you thought about going back to Illinois where your family is from?

01-00:39:41
Schilling: Yeah, absolutely. Super expensive, and just not in the cards for me, and that's fine. That's fine.

01-00:39:48
Eardley-Pryor: Had other family members gone to college?

01-00:39:50
Schilling: Pardon me?

01-00:39:50
Eardley-Pryor: You said both your brothers went into the military.

01-00:39:51
Schilling: Correct.

01-00:39:51
Eardley-Pryor: Your father was in the military. Were you among the first—

01-00:39:53
Schilling: I was the only one to go to college. Dave, later in his life, once he was out of the Air Force, then he got a degree in social work, so he has a master's—or he had a master's degree. He's since passed, as has my older brother, John. But yeah, at the time, I was the only Schilling to go to college. That was intimidating a little bit. There was a lot riding on my little shoulders. And honestly, I wasn't motivated the way I am now. Motivation is, again, one of those things that, it has to overtake you, for me at least, to do really well. All of the high school and elementary school came so easily. And in college, I actually had to start working, and I wasn't used to that. So I wrongly thought, oh, I have to work now, so this isn't my field. I'm looking for the field that would come easily, thinking wrongly that that's the way I should approach my

education. So once I met Cherrie, super motivated. She convinced me that motivation was the way to go.

01-00:41:09
Eardley-Pryor: What were the other things that did motivate you while you were a young man, in high school, or even right after?

01-00:41:16
Schilling: Oh, that I enjoyed? Certainly enjoyed music. I just love listening to music. And like I said, music's in my head all the time.

01-00:41:19
Eardley-Pryor: Do you play any instruments?

01-00:41:23
Schilling: I tried different things. I don't play anything very well, but I can noodle around on the piano. My brother, Dave, learned the accordion. We had an accordion at home, so that was fun to get out the big accordion. Guitar, I liked that. I'd play the flute. Yeah, so just not very well. But I loved to whistle, and I loved to sing along in the car, when the windows are rolled up. But I love music. I love philosophy—

01-00:41:52
Eardley-Pryor: What do you mean by that?

01-00:41:54
Schilling: Pardon?

01-00:41:54
Eardley-Pryor: What do you mean by philosophy?

01-00:41:56
Schilling: Oh, just thinking, thinking about things deeply, and just different ways of looking at life and life situations, and making sense of the world as kind of augmenting what I learned in church, as a Christian. That was interesting to read about what other intelligent people had to say about certain big issue topics, like why are we here, and what's the meaning of life, and all of that. So never went very far on that, but I find it fascinating. Comparative religions, Zen, is something that I like. I like the concept of Zen, just getting in the moment and doing something well, just because you're there, and that's what you're doing at the moment, so let's do it well. Love to garden. I love the little mindless activities like raking, weeding. It's a Zen experience. Sitting at the computer and doing Excel is a Zen experience. Just getting the numbers right, making the forms look right. It's a Zen experience. I don't know if there's a Christian version of that concept; I don't think so. But I love that. And I think, again, it's people doing what they really are passionate about, and they're willing to do it forever.

01-00:43:21
Eardley-Pryor: When did you find that language, even, of Zen? You mentioned comparative religions. When did that come into your world?

01-00:43:29
Schilling: In college. Yeah, in college, and just taking comparative religion classes, and reading books by Joseph Campbell and about mythology and symbols. Huston Smith has a really wonderful little book on the world's religions, and it's just fantastic, just to learn what motivates other people, and what they think is the answer.

01-00:43:53
Eardley-Pryor: So colleges were a broadening experience for you?

01-00:43:55
Schilling: Absolutely. Absolutely, and I just find it—

01-00:43:59
Eardley-Pryor: Who helped you select Cal Poly? I mean, if you were the first in your family to go, make this route, how did you go about making your decisions, and even understanding what the process was to get into college, and which ones to choose?

01-00:44:12
Schilling: Yeah, Cal Poly, geographically, was close to us, so it was the state college, I think, was closest to where I grew up. And it still has a very high reputation for science, engineering, business, hotel and restaurant management, and agriculture. Those are really the strengths. Cal Poly, it's the Kellogg Campus is where I went. There's another campus. The Kellogg Campus, Kellogg is the cereal magnate. Again, that's why agriculture is such a strength. It's a really beautiful campus. It's very pastural, a lot of green spaces, crops going, animals—all of that. It's just a really wonderful place to walk around, it's a beautiful campus in Pomona. It just had a really good reputation for science, and really great teachers who are there to teach. That's the defining difference between the university system and the state college system, I think, is that the university system is really finely tuned to produce research and researchers. And if you wanted to be a teacher, and you want to actually work with the professors and have a chance to work with them side-by-side, and not a TA [teaching assistant], you'd go to a state college. And so that was just great, to be able to work with the top people at that campus.

01-00:45:50
Eardley-Pryor: And you went in knowing you wanted to do chemistry?

01-00:45:53
Schilling: Yes. Yes. And so again, not a great student. Fumbled around for a while, just experimented with different things and different ideas. Then what really made the difference in my career—and I recommend this for anybody who's getting into science—is to get a job in the field before you graduate, and you get work experience. So Cal Poly had a program called "cooperative education." It was

headed up by an organic chemistry professor, J. Ernest Simpson—he goes by Ernie Simpson—lovely man. Absolutely lovely man. I can't say enough good things about Ernie. He's just such a people person. You wouldn't know it, looking at him. He doesn't look like a people person, but he's the most warm and empathetic person at that entire campus, I think. I've never met anyone quite like Ernie. His passion, besides chemistry and cooperative education, is basketball. And he was a basketball referee for decades. He finally retired doing that after 42 years of being a basketball ref. And he loved it. But Ernie—

01-00:47:03
Eardley-Pryor: What are your—oh, I'm sorry, go ahead.

01-00:47:03
Schilling: Ernie was the guy who got me involved in cooperative education. So at Cal Poly at the time, they had long hallways with cork boards, and billboards, and people would put notifications up. And I saw this one big section on the cooperative education program, and jobs in science and engineering. All these jobs, I'd look around. The Metropolitan Water District, General Dynamics, Sunkist. And it said if you're interested in any of these, talk to Ernie Simpson. So I bothered Ernie. I came into his office one day, he told me about it. I was a junior. And I thought, well, this would be great if I could get a job doing that. I was working at Radio Shack at the time. I love people, and I love talking to people and helping them. Sales was a natural way of doing that, getting people connected with the stuff they really want, and that would kind of fit their needs. But anyway, working in the lab just sounded like a great thing to do, because I loved being in the lab. A lot of students don't actually like the labs, because they're long. You have to do a lot of work, and then you write up a report. But I love that part of chemistry.

So I got into the co-op program, we call it, and I did that for two years as a junior and senior. And I worked at Sunkist in Ontario, California, which is a little farther east from the Cal Poly campus. At the time, after my dad passed away. Or sorry, after my brother, John, passed away, we moved from Temple City to Upland. So Upland was on the other side of the Cal Poly campus, so I was even closer to Cal Poly at the time. And I was much closer to Ontario than being in Upland, so I was able to work at Sunkist very easily, it was just a few miles from my house. And I loved it. What it was, was I worked in a group called the Fresh Fruit R & D [Research and Development] lab, and we didn't develop new fresh fruits, but what we did do was, we analyzed pesticides and fungicides for packing houses. So the people that would get the crops of citrus fruits from the growers, then they would clean them and wax them and store them, and then make that fruit ready, then, for retail sale throughout the year. So you can have oranges all twelve months of the year, not just when growing season happens. That's why they get protective waxes, that's why they get fungicides. That's why you can enjoy citrus fruit all year around, because of the—

01-00:49:54
Eardley-Pryor: So the Fresh Fruit R & D—

01-00:49:56
Schilling: —because of the work of the packing houses. And so we provided that service through the packing houses.

01-00:50:02
Eardley-Pryor: The freshness, maintaining the freshness throughout the year?

01-00:50:05
Schilling: Right. Because what they wanted to do, they wanted to apply just the right amount of fungicide to the fruit so that it would be effective, and minimizing spoilage during cold storage in the refrigerators. But not so high that, A, it's a waste of money, and B, you don't want people to be eating this stuff inadvertently. So it was our job to just track where it was in the fruit, make sure that it was really just in the peel, and that it was at an acceptable concentration level. So we were doing a service for the packing houses. And we used a lot of the same lab equipment that I use here at the Getty.

01-00:50:41
Eardley-Pryor: Was it your first introduction to some of that equipment?

01-00:50:43
Schilling: That really was, yeah. Because at Cal Poly at the time—it's different now—but at the time, they really didn't have some of those instruments. Or they were just really being used by the teachers in some of their research. So they might be used by the master's degree students, but not an undergraduate. So that was great to be exposed to equipment that I wouldn't have had access to at school. So the co-op program just was in line with the learn-by-doing mantra of the Cal Poly Campus. And it was a game changer. It was like a little switch went on, and Mike, you really want to do this. You're made to do this. Try harder, and put in the time, put in the effort. My grades got better and my attitude improved, and I knew exactly what I wanted to do. So can't thank Ernie enough for getting me in that program, because I wouldn't be here without Ernie's influence.

01-00:51:42
Eardley-Pryor: Yeah, he sounds like an influential and charismatic figure.

01-00:51:44
Schilling: Absolutely. And so he still calls me to come back from time to time to talk to the students about what I do. So Ernie started a program called "Alumni Professor for a Day." And so the alums come back, and we talk for any length of time, five minutes, ten minutes, sometimes an hour, hour and a half, about how you use chemistry in the real world at different jobs. So it's fun to go back and listen to the other alums, so all of the professors for a day are sitting in the back of the room, and one by one we go through the gauntlet; we get up and we address the students. So it's fun to hear about what some of the other

grads do also, with their chemistry degree. Yeah, that's just a fun experience. To reach out and give back to the community.

01-00:52:38
Eardley-Pryor: What are some of the other things that other chemists are doing?

01-00:52:41
Schilling: Oh, there's one guy, Dave Srulevich, he worked for a cosmetic firm. So he would formulate cosmetics and do QC. There was a guy, Paul Salverda, works for Agilent Technologies. They make the GC/MS [gas chromatography–mass spectrometry] machines that we use in our labs. And he worked in the Engineering Department and in the Service Department. We had people that worked in aerospace industries, just a whole range of things. Paints, water quality, yeah. It's just fun to hear about all of that. Some people go into teaching. Some people go out of chemistry completely and they go into business, they started their own business.

One guy that I worked with in the Fresh Fruit R & D Lab at Sunkist really liked a technology that came out when we were both working there at the same time. And he started using it in his work at Sunkist. It's a sample preparation device; it's an inexpensive, consumable item that's used to kind of purify samples before they're analyzed. So it takes out chemicals that would be in the background, and if you left them in, would reduce the signal to noise, make it harder to detect what it is you want to analyze. So this little disposable device was developed at the time by this company. A guy from the company came by, said "This is what these things do." His name is Phil Dimson, he really enjoyed using these things. He started working for the company. And I just heard from him recently, because of Ernie, and still working in the Alumni Professor for a Day program, that Phil ended up buying the company.

01-00:54:32
Eardley-Pryor: That's great.

01-00:54:33
Schilling: It was really fun. He's had quite an interesting career path; he's moved around and he's ended up doing that. And that he's retired. He sold the company to an even larger corporation.

01-00:54:44
Eardley-Pryor: Good for him!

01-00:54:47
Schilling: And now he's retired.

01-00:54:47
Eardley-Pryor: That's neat.

01-00:54:49
Schilling: Yeah.

01-00:54:46
Eardley-Pryor: Well, there's a lot of things that you've mentioned that I'd love to go back and unpack. And one of them is that you mentioned that your brother passed away while you were in college.

01-00:54:56
Schilling: Yes.

01-00:54:54
Eardley-Pryor: What's the story behind that, if you don't mind my asking?

01-00:54:59
Schilling: He had an addiction problem, and it started during the war. And it was unfortunate. It was sad to see that happen to him. We would see him coming back—

01-00:55:05
Eardley-Pryor: He was the Vietnam draftee?

01-00:55:09
Schilling: Pardon?

01-00:55:10
Eardley-Pryor: The draftee who served in Vietnam?

01-00:55:12
Schilling: Yes. Yes, John. He just had a tough life. He had a tough life. His wife left him, he got drafted. He went to the South Pacific where drugs were rampant, and he was one of the victims of them. And just came back a different person. It was really tragic for my parents to see that. Confusing for a young boy to see that, and a really fun man. Just really fun man, just a great guy. Really great zest for life, and it's really a shame. But anyway, yeah, he was in the Army, stayed in the Army, got remarried, had a young son. And he was a year old when he passed away. It was just an accidental overdose. Boy, that really affected my parents, wow, my dad especially, just had a hard time. Never really moved past that.

01-00:56:05
Eardley-Pryor: Your father did not?

01-00:56:05
Schilling: Yeah. He never really moved past it. All this made him emotional, the same way I'm getting emotional now.

01-00:56:14
Eardley-Pryor: How about its effect on you at this time, as a young man?

01-00:56:18
Schilling: Oh boy, that was the best anti-drug, PSA [public service announcement] that you could imagine. So it was really easy to pass that lesson along to my kids when they were young. Then my middle brother, then, just passed away. He

was just in poor health. Again, he went and got his master's degree, married, two sons. And he lived in the Central Valley in Fresno. Then he had a heart attack. My dad had a heart attack also, in '86. He wasn't feeling well at work, came home, showered, got in his bathrobe, sat in his rocker and passed away. And my mom found him at home.

01-00:57:11
Eardley-Pryor: Wow.

01-00:57:09
Schilling: So that was a shame.

01-00:57:11
Eardley-Pryor: Yeah.

01-00:57:13
Schilling: That was just a shame. And that was hard on my mom. She remarried, outlived the second husband, remarried again, and then she passed away in 2012, I think it was. Yeah. So I'm the last Schilling. I'm the last of that family that Roy and Doris started. So Cherrie and I, my Cherrie and I, we're the keeper of all of the memorabilia from the Schilling family, so all five of us. It's kind of an interesting responsibility to have that, and to pass that along to my kids, and nephews and nieces, and things like that.

01-00:57:53
Eardley-Pryor: You also had mentioned that your family moved around the time that your brother passed away.

01-00:57:59
Schilling: Yes. Once my brother passed away, it was really hard for my parents to stay in the house that he grew up in. That's when they moved to Upland, which was a nice neighborhood, but again, left behind all my friends from high school. Yeah, but it was more convenient for me to go to Cal Poly, that's for sure.

01-00:58:20
Eardley-Pryor: Were you still living at home and commuting to campus?

01-00:58:25
Schilling: Yes. So did that, and yeah, did that through graduation. Yeah.

01-00:58:32
Eardley-Pryor: You mentioned your wife, Cherrie, being such a motivating factor for you.

01-00:58:38
Schilling: Absolutely.

01-00:58:39
Eardley-Pryor: A new Michael emerges from that.

01-00:58:42
Schilling: Yep.

01-00:58:41
Eardley-Pryor: If you would, Mike, tell me how you met.

01-00:58:43
Schilling: Sure. My best friend in high school, Rick Eberhardt, he was interested in music. He was a band member, he played the trumpet. He was into AV [audio/visual] stuff, so he worked in the high school media center, which is part of our library. So he did audio recording, video recordings. He showed me tricks and things like that that I could use at home, with my reel-to-reel tape deck, and things like that. But anyway, Rick and I were best friends in high school. So he lived at home with his parents. I was living at home with my folks, we were just about a mile apart. And it was his twenty-first birthday. And he invited me to come over to his house to celebrate with him and his family. He had a sister, younger sister, Linda. And Linda happened to be a roommate of Cherrie, Cherrie Carr. And Linda didn't want to go alone to her parents' house, "Oh, I'd really like to have you come along, Cherrie." And Cherrie was on the phone with one of her cousins. He was having a hard time. She was talking to him, trying to help him get through it. Even back then, she had a heart for people, and helping people. So Linda won the argument. Cherrie tagged along.

So I was there. Linda and Cherrie, and Linda's boyfriend arrived. Rick's parents had the chairs out in their front room, and so we were sitting down. And when Cherrie and Linda and her boyfriend came, Cherrie said to the boyfriend, "You sit next to him. You should get away from this or that," I can't remember why she wanted him to sit there. And I just thought, "I like her. I like that attitude," you know? She's just direct. You don't have to wonder about where Cherrie stands on something. She's smart, she's articulate. She can tell you exactly what she's feeling, why she's feeling it. And I just really admired those qualities. So then I moved later, sat next to her, and struck up a conversation. Found out that she worked at King Arthur's Pizza, and I love pizza. And I liked Cherrie.

So a few days later, I thought, "I'm going to King Arthur's. Because I know where she works. I don't know where she lives, but I know where she works." So I mustered up the courage, got in my car, drove out to Temple City where King Arthur's was. And I drove around the parking lot, and I drove around the city of Temple City for about five hours, because I didn't have the courage to just go in there—like she would—to just go in there and meet her. So it's around 7:30, the restaurant's getting ready to close, and I come in. Linda also worked there. So Linda saw me and said, "Oh, you're here for Cherrie? I'll get her." And Cherrie comes out. So Cherrie had been making dough. And the uniform that they wore at King Arthur's was a polyester red short-sleeved shirt and black pants, and she was covered head to toe in flour, and she smelled like onions because she was chopping. So she felt embarrassed for looking and

smelling the way she did. Oh, I forgot the most important part of the ensemble, is they all had to wear a black derby hat. So she had the derby hat, and the red polyester shirt, the black slacks and the flour, and she was wonderful. And she just has the best smile. And I asked her if she wanted to go out, and she did.

So a few days after that, we went out on our first date, and we went to the mall, and she just talked for hours and hours. And we went to see *The Shining*.

01-01:02:59
Eardley-Pryor: Wow!

01-01:03:01
Schilling: It had just come out, a lot of good stuff about *The Shining,* we heard that in the newspaper. And it was the best date movie, because she spent so much of it cuddled up to me. It's just the craziest thing to do on the first date. But the best part about the date was just spending time with her and talking, and getting to know her. And that was great. She had a hard childhood. I won't go into details on that, but the one great thing about her dysfunctional family was that they were involved in the Masons and Job's Daughters. So these fraternal organizations, they were so popular when I was growing up, you know? And so her dad was in the Masons, her mom was in Job's Daughters. Oh, sorry, her mom was in Evening Star, that was what the women did. The group the Masons for men, Evening Star is for women, Job's Daughters was for young girls. So Cherrie was in Job's Daughters. And even though they didn't teach some specific religion in it, they taught about a higher power. And so it was then, because her parents weren't church goers. It was at that moment that she ran into Christians, because they actually had conversations, part of the rituals—very ritualistic organizations—part of the rituals were talking about the Creator. So it was through those connections in Job's Daughters that Cherrie became a believer in Jesus. So even though it was not a Christian organization, it led to Cherrie becoming a Christ follower.

So she was going to church when we met. So she was the reason why I started going back to church, because it was just something that she did, and I was comfortable being at church. I wasn't opposed to God. And it was just great to kind of reignite the passion in my faith again. So that's one of the best things that Cherrie did for me.

01-01:05:15
Eardley-Pryor: You had something to share together.

01-01:05:14
Schilling: It was connecting me back to Christ. Yeah, and it was something that we shared. So we went to the church that I grew up in, and Pastor Schultz was still there as an emeritus pastor, and I remember talking to him, and it was just great to see him again.

01-01:05:32
Eardley-Pryor: And probably wonderful to come back to this familiar place, and have Cherrie feel at home there.

01-01:05:37
Schilling: Yep. And my Aunt Lil was there. Her husband had passed away, again of a heart attack; the Schilling men seem to fall victim to heart attacks, especially if they're overweight. And so I'm trying to keep the weight down. So Aunt Lil was on the Altar Guild, and we would see her blow in and out of church. It's just a great experience, being back there again.

01-01:06:00
Eardley-Pryor: And when did you meet around, timewise?

01-01:06:04
Schilling: Beg pardon?

01-01:06:03
Eardley-Pryor: How old were you when you met Cherrie?

01-01:06:05
Schilling: Oh, how old was I? So we met in 1980. So that would make me almost 23.

01-01:06:12
Eardley-Pryor: Early twenties, yeah, great. And this is—

01-01:06:15
Schilling: She was a couple of years younger. She was born in June of 1960. She has a younger sister.

01-01:06:20
Eardley-Pryor: And she's also an Angelino?

01-01:06:24
Schilling: Yes. So she grew up in Arcadia, the Temple City High School's dreaded opponent. Arcadia was bigger and better funded than we were, but we were scrappy, so we tried our best to beat Arcadia High School in football.

01-01:06:39
Eardley-Pryor: That's fun.

01-01:06:40
Schilling: And we just grew up just a few blocks away from each other, which is really interesting. We both were on kind of the border between the two cities. So even though we spent twenty years growing up next to each other, we didn't meet until we met at my friend's house.

01-01:06:54
Eardley-Pryor: And "thank you" for your friend turning twenty-one that day.

01-01:06:55
Schilling: Absolutely. And I'm really glad that Linda convinced Cherrie to come, because otherwise, she would have stayed on the phone and consoled her cousin.

01-01:07:08
Eardley-Pryor: And at this time you were in college, pursuing your degree in chemistry?

01-01:07:10
Schilling: Yes.

01-01:07:11
Eardley-Pryor: Had you started to work at Sunkist at that point?

01-01:07:12
Schilling: Yes. Started about the same time, which was fantastic. So got the motivation from Cherrie, Cherrie was a straight A student at Cal State LA. She was getting a degree in social work, and we—I really thought she was going to stay in social work, and work, at halfway houses and things like that. But once we got to know each other and we started talking about children, it became clear that you can do social work at home with your family, right, in raising the kids. So that's what she chose to do. She really wanted to do that. So she's always had the two passions in her life; our children and her faith.

01-01:08:02
Eardley-Pryor: How soon after you met did you get married?

01-01:08:04
Schilling: About two and a half years. So we met on my friend's birthday, July 19, in 1980. And we got married September 25th in 1982.

01-01:08:16
Eardley-Pryor: Oh, that's great.

01-01:08:19
Schilling: Yeah. And she was living with Linda in an apartment in Sierra Madre. And so then we got a house together—a house—a rental. We rented a duplex in Temple City, not too many blocks away from our church, actually, the church where I kind of grew up. The other person in the duplex was somebody who I knew through high school. She was a friend of mine. Her last name is Shoemaker. Very similar to my mom's maiden name, Schumacher, but it's actually with a K. The woman had really amazingly curly hair, just different to see somebody with such curly hair, but so white. Jane. So when our son was young, he called her "Ane," because he couldn't say "Jane." So it was "Ane."

01-01:09:14
Eardley-Pryor: Oh, so you lived there all the way through the time your son was born?

01-01:09:20
Schilling: Yes. So we were there, let's see, actually our daughter—also grew up there in that duplex. The one thing that we had to develop was a fiscal discipline to live off of one paycheck. The Sunkist paycheck just wasn't going very far, and it was tough. Those first years were really lean years, living off that one paycheck. And the duplex was about all we could afford. So we were blessed by Aunt Lil, who didn't have children. And when she passed, Cherrie was very involved in taking care of my aunt after she had a stroke. And we visited her at the board and care facility. We took care of her for about nine months until she passed. But we were really blessed in that she left a small amount of money to us that we could actually use as a down payment. So without that, I don't think we'd ever have a house, because the salaries just can't keep pace with home prices here. So we use that money, and we already had Nicholas, our oldest son, Katie, our younger daughter. Then the four of us then moved to a small condo in Azusa, which is north of Cal Poly.

So we've never gotten very far from home. It's the native Angelino blood that courses through our veins. And that's where the kids really grew up, and they spent many years there. We got to know all the people in the condo. The good thing about being in Azusa, and Azusa, I think, was an Indian name. But the city founders like to say everything from A to Z in the USA can be found in Azusa. The great thing was, it was—how would you say it? It was a fairly poor community, so the state had invested a lot of resources into the school system, especially the kindergarten and grade school system. So they were recognized by the state as excellent schools. So we really had the benefit, even though we sent our kids to public schools. They were excellent public schools.

But the quality really dropped off after junior high. That's when the gangs started to become more obvious on campuses, and we really didn't want our kids to go to a school system where there was gang violence, and just that whole vibe, if we could afford it. So we sent Nicholas to a parochial school for one year. That was really a financial stretch. Then we just decided it's time to pack up, leave our condo in Azusa, and move to another city that had a better middle school and high school. So once Kate finished her grade school, elementary school, then we moved to West Covina, which is, again, even closer to Cal Poly.

01-01:13:05
Eardley-Pryor: When was that?

01-01:13:05
Schilling: Ooh, good question. When was that? I could probably back-calculate. But that would have been when Nicholas was going to go to high school. Or, junior high. Yeah.

01-01:13:17
Eardley-Pryor: Okay. Well, we'll get into more of that. I want to make sure that we don't leave behind some of the—this is really rich storytelling.

01-01:13:26
Schilling: Right.

01-01:13:27
Eardley-Pryor: One thing I definitely want to make sure we get into is your experience in the lab at Sunkist. This is your first introduction to some of this instrumentation—

01-01:13:35
Schilling: Absolutely.

01-01:13:35
Eardley-Pryor: — that you've become a world expert in, here at the Getty. So tell me a little bit about that. What was this lab like? What was the learning process like? What are your memories from that?

01-01:13:45
Schilling: So in that Fresh Fruit R & D Lab at Sunkist growers, it was staffed by temps. We worked for the Kelly Temp Agency. It was really neat, a neat experience to be part of that because it was easy for Sunkist to hire temps, because we can try them out. If they work out, great, they stay. If they don't work out, okay, fine. I think that's why Cal Poly did that specifically, through a temp agency, so they could convince these labs to hire the students. If it doesn't work out, no problem, you're not committing to anything.

So we were all temps working in the lab. It was really interesting. Some of us went to Cal Poly, and some of us not. So we were all working there for this temp agency. And we were all about the same age. It was just a great experience to be in the lab, and to actually do what I was learning how to do at Cal Poly Pomona. So having access to a gas chromatograph for the first time, liquid chromatograph. Atomic absorption spectroscopy—these are all things that we had a limited access to at Cal Poly, but we could actually use them daily. We did water analysis, because we didn't want to pollute the water at these packing houses, so they sent us a liter of water that was destined to go into the sewer system, just to make sure there were no heavy metals and things like that. So everything was carefully controlled and monitored for safety, and environmental safety. So that was just a great experience to do that.
We would get these assignments, so the assignment would come in. There would be a case of lemons, and they were really the best lemons and oranges and grapefruits that I'd ever seen, because Sunkist would reserve the highest quality fruit for overseas markets.

01-01:15:59
Eardley-Pryor: Interesting.

01-01:16:00
Schilling: Because they paid so much more for them overseas. So even though our fruit looks great here in the Southern California grocery stores and produce stores, it looks much better overseas because they were willing to pay ten times,

fifteen times, twenty times what we paid for the same fruit here. So they always got the best stuff. So the boxes of fruit were astonishingly high-quality. And I just remember the smells in the lab. Every time I have an orange or make lemonade or something, I flash back to those days of Sunkist, because that was my income. That was my life and livelihood. That's what I was doing when Cherrie and I got together.

01-01:16:43
Eardley-Pryor: What was the difference, then, from your work in the lab after meeting Cherrie, when you said motivation changed for you?

01-01:16:51
Schilling: Yes.

01-01:16:52
Eardley-Pryor: How did that reflect in your working life, then?

01-01:16:55
Schilling: I was always motivated at work, but I was more motivated at school, so at university. Then I just applied myself more. I saw how hard she studied to get those As. Then I thought, I should try and match that intensity and dedication. I'm still pretty fluffy about doing certain things, I have to admit. But she was a good motivator. Then again, the great thing about being at Sunkist was it provided, beyond a shadow of a doubt, that I had what it took to succeed as a chemist, right? And that made all the difference. All the difference in my academic career, because I knew I could do it. Once I knew I could do it, then doing the extra effort that was needed to do university-level chemistry, and not high school chemistry, now it made total sense to me.

01-01:17:49
Eardley-Pryor: It became worth it to learn it.

01-01:17:51
Schilling: Yeah. Exactly.

01-01:17:51
Eardley-Pryor: Worth it to learn and dig in.

01-01:17:52
Schilling: Exactly. Exactly.

01-01:17:55
Eardley-Pryor: Did you make the transition, then, from the temp to being a full-time employee at Sunkist?

01-01:18:00
Schilling: I wanted that so badly. And I was so disappointed when they said, no, we don't really do that. If we hired you, you would actually make less money, because then we'd have to deduct your benefits from your salary, right? Now,

whatever you earned working for the temp agency was take-home. Then we didn't have health benefits, right? That was a fact of life back then.

01-01:18:25
Eardley-Pryor: I remember those days.

01-01:18:28
Schilling: Yeah. That was discouraging, it really was. But like so many things in life, when you run into these—like a crisis, when something's not going well, it gets you out of your comfort zone. So I would have been comfortable still working at Sunkist, probably, if it still exists, I don't think it exists anymore. But I would be comfortable in doing that. But it forced me—that and, again, having an extra mouth to feed, single income—now looking for another job wasn't a luxury. It was a necessity. It was a real necessity. But for those almost two years, it was just great to get to know the people there, to work on this equipment, the connection back to school at the university. Again, it was just fun. It was a fun job. When I was there, it was the crisis period in Southern California, the Medfly. You might not remember that one.

01-01:19:36
Eardley-Pryor: I was not here [in California] then, not at all.

01-01:19:38
Schilling: The Mediterranean fruit fly invaded Southern California, and all of the citrus groves and orchards in Southern California were threatened by this pest. It was not native to LA. It came from the Mediterranean region, so it was the Medfly. Actually, when we were living in Temple City at the time, I remember in the middle of the night helicopters flying overhead spraying Malathion on everything, to try and eradicate the Medfly.

01-01:20:08
Eardley-Pryor: Wild!

01-01:20:11
Schilling: It just sounds crazy.

01-01:20:09
Eardley-Pryor: Yes.

01-01:20:11
Schilling: Can you imagine that happening today, you know? Like, the helicopters from Apocalypse Now, da-da, da-da-da, da—and the big spray nozzles, and they would just spray this—what was it? They called it something special. It wasn't just a pesticide, it was in almost like a jelly kind of material. It was like a high-viscosity liquid. And it got on the cars, and it got on everything. It was outside, so bring the pets in. Don't be outside when we're aerial spraying, you know? Malathion, to try and eradicate the Medfly. It was bizzaro. It was bizzaroland in LA at the time.

01-01:20:54
Eardley-Pryor: That's crazy. So—

01-01:20:56
Schilling: I don't know if it ever really worked. I think they just learned to deal with it in different ways.

01-01:21:02
Eardley-Pryor: What was the reaction at Sunkist, in the lab?

01-01:21:04
Schilling: So the interesting connection, and back to Sunkist, was, at that same time, then, the clients of Sunkist, the packing houses overseas, didn't want their fruit that they were allowing into the country to be contaminated with Medflies. So what Sunkist had to do was, apply a pesticide to the citrus fruit after it was loaded into container ships that were going to go across the ocean to these Asian markets. So they had worked out a way of introducing methyl bromide as a pesticide in the cargo hold of the ship. So the ship was loaded down at the port of Long Beach with crates of citrus fruit, and then a small amount of methyl bromide was introduced in the vapor phase, kind of heated, basically. That liquid was heated, boiled off, and it was distributed through the HVAC [heating, ventilation, and air conditioning] system, air conditioning system, in the cargo hold. So they had me measuring the concentration of methyl bromide in the air, in the cargo hold, while I'm wearing a scuba outfit.

So I'm in a scuba outfit, crawling around in the crates of citrus fruits in the cargo hold of this container ship at the port of Long Beach, and I'm surrounded by EPA people, Environmental Protection Agencies, OSHA [Occupational Safety and Health Administration]—all of these people are standing out with clipboards and things like that, no protective gear. I'm wearing protective gear standing right next to them. And I'm thinking, okay, it's probably not as bad as this garb is implying, if they're willing to stand there next to me with no protective gear. It just seemed really ludicrous. But anyway, they weren't the ones crawling around in the ship, I was. So would collect samples of air and things like that from the cargo hold, and those would be sent off for analysis. We didn't do that analysis, I just would collect the samples. Did that once. That was enough.

01-01:23:20
Eardley-Pryor: That's a crazy day at work.

01-01:23:21
Schilling: It was a really bizarre evening, yeah. It was a long twenty-four-hour shift. And I was pooped out by the time I got home, I have to admit.

01-01:23:28
Eardley-Pryor: That was a twenty-four-hour shift?

01-01:23:31
Schilling: Yeah. Yeah, because it happened in the middle of the night. They didn't want this to happen during the day when there were a lot of people out. So it was, 2:00 in the morning, down in Long Beach.

01-01:23:42
Eardley-Pryor: Because they didn't want the publicity for it?

01-01:23:44
Schilling: Yeah, I think it was a lot of different things. Maybe the publicity, maybe the risk involved. It was the only time I ever got involved in that. I don't know exactly how many times they did it, but eventually they abandoned that idea. And they just found another way of dealing with the risk of pest infestation.

01-01:24:05
Eardley-Pryor: What were some of the toxicity concerns with either the spraying or this methyl bromide that was an issue?

01-01:24:10
Schilling: The methyl bromide is a fumigant, it's just a nasty chemical. That's why I had to wear the full gear, yeah. And it was in low enough concentration, you know? It's fairly toxic, so it didn't have to have a lot of it to kill the bugs.

01-01:24:24
Eardley-Pryor: And this is the stuff in the lab, when you're not in the field like that, in the lab you're also measuring the content?

01-01:24:28
Schilling: In the lab, I never looked at that one. That was one that we never dealt with. Again, those samples would have been sent out to some other lab that was used to testing for that particular pesticide.

01-01:24:38
Eardley-Pryor: So there's different kind of fungicides that you were measuring within the lab?

01-01:24:41
Schilling: Fungicides are different. The pesticide is something to kill insects. Fungicides—and again, the pesticide is applied in that container ship to make sure there are no live Medflies when they open it up in Japan, and start offloading the crates of fruit. Fungicides are compounds that are added to the protective waxes that the fruit is coated with before it goes into cold storage, so that mold doesn't grow all over the fruit. So it's in the wax. Again, it's kind of washed off when the fruit emerges from cold storage and before it goes to the market.

01-01:25:23
Eardley-Pryor: Oh, I see.

01-01:25:23
Schilling: Yeah, so it's an interesting process.

01-01:25:26
Eardley-Pryor: Were there any concerns about measuring those kinds of things in the lab?

01-01:25:28
Schilling: Not so much, because we're chemists. We're used to dealing with things. We're used to protective gear and low concentrations, working in fume hoods, and use gloves, and all of that; lab coats, and you name it. That's part of the charm of being in the lab, you know? If you don't like that stuff, you probably aren't cut out for the lab. But you know the risks and you know the precautions to take. It's no big deal, you know? You take your life in your hands when you're on the freeway, right? And how much training do you get for that?

01-01:26:04
Eardley-Pryor: Tell me a little, if you could, about the training itself. In the Sunkist Lab, you're using these instruments you don't have much experience with. What was the teaching process like for you? The learning process?

01-01:26:10
Schilling: Those other temps, then, the ones with more experience, would train the ones like me with less experience. So a carton of fruit comes in, oranges, and we have to measure some fungicide on it. So that person would show me, okay, here's how you extract the fungicide to do this kind of analysis. So the type of analysis dictated the treatment procedure, the extraction procedure. So there's some fungicides that just reside on the very surface of the peel, and they never get into the peel and into the fruit. So for that, for that type of analysis, there was a protocol that you followed. They developed these protocols, and they would follow the protocol that was specific for the chemical that they wanted to analyze. So in the case of the ones that the fungicides that just resided on the surface of the peel, you could put the fruit into a large glass jar, this tall, this big around, wide-mouth jar, pour it in, and half a liter of solvent. Then cover the jar, put it onto a tumbler. So the fruit would just tumble in this jar. You would leave it on the tumbler for X-number of minutes, take it off, decant, and discard the fruit then, and then analyze the stuff that the solvent extracts. You would use whatever technique was the best for that particular analysis, so the protocols were things that were already developed that were taught to us by the more experienced technicians.

01-01:27:52
Eardley-Pryor: And those technicians were all temp agent-supplied technicians?

01-01:27:55
Schilling: Yes.

01-01:27:56
Eardley-Pryor: That's a fascinating economic system/model.

01-01:27:58
Schilling: It was really interesting, because it's not rocket science. By the time you're a junior level at Cal Poly, you would have already had analytical chemistry,

quantitative analysis, so the educational experience was essential. You couldn't just take someone off the street to do it. You had to have some knowledge of what it is that you're doing. Again, the safety things, which we would have been taught at school, were important.

01-01:28:29
Eardley-Pryor: And protocols are something that you have developed here, and shared with others?

01-01:28:35
Schilling: Yes.

01-01:28:34
Eardley-Pryor: I am imagining, was this your first experience of following these kinds of protocols? Learning what is required in a protocol, to then later in your career be the developer of them?

01-01:28:46
Schilling: Sure. Yeah, it's interesting. Again, I mentioned the labs, kind of the bane of people who like to whiteboard everything, the doers and the thinkers, you know? And in chemistry, you have some really outstanding experimentalists. Then you have some outstanding theoreticians. Those are kind of the two camps. And people usually fall into one camp or another, they're either great at coming up with new ideas that other people who are skilled in the lab carry out, or they're really outstanding in developing new test protocols and new equipment, and things like that. So there is that division in chemistry. There’re so many ways of dividing up the chemistry pie. But that's kind of the two big buckets. So the people who like the lab liked following protocols.

So you get in the lab—let me backtrack—if you're taking a chemistry class like organic chemistry, if you were a chemistry major, you also had to take organic chemistry lab, three hours, twice a week. So the people who weren't chemistry majors didn't have to take that. They just had to be exposed to chemistry terminology and principles. So me, I'm a chemistry major, so I would have to take that class. So then there's a lab book. Each week had a different protocol to follow. All right, tonight, or this week, we're going to measure molybdenum in solution. So you're going to use this machine, you're going to follow this protocol, and you're going to get the answer. Then you're going to explain the accuracy of your answer. And if it didn't live up to what you expected it to be, why didn't it? What could have gone wrong? What could have affected the results, you know? So the error analysis, where the errors creep into our work, because every measurement has a certain error range, you know? It's some number, plus or minus another number. So the better you are, the better the protocol, the smaller the plus-minus number was. So those protocols were good, reliable, robust protocols that undergraduates could follow.

But somebody had to make those protocols, right? So there would be somebody who's, again, good in lab work that could craft it in a way that all of the necessary information is embedded in the protocol. It's all there. You don't have guess work. Poor protocols would be things that you often see in the literature, where in a publication, a scientific publication, there's all this space for experimental, but it's always a little too short to give you all of the information that you really need to reliably repeat the writer's work. And science is all about reproducibility, repeatability. I want to be able to reproduce what this scientist did in the lab. And so my source of knowledge, then, comes from that protocol that's described in the experimental section of a publication. So at school, the protocols were robust, they were well-written. Every last detail that could affect the result is somehow reflected in the detailed protocol. We had those protocols at Sunkist also. The more experienced people, who were actually salaried people that ran the lab, developed these protocols. They taught them to the temps. And the new temps, like me, came on board. I learned them from the more experienced temps. So that was kind of the food chain there, and where the things came from.

So the great thing about, again, Sunkist, the co-op ed program, was that they liked my work at Sunkist, and they saw that I had enough promise to allow me the luxury of time to develop a protocol to test for a more effective fungicide that could be applied at lower concentration, that was safer than the other fungicides they were using. It was called imazalil. That was the trade name for it. So I worked with my supervisor, and we realized that liquid chromatography, or LC, was the method to use. It wasn't volatile enough to be analyzable by gas chromatography, but you could dissolve it all right, and you could then put it through a liquid chromatograph, and you could measure the amount of it by the size of the peak. If you have a little bit of it, you get a small peak in the chromatogram output. If there's a lot of it, the peak's much bigger. You can make a calibration curve, then, where you make standards of imazalil and solution, different concentrations. You make a calibration curve. They're generally a straight-line curve. You put a proportional amount in, you get a proportional response. A nice straight-line calibration, peak area versus concentration. So if you know you have an unknown, you just extracted off the lemons, extract it, analyze it, you get a certain peak size, you can read over that peak area, read down to concentration. That's how you can measure the concentration. Then you back-calculate to the number of PPM [parts per million] or PPB [parts per billion] on the fruit.

01-01:34:20
Eardley-Pryor: So you developed this protocol—

01-01:34:22
Schilling: That was the protocol that I developed then, in my last year of working there. And in my senior year at Cal Poly, all of the chemistry students had to do a senior project. So mine was work-related. It was great, because I was getting

paid to do my senior project. I loved that concept. I really liked that idea of doing it and getting paid to do it at the same time. So that's what I did. I developed a protocol and published it with my supervisor there at Sunkist, Sri Pfuntner was her name. She was the head of the lab. I actually presented that—

01-01:35:02
Eardley-Pryor: You published the work that you did there?

01-01:35:02
Schilling: Published that, yeah. And actually got a chance to present it at a local American Chemical Society meeting. I was petrified, I had never done that before, I had never spoken at an ACS meeting—there's the acronym, American Chemical Society. So it was a local meeting. Petrified, but I gave that presentation of our work. It was fantastic. I got a senior project out of it, Sunkist got a new validated method out of it. We got a publication and a presentation. So talk about bang for the buck.

01-01:35:37
Eardley-Pryor: That's a fantastic experience through an undergrad education program.

01-01:35:40
Schilling: Yes. Absolutely.

01-01:35:39
Eardley-Pryor: Remarkable.

01-01:35:41
Schilling: All of those little steps along the way to maturity, as being a researcher were kind of checked off in that one experience.

01-01:35:51
Eardley-Pryor: I have a note that you were, in 1983, you were twenty-five when you got your Bachelor of Science in that final year at Cal Poly.

01-01:35:58
Schilling: Yes.

01-01:36:00
Eardley-Pryor: But the year before, you had said, is when you and Cherrie got married.

01-01:36:02
Schilling: That's when we got married, yes.

01-01:36:06
Eardley-Pryor: Tell me some of your memories of your wedding.

01-01:36:06
Schilling: Oh, it was wonderful. It was at our church, the one—no, sorry. I was living in Upland at the time, so it was the church that my parents went to, Christ Lutheran Church. So we got married there. It was a really nice day. My friend,

Dave, was my best man. It was just a great experience. Had a reception at my parents' house, it was so much fun. After that, we stayed one night down in Orange County. Gosh, what hotel was it? I can't remember the hotel. It was a special hotel, though. But next day we packed up, and our honeymoon was in Yosemite.

01-01:36:57
Eardley-Pryor: Wow.

01-01:36:58
Schilling: So we made the drive to Yosemite. Then after spending some time there, we went to visit one of Cherrie's cousins in San Francisco. It was my first time—and our first time to be in Yosemite, and San Francisco. So it was really neat. And that trip was when I learned that there's more shades of gray than black and white. I tended to be a black and white kind of person when it came to issues and ideas. We had our first real argument in the car on the drive to Yosemite, over that idea. I can't remember what the topic was, but Cherrie convinced me that really, on a lot of issues, there's gray. You have shades of gray, not black and white. I sure wish our politicians would understand that. I wish Christians would understand that. I wish people would embrace that idea, that there is just a spectrum, and not these two camps. There don't have to be two camps.

01-01:37:59
Eardley-Pryor: As a scientist, where science is often trying to find this definitive answer, this reductive process down to, "it is black or white, it is this or it is this"—how does that reality that the world is much more diverse in its grayness—or the diversity of colors, rather than just black and white—how does that play into your approach as a scientist?

01-01:38:23
Schilling: I think, in a way, being a scientist helps understand the limits of science. Your result is only as good as the experiment that you're using, and the thought that's gone into it. So I think there's a lot more subtlety to the scientific results than are implied in the popular media. Great example, really great example is cold fusion. We were living in Temple City at the time. We got the *LA Times*, it was one of the luxuries that we had, was buying the *LA Times* daily. And headline "Cold Fusion." And I looked at Cherrie, I said, "This is going to change the world. No more fossil fuels. If they can generate fusion energy without a fusion reactor, energy shortages are a thing of the past," right? It had such incredible promise.

01-01:39:21
Eardley-Pryor: Especially in the early eighties when the energy crisis was still pretty fresh.

01-01:39:25
Schilling: Oh, it was incredible, yeah. Boy, those long lines at the gas station were horrifying for somebody who just got their driver's license. Is this going to be the new norm now? But cold fusion had such potential. And at the time, it was

published—their results were disseminated to the media before other researchers had a chance to really go over the protocol, and reproduce what the authors did in the lab. And it turned out there was some really obscure aspect to the experiment that they would have never really dreamt of. They would really have to be incredible researchers to understand all the nuances of the experiment. And it turned out, it was that nuance for which they were unaware, that really invalidated their experiment. But it took a lot of researchers a lot of time to verify it, that that result was not reproducible, and here's why it wasn't reproducible. It just turned out it was a contaminant in the—I think it was a palladium electrode. And there was helium gas, I think, in the electrodes. It was a very obscure thing. But it was just part of it, through the manufacturing process. And it was released.

01-01:40:53
Eardley-Pryor: It tainted the results?

01-01:40:52
Schilling: That gas was released, they were measuring that gas. "Oops." So yeah, the black and white, gosh, the black and white is just everywhere. It's gray, it's subtle. There's always something in the experiment that could be better, that we could better understand, you know? Certainly Newton's laws kind of up-ended by Einstein, there's still that continuum. But when looked at from a different perspective, there is more data there than our sensors were capable of really understanding. Came out of a thought experiment, and now gravitational waves, were discovered recently. The images of the black hole that matched what they predicted—so who knows what the new norm will be in, a hundred years, when our minds are sharper, when we're more aware of those subtleties of the thing that we're trying to model and reproduce in the lab. Who knows where we're going to be, you know? There's just so much more to the world than what we can really understand. And certainly in political issues, it just brings people together if you just decide that they're not Satan. If the other guy is not Satan, but just another version of you from another background and lifestyle—okay. We have common ground. And maybe these issues aren't so cut and dry.

01-01:42:26
Eardley-Pryor: It's a great way to bring that together. Let's take a little bit of a break here, before we move in to talk about the post-collegiate experience.

01-01:42:32
Schilling: Okay. It was a high school recollection.

01-01:42:37
Eardley-Pryor: What is it?

01-01:42:37
Schilling: So the one science recollection from high school that was happening in the world was the discovery that aerosol propellants were damaging the ozone layer.

01-01:42:45
Eardley-Pryor: CFCs [chlorofluorocarbons].

01-01:42:49
Schilling: And it was such an incredible time, because there was so much opposition to this concept that what people are doing for these commercial products, and these consumer products, could actually be making their way into the stratosphere where the ozone layer is, and damaging the ozone. So it was really kind of the forerunner of the whole global warming, kind of an echo of that. But the interesting thing was, industry and governments mobilized, and they took it seriously, because they could actually measure the size of the ozone hole, saw it was increasing. And that came out when I was in high school. So I actually gave a presentation on that in, a social studies class. It was this cutting-edge research was going on—

01-01:43:38
Eardley-Pryor: In the mid-seventies?

01-01:43:43
Schilling: In the mid-seventies. Cutting-edge research going on, oh gosh--

01-01:43:48
Eardley-Pryor: Scripps, I believe.

01-01:43:50
Schilling: No, University of California at—oh, rats.

01-01:44:00
Eardley-Pryor: San Diego?

01-01:44:01
Schilling: No. Irvine.

01-01:44:02
Eardley-Pryor: Oh.

01-01:44:02
Schilling: So the researchers that were studying it, Rowland and Molina were researchers at University of California at Irvine. And that was the groundbreaking research that showed that how the propellants are inert, stable chemicals, but once they get high enough into the atmosphere, they react with the UV light, break them up into free radicals, and those free radicals would start gobbling up the ozone.

01-01:44:28
Eardley-Pryor: And this is in high school?

01-01:44:30
Schilling: That was in high school. And it was such a big deal at the time. And it led to new technology, new refrigerants, new propellants. Just a new way of looking at things that were environmentally friendly.

01-01:44:45
Eardley-Pryor: Did it have a role in shaping your thought about becoming a chemist?

01-01:44:46
Schilling: Yes. That was definitely just another cool thing that was happening at the time. I already knew I wanted to be a chemist, but I guess that sealed the deal, maybe. Yeah.

01-01:44:57
Eardley-Pryor: And it took another ten years before the Montreal Protocol was signed for the world to control this issue in '87.

01-01:45:02
Schilling: Yeah, there was a lot of inertia, wasn't there?

01-01:45:05
Eardley-Pryor: You were right at the cutting-edge of understanding this process had been just realized, let alone the political global process that it took ten years to try to control.

01-01:45:15
Schilling: Right.

01-01:45:13
Eardley-Pryor: That's really cool. So you talked about [how] you did this really wonderful employed senior experiment, while you were a senior, while you were finishing up at Cal Poly.

01-01:45:27
Schilling: Mm-hmm.

01-01:45:29
Eardley-Pryor: What were your thoughts about what your next steps were, if you knew the Sunkist position wouldn't offer you a full-time opportunity?

01-01:45:35
Schilling: Right.

01-01:45:34
Eardley-Pryor: What were you thinking as you were finishing your degree, what the next steps were for you and Cherrie?

01-01:45:39
Schilling: Sure. At the time, I knew I was going to stay in chemistry definitely, and just started looking at ads in the *LA Times*. That was when the *LA Times* had big Help Wanted job ads. At the time, it was Memorial Day, so that's a time when a lot of colleges are graduating people, and these newly-minted chemists are going to want jobs. So we got the *LA Times* that day, the big, thick *LA Times*, pulled out the job ads, looked through them, and at the time, where were so many jobs for bachelor's degree chemists and associate degree chemists, working in the lab. And I thought, great, it shouldn't be hard to find another

job. As much as I wanted to stay with what I knew, what I was comfortable with was Sunkist. I knew that on a single income, because Cherrie and I decided we wanted children, and just couldn't make it on that salary. So looked at that one ad, and it was for the J. Paul Getty Conservation Institute. And they wanted an assistant scientist. I had no clue what conservation science was, had never been to the Getty Museum. Had no clue that there was science involved with art at all.

So I called them up, because I called the number, had questions. The person who answered the phone was the staff assistant of the director of the museum. I asked that person, "What does an assistant scientist do at the Getty?" She said, "I think you would X-ray paintings." I thought, that sounds completely cool. So they only accepted applications for a week. So I filled out my resume; they were resumes at the time, they weren't CVs [Curriculum Vitae], not for a person with a bachelor's degree. And I waited a little too long, so I drove out there. I got permission to drive out there on Friday, drove into the Getty Villa Museum—at the time, there was only one museum, it was the Getty Museum, it was in Pacific Palisades—

01-01:47:45
Eardley-Pryor: Which is a heck of a drive from where you're living.

01-01:47:49
Schilling: It was a long haul, yeah. I'd never been out there, never even been to the West Side that much, the West Side of Los Angeles. Certainly not the coast, on my own. And I drove in, and it's a cobblestone road. I was greeted by a security guard in a suit and tie. And I thought, they will never, ever hire somebody from Cal Poly Pomona with an undergraduate degree. Certainly they're going to want someone with a PhD from UCLA, Cal Tech, USC, right? But I thought, no, I drove all this way, I'm going to at least turn in the darned application. So I was directed by one of the nice security guards to the office. I met the staff assistant there. She handed me a job application form. She said, "Well, since you're here, you might as well fill out the application form, too." I handed in my resume. I printed up a copy of my undergraduate project, looking for imazalil. I thought, well, I'll show them that I know how to develop a method, right? So I left that. I filled out the application. And I was satisfied, I looked around. I thought, this is beautiful, but I'll never work here. It was fun to see it, I'll have to go out with Cherrie, take her out here sometime.

And a few days later I got a postcard in the mail of the Getty Museum, and they thanked me for applying. So I still had that postcard. I really thought that would be the extent of my Getty correspondence. But strangely enough, I got a call. I got a call from them that they wanted me to come out for an interview. And I was overjoyed at that.

01-01:49:29
Eardley-Pryor: At this time, were you thinking of other opportunities, too? Were there other places you would apply, or were thinking about?

01-01:49:35
Schilling: I was, actually. There was one other career path I was considering, and again, it's one that chemists with a bachelor's degree would do, and that would be criminalistics. So forensics science. And there was a job opening at the LAPD, Los Angeles Police Department, in their forensics group. So at that time, they had a number of vacancies. But because it's a civil service job, there's a hiring list. So they have to go through all the names on the hiring list before they can get a new list of potential employees, right? So they have to burn through all the names before they can start interviewing new people. So once they got to the bottom of that list, then they got in touch with me and said, we're going to have the civil service exam being offered, come out and take that. So went to take the civil service exam there, I did well on that. There were hundreds of people there taking the test, and I think I was second or third on that list. So I felt good about that, okay, I'm high enough on the list. Maybe I can get a job here sooner rather than later.

01-01:50:55
Eardley-Pryor: What kind of work do you think you would have been doing?

01-01:50:58
Schilling: That would have been forensics work, so CSI [Crime Scene Investigator] type stuff. Go out to a crime scene, late at night, you're on call. Collect evidence, bring it back to the lab for the forensic examiners. The forensic scientists would analyze fiber, paint—whatever. Whatever the evidence was. So again, science using the same kinds of machines, more or less, that I would have used at Sunkist, or that I use now here. We're just pointing and shooting at a different kind of sample for a different purpose. That's the great thing about being an analytical chemist, is that one background equips you to study a whole range of things, a whole different range, or career opportunities that are ahead. So I had these two career paths kind of competing with each other, pacing each other.

01-01:51:49
Eardley-Pryor: And at the same time that you were taking the civil service exam and did well on it, was also when you had already applied with the Getty?

01-01:51:55
Schilling: Yes.

01-01:51:54
Eardley-Pryor: And got this postcard.

01-01:51:55
Schilling: So I did both of them at the same time, and I was just wondering, who would I get a job from first? So I got this call, please come out for an interview to the Getty. So I did. And I went to a part of the Villa Museum; it was down in one of the Antiquities Conservation labs, it was a small lab. There were conservators working there. One of them was cleaning volcanic ash off of some terracotta figures, the Orpheus group, it's a famous sculptural group in

the Getty collection. And I saw it actually being conserved under a microscope, with a small scalpel tool, just scraping away slowly this volcanic residue, and exposing the actual surface of the object, just painstaking work done by conservators. I have nothing but admiration for them, because they're so detail-oriented, and they're willing to get into that Zen zone that we talked about, and do their work well.

So that's where the interview was held. Frank Lambert was the main who did the interview. Dr. Frank Lambert was a retired professor of organic chemistry at Occidental College; small liberal arts college in the LA area, in Eagle Rock, has a really great reputation for their undergraduate program in chemistry. They just produced some really wonderful scholars from that program. But Frank, at the time he was already retired from, he called it, "Oxy"—that's Occidental College, it's Oxy. He retired from Oxy, and he's just the most wonderful uncle-type figure, doing this interview. "Oh, Michael"—he had a deep voice— "Michael, now I want you to relax." He had a video camera like you have there. He's recording my interview. It was a weird experience, just to talk about yourself. And he just guided me, step by step, through the interview process. He made it easy, relatively easy, even though I was talking to him, I was really talking to the head of the department, the head of the Science Department at the Getty Conservation Institute.

01-01:54:06
Eardley-Pryor: And who was that then?

01-01:54:07
Schilling: That was Frank Preusser. And Dr. Preusser came from the Doerner Institute in Germany. He had a background in biopolymers. He became the head of Conservation Science at the Doerner Institute, which is a private organization in Munich. He was the person tapped by the Getty Trust to be the first Head of Science at the Getty Conservation Institute, and he was actually the first person hired for the GCI.

01-01:54:36
Eardley-Pryor: And the GCI [Getty Conservation Institute] was just forming at that point.

01-01:54:36
Schilling: The GCI was still on paper. So our first business card said, "The J. Paul Getty Conservation Institute." They're a keepsake now. You're not going to see that anymore. Now it's the Getty Conservation Institute. But anyway, yeah, he was the first person hired for the GCI, what became the GCI.

01-01:54:55
Eardley-Pryor: To build the GCI, essentially.

01-01:54:57
Schilling: Back in '83, and the GCI actually was founded in '85 when we hired our first director, Luis Monreal. So that's the official start date of the GCI. So Frank was hired to the GCI, two years before the GCI. So Frank Lambert was the

man who was tapped by Frank Preusser to do these videotaped interviews. I think Frank Lambert told me he interviewed thirty, forty people. He said there were about 130 applications that the two Franks, Frank Preusser, Frank Lambert went through.

01-01:55:36
Eardley-Pryor: And Frank Preusser eventually saw your interview?

01-01:55:40
Schilling: Yes. So he, Frank Lambert gave him all the videotapes, and he had my application. Frank told me I was the only person out of that 130 who actually came to the Getty and filled out a job application form. So that, and then my work, were two things that were different about my application.

01-01:56:06
Eardley-Pryor: He knew that you were a doer by coming all the way out here.

01-01:56:06
Schilling: Yes. Well, I think it was because I was lazy, too. That was the real reason, I just didn't get the application in on time, if I would have mailed it. So I wanted to make sure they had it. I'm sure they would have accepted it. But anyway, I just wanted to make sure. But I thought, okay, great. I had that interview, probably won't be hearing back from them, because surely they're going to want someone with a PhD. I just couldn't imagine a high-profile place like the Getty hiring a person with a bachelor's degree that came from Sunkist, and not from another cultural heritage organization. But to my surprise, I got a call again later from the Getty, and it was Frank Preusser. And he wanted me to come out for a final interview. So I thought, a final interview with Frank Preusser? Great!

So there were four of us that were called back for a final interview. And it was with Frank Preusser—nice man. Booming voice. You could hear him without a microphone, easily, throughout the interview. [Strong voice] "Michael, how are you? I'm Frank Preusser." That's the way he spoke. Heavy German accent, just a nice man. Very knowledgeable about the field. Very willing to share his knowledge with me, which was great. And one of the things that he told me that kind of put me at ease was, he wanted to build up his science program from scratch. He didn't want to have people who were already in the field, because he wanted to bring new life, new blood, new perspectives to his staff. And he said, "I want good scientists. I want good scientists, and I can train you in what you need to know. You'll learn conservation science by doing it," kind of going back to the Cal Poly mantra.

Again, I had no thoughts that I would be hired. So while I was waiting to hear back from the Getty, I'm interviewing at the LAPD forensics lab. I took the civil service exam, did well on that. Then I was called in for an interview. It was a panel interview. And I was terrified. I've never been so nervous. I was perspiring, and just waiting was agonizing. And it was a panel, it was going to

be a forensic scientist from the department. It was going to be a person in the administration of the civil service program. It was going to be a forensic science instructor from Cal State LA. And I was terrified, waiting. But when I came in for the interview, all of the apprehension melted away. And I just was as relaxed as I am now sitting with you. And it was a great interview. One of the things was, said, "Okay, pretend that you're an expert witness, and you're being called to the stand to explain something that you know how to do in the lab. I want you to address the lawyers and address the jury." He said, "Whatever you want to pick." I thought, okay, I'm used to this one instrument in the lab, I'll talk about it. The instrument uses light, you pass light through a solution, you can measure its spectrum. So you put a small amount of that solution in a cell, it's called a cell. So I said, okay, so I take a milliliter of it, I add it to a cell. And the guy stopped me. One of the people stopped me. "Wait, a cell to me is a jail cell. Is that what you're talking about?" And I laughed, and I said, "Oh, that's where we're going with this. Okay." And so from then on, I used layman's terms to explain what I did. And that got me through the interview.

01-02:00:05
Eardley-Pryor: And you're so great at explaining the science—the very technical science you do—in layman terms. It seemed to be kind of a revelatory moment for you.

01-02:00:13
Schilling: You're kind. Thank you. Yeah, it just was a great moment. It was really fun to be able to talk with them in that way, and to give them the kind of feedback that they wanted from me. So that was a good feeling, especially just thinking, boy, I really want a job. I really want a better-paying job.

So I found out later that I was second on the hiring list. So I thought for sure—they had eight openings. I thought, I'm going to get a job there. Fantastic! Then I get a phone call, when I was at Sunkist, and it was Frank. Frank Preusser.

01-02:00:52
Eardley-Pryor: Called you while you were still—you were still working in the lab there?

01-02:00:57
Schilling: Called me when I was working in the lab. And he said, "Do you want the job?" "Yes!" Cherrie and I had already decided that if the Getty job came through, that was the one for me, because as cool as it would be to do the CSI type stuff, it's looking at the worst of humanity, really. And it would be emotionally draining. And I think that's an experience that all good forensic scientists have to cope with, one way or another. They're seeing the worst that people do to each other, on a daily basis. And they're having to look at awful things, in awful places. So cultural heritage, easy. That was an easy pick.

So I hung up the phone, and I said, "Woohoo!" I was in my boss's office, she let me use her phone. And they all said, "Oh, he got the job!" So that was a

great day. That was a great day. And I got called into my boss's office later, and they said, "Well, maybe we can match your salary. How much is it?" I'm thinking, couldn't you have tried that earlier? I wouldn't have had to go through all this trouble. I told them it was much higher than what Sunkist was paying me. They said, "Good luck."

01-02:02:13
Eardley-Pryor: "Congratulations, young man."

01-02:02:13
Schilling: Yeah. So that was just a great experience, to go through that. I heard years later from Frank, one of the reasons they hired me, why they hired someone with a BS in chemistry, was that he wanted someone to help set up the lab. You don't need a PhD to help set up the lab, to buy stuff, unbox it, put it away properly. Just start things rolling. You don't need a PhD for that. And he said a PhD would have been bored, absolutely bored, doing that. So that was another reason why I got the job, was that I had the right background for that particular position.

01-02:02:55
Eardley-Pryor: In that moment in time.

01-02:02:56
Schilling: Yeah. Yeah.

01-02:02:59
Eardley-Pryor: So what was some of the first work that you did? It sounds like a part of it was setting up the lab.

01-02:03:04
Schilling: Absolutely. Setting up the lab, setting up the office. Our first office was the lounge, the women's lounge in the ranch house, which was the original museum, before the Villa Museum was built. So we had our first office there. We had this couch that was enormously deep so our legs could lay on a—it kind of felt like a child sitting on a sofa, legs sticking out, kind of pulled up a table like we have in front of us, and that was our first office. Again, contacting vendors, getting catalogs. That was in the day pre-internet, everything was on paper. You had to get catalogs, you write vendors. You call them. They send these enormously thick catalogs, *Fisher Scientific*, *VWR Scientific*, microscope companies, just making contacts, letting people know, hey, we're a new organization. We exist. We do cultural heritage research. Come out and visit us, get to know us and see what our needs are. So there was a lot of that.

01-02:04:05
Eardley-Pryor: Was Frank Preusser helping guide you through that? Or were you sort of left to your own devices on that?

01-02:04:11
Schilling: I was mostly on my own. But again, he was teaching me conservation science. So that lab that I got interviewed in, that was actually our first lab. We borrowed that space. We had some equipment that was already at the Getty Museum, an X-ray fluorescence spectrometer, it does elemental analysis. It's a point and shoot device. You can tell what an alloy is made of, what composition the glass is, or stone, that kind of a thing. We'd had a microscope—

01-02:04:38
Eardley-Pryor: So you would direct that at a painting or the object?

01-02:04:44
Schilling: At the object, yeah. And you could tell what elements were there. By knowing what elements are there, you can deduce something about what materials the object is made of, what the pigment is, what the alloy is. Is it a brass or a bronze, or gold or copper?

01-02:04:55
Eardley-Pryor: It wouldn't require a sample, so you wouldn't have to damage the item?

01-02:04:57
Schilling: No samples, no damage to the art. Yeah. So we would call it a "noninvasive tool," so we don't have to invade the privacy or space of the object. We don't have to sample it. It's a point and shoot. Nothing bad happens to the object. Invasive measures are things that I use now; take small samples and get the most information out of them. But at that time, we had a microscope, we had an X-ray fluorescence spectrometer. And we had a lot of enthusiasm to build the lab up as quickly as we could.

I was the third person hired by the GCI. Second person was Frank's staff assistant, Mary Riedel. And the fourth person was actually one of the four people interviewed during that final interview process, Michele Derrick. So Michele and I were the two junior members working for Frank Preusser as the department head, being advised by Mary Riedel, we were a foursome living in that little lounge area for a while. Then we got a bit more space in our office area, the next office was in the theater of the ranch house. It had a small theater for private showings. So there were a number of us with desks and printers and things like that, who worked in that space. That was an interesting space.

01-02:06:15
Eardley-Pryor: From the women's lounge to the theater room.

01-02:06:18
Schilling: To the theater. Exactly. We got our first computer terminal that was attached to the library. You could basically do searches for books and things like that, bibliographic searches. Had a dot matrix printer, incredibly loud, in a place with good acoustics, like a theater. So we got a Plexiglas box, sound shield,

put it over that. So again, that was our next place. And all the while, we were working in the small lab. Then we had a new lab built for us in a storage room of the Decorative Arts and Sculpture Department. They didn't need the space anymore, it was converted to a lab space for us, just for us. Particle board benches. We had our first equipment put there. Sorry, our own XRF [X-ray fluorescence spectroscopy] that worked better than the one we inherited from the museum. It had to be installed behind lead shields, so we had these lead shields on wheels that we would put between us and the object. A sight glass, you could look through there just to make sure everything's okay. Particle board benches, everything was kind of made for us on a temporary basis, knowing that they were going to remodel one of the gallery spaces of the ranch house museum area. Because the original museum was in this ranch house of Mr. Getty. So they were going to convert one of the spaces for us.

01-02:07:51
Eardley-Pryor: And this was all at the Villa? These are all different buildings throughout the Villa?

01-02:07:53
Schilling: It was when the Villa was called the J. Paul Getty Museum. So it predated that name.

01-02:08:00
Eardley-Pryor: Tell me, if you would, you mentioned going into the second lab space, it was really designed for your lab. But it was temporary.

01-02:08:07
Schilling: Totally temporary, yeah.

01-02:08:08
Eardley-Pryor: So what was the thought process about? "Now we have a new space, now we're really starting to get things moving, the gears are moving forward?"

01-02:08:13
Schilling: Yes.

01-02:08:16
Eardley-Pryor: What was the thought in what you wanted, when you could start thinking about designing your own lab space?

01-02:08:22
Schilling: What Frank did—and I think Jim Druzik and Neville Agnew already had oral histories done—they kind of explained the logic of Frank and where he drew his inspiration. But basically, he was recreating the kind of department that was already in effect at, say, the Canadian Conservation Institute, where it was broken up by types of studies, so preventive conservation, analysis, and the museum-related work, object studies, built heritage—things like that. So depending on the subject matter, the type of research, then there is equipment that goes along with that kind of naturally. So one of the things that you would use to study stone, for monuments and buildings, would be X-ray diffraction.

That doesn't work at all on coatings and binding media. So it's made for that kind of work, so that needed its own space, it needed its own power. It needed the cooling water—all of that kind of stuff. X-ray fluorescence—great for pigments on paintings, and like I said, metals and glasses, and things like that. It needed its own space and supporting supplies, and things like that. So really, the lab grew around Frank's vision of what we wanted the department to do, what activities were important for the Getty Conservation Institute, whose mandate was beyond looking just at the Getty collection. We had an international mandate.

01-02:09:54
Eardley-Pryor: From the start.

01-02:09:56
Schilling: Frank knew at the very beginning he was working with really brilliant people at the Getty Trust level, the first trustees that were put together. What you see here today was due to the visionary work of Harold Williams and Nancy Englander and the trustees, who were tasked with figuring out the best way, the wisest way, to carry out the will of Mr. Getty, who wanted the bulk of his fortune to go toward the visual arts. So they took that one small paragraph and created everything, they were true visionaries.

01-02:10:35
Eardley-Pryor: When you were working with Dr. Preusser to develop what became the Conservation Institute, what was the relationship between your lab, as it was growing, and the actual conservators on site with the museum itself? If you have this mandate that is much broader, there's more global service for conservators worldwide, and yet right down the hall, in a building next door you also have people doing that work—what was your relationship with others on campus?

01-02:11:08
Schilling: When Frank hired me and Michele Derrick, he had to decide, with his staff of two, who's going to do what kind of work. So with my background being organic analysis, LC and things like that, I thought for sure I would be doing organic analysis. He threw me a curve ball, and he assigned X-ray fluorescence and thermal analysis and microscopy to me. And he assigned infrared analysis and liquid chromatography to Michele.

01-02:11:37
Eardley-Pryor: And what was her background?

01-02:11:38
Schilling: Because of our backgrounds. She also had an organic analysis background. She had a master's degree at the time, and that made sense to Frank. And so my learning curve was incredibly steep, to learn all of those things from scratch. But it was my set of techniques that were of most use to the conservators, because they were interested in pigment analysis, alloy analysis of sculpture, glass analysis—things like that, that those techniques that I was

specializing in would be relevant. So I was the liaison, then, that worked the most closely with the museum conservators.

01-02:12:14
Eardley-Pryor: On-site?

01-02:12:15
Schilling: On-site. So we were still in the ranch house, conservation work was taking place in the basement of the Villa Museum. While we were waiting to have our lab—the renovation work in the ranch house to take place, where we'd move into the first lab that was really created at a high level specifically for our needs. And again, this was before we even had a director. But when the director was hired, then he started articulating his broader vision of what the Getty Conservation Institute would do. And that's when we all realized, hey, our activities are going to exceed the boundaries here in the museum, in the ranch house, basically. We had to find another place as our base of operations. And that's when they started looking for leased buildings in the LA area, where all of the GCI could be located except for the person who is the liaison with the museum collections, and that was me.

01-02:13:22
Eardley-Pryor: Oh, I see.

01-02:13:26
Schilling: So in '95. I remember this very clearly because our son was born on Halloween of '95. And that was when all of my colleagues who were working in the science department in that small space that we had in the ranch house lab—

01-02:13:44
Eardley-Pryor: *Eighty*-five?

01-02:13:46
Schilling: Nineteen eighty-five.

01-02:13:47
Eardley-Pryor: Eighty-five.

01-02:13:49
Schilling: So we had other people like Eric Hansen, his boss Bill Ginell, Cecily Grzywacz, Ana Lisa Dia, Michele Derrick, all the other people, basically, then relocated to the Marina del Rey facility that was leased, and that was our permanent headquarters of the GCI. That was kind of the official founding date of the GCI. Again, I started at the GCI two years before, with Frank and all the other new staff, and got us ready and on the path to relocate to our more permanent facility, where all the different departments of the GCI were then able to work.

01-02:14:32
Eardley-Pryor: And that transition happened around the time that Nicholas was born?

01-02:14:35
Schilling: Yes. So I went on paternity leave, and I left the lab, with the full, bustling activity of the lab, all my other colleagues there. I came back and it was empty—just me and the conservators.

01-02:14:49
Eardley-Pryor: Because everyone else had gone to this Marina del Rey facility?

01-02:14:53
Schilling: Correct. Because I was the person that learned the techniques that were applicable to objects to the Getty collection. So then I stayed there for a while, for a few years. So I was there during the Challenger [Space Shuttle] disaster.

01-02:15:06
Eardley-Pryor: What's your memory from that?

01-02:15:09
Schilling: That was traumatic. It was just absolutely traumatic. The head of Antiquities Conservation at the time, Jerry Podany, had a great sense of humor. So he came by the lab one day, one morning, and said, "The Challenger exploded." I thought it was a joke. He said, "No, it really did." And it just floored me that that tragedy could happen. I didn't see it until I got home on the news. But that happened, and that was just a devastating thing for humanity, really, when that happened. Again, it just reflects the fact that science sometimes, when it's at the edge, is really at the edge of safety, even, and that it had all of that promise of going well, and it looked like it was going well, and it really wasn't.

01-02:15:55
Eardley-Pryor: You spoke, as a young man, [of] your inspiration that came out of the Apollo missions and Voyager, and then to have this tragedy happen.

01-02:16:04
Schilling: Yeah. Yeah, that was really terrible. But at that time it was just great to work with the conservators, and use XRF, we call it—X-ray fluorescence spectroscopy, or XRF. Again, it's a point and shoot, non-invasive type of test, so you could point it at a painting. So one thing that's important to remember in our field of cultural heritage research, it's hard to prove how old something is. It's easier to prove how old something is not. So the Getty Museum at the time was in the process of acquiring new art, because they had a much bigger budget because the will was settled and the endowment happened. So our operation expanded greatly because of those extra financial resources.

01-02:16:52
Eardley-Pryor: And that happened in the early eighties as well?

01-02:16:54
Schilling: That happened at that time, yes. So at that time, then, the Getty was acquiring more art, quite a rapid pace, actually. Again, since I was doing XRF, that is a great technique to look at mineral pigments on easel paintings. I remember a painting came in, it was on loan to us, it was a painting supposedly by

Ugolino di Nerio, and it was a panel painting, fourteenth century—very expensive price tag. Very expensive price tag. So I worked with Frank, Frank Preusser, our department head, and the head of Paintings Conservation at the time, Andrea Rothe, an incredibly energetic, fun man, really knew his stuff, also a German. Knew Frank back at the Doerner Institute in Munich. Anyway, the three of us were tasked with authenticating the painting. So everywhere I analyzed on that painting, and I looked at probably almost a hundred places, all I found were the elemental signatures of pigments that were made in the nineteenth century and beyond.

01-02:18:05
Eardley-Pryor: Wow, for the supposed fourteenth century piece!

01-02:18:10
Schilling: Correct. Everywhere I look. So Andrea Rothe said, "Yeah, but is it calibrated?" Because he couldn't believe it. He couldn't believe that it could be even possibly, even remotely possible that it was fake, or not authentic, not as old as it was purported to be. Yeah, it's calibrated, chromium pigments everywhere, cadmium pigments everywhere. And so it was interesting to see how the perception of the painting changed from, oh, it's got to be real to, oh, I knew that wasn't right. But it's funny, Frank Preusser knew it wasn't right. Because at the Doerner, he had ten years of experience of looking at paintings up close. Because the Doerner's collection is paintings, so he knew European easel paintings just cold.

01-02:18:59
Eardley-Pryor: And he knew by sight, because—

01-02:19:00
Schilling: He knew, yeah. You can learn an incredible amount about an object by looking at it under a low-power microscope, less than fifty times magnification. And you can see the crack pattern, you can see discoloration, fading, wear, dirt, layering of paints on paintings—you can learn so much by looking at that.

01-02:19:24
Eardley-Pryor: Was he teaching you that as well?

01-02:19:25
Schilling: So he's a skilled scientist. He developed that skill working at the Derner, because again, he came from a background of biopolymers. So he worked with Hubert von Sonnenburg, who was the head of paintings conversation at the Doerner. And he really learned paintings conversation and conservation science, science applied to art from Hubert. And so I learned it from Frank.

01-02:19:50
Eardley-Pryor: And was Frank teaching you these microscopic analysis techniques as well?

01-02:19:53
Schilling: Yes. We actually had a stereo microscope with two viewing heads, so Frank could pick a spot. I'd be looking at the same spot through my set of eyepieces. Together he would explain what I was seeing. So what did that real estate look like up close, up close and personal.

01-02:20:12
Eardley-Pryor: It's a great teaching method.

01-02:20:14
Schilling: It's amazing what he could see. I said, yeah, I see that crack pattern's not right. It should go through the end of the paint layer, and it's really at the surface. There are ways of making a painting look older. So the interesting thing about it is, not to disparage it too much—it definitely wasn't fourteenth century. And we saved an awful lot of money in not buying it. But it could have just been made for a wealthy person who really liked that kind of painting. Then it was made for that purpose, it hung in somebody's house, then it gets passed on generation to generation. Then suddenly, now, nobody knows what it was originally made for, and it looks like it's Ugolino di Nerio, right? So anyway, that was a funny thing. That justified my entire Getty salary, tens of millions of dollars for that painting. So I feel good about that. Early on, I justified my salary.

01-02:21:12
Eardley-Pryor: What was your experience in doing this analysis and getting these readings back that said, "Gosh, this doesn't seem to be what it's supposed to be"—what were your thoughts about your work?

01-02:21:21
Schilling: Boy, that was exciting, to see something I could really prove wasn't as old as it was supposed to be, right? If the elements would have been traced back to pigments that were available at the time, I couldn't prove how old it was. But because elements were there from pigments that were made after the purported date of the making of the painting—I knew how old it wasn't. That's what we're good at. We're good at telling how old something is not, proving how old an antique sculpture is, that's a little harder.

01-02:21:59
Eardley-Pryor: Process of elimination.

01-02:22:00
Schilling: Yeah.

01-02:22:01
Eardley-Pryor: You'd mentioned another technical study that you had done on a piece of work, called *The Annunciation*?

01-02:22:05
Schilling: Yes.

01-02:22:08
Eardley-Pryor: What's the experience with that?

01-02:22:09
Schilling: That's a beautiful painting. We did buy it. Again, it was the subject of a technical study in our lab at the Villa Museum. I did it with XRF. Now we have other ways of doing augmenting the information with XRF, so now we have more equipment and more experts that could investigate the painting to more levels of detail than I had access to at the time, with the lab that we had in place. But again, I used XRF, and it was one of those cases where all of the elements that I found on this beautiful painting by Dieric Bouts, were actually consistent with what Bouts would have had in his studio.

01-02:22:46
Eardley-Pryor: So you could verify it.

01-02:22:45
Schilling: So again, it's a fifteenth century painting, totally consistent with the purported age of the painting. It's gorgeous, I recommend seeing it. It's painting in a distemper technique called tüchlein—sorry, I don't speak German, so I didn't pronounce that well. But anyway, tüchlein paintings were made with animal glue as a binding medium. It has a matte surface finish, and they're made to be displayed just that way. Even though it's an easel painting, it's not made to have a glossy varnish put on it. So there are very few tüchlein paintings left that haven't been varnished. And the surface of this is pristine, it's gorgeous. So that was a really interesting study. Again I had to do a lot of XRF analysis, and a lot of validation that, yes, every elemental signature that I'm seeing, and all of the different colors on this beautiful painting, *The Annunciation*, so it's Mary and the angel, a beautiful red baldachin over Mary and the angel, rainbow colored wings on the angel—gorgeous painting. But it's very soft and delicate. It has a very delicate appearance, because of that special technique that Bouts used.

01-02:24:03
Eardley-Pryor: Now that you're doing this heritage conservation work and invested in one of the epicenters of the world art scene, had you had much experience with artwork before?

01-02:24:16
Schilling: Not so much, no. I was never a museum goer, per se. I loved going to museums when I was there, but I never made time to do it, the way many of my colleagues do now, because they knew about cultural heritage research when they were growing up, and they knew they wanted to get into it. It's such a great field.

01-02:24:36
Eardley-Pryor: What was the experience like, then, being in this environment for you, surrounded by all this art?

01-02:24:42
Schilling: It was wonderful. It was just really magical to go through the galleries. Frank told me once that being a conservation scientist changed the way he looked at art. He developed more of an appreciation for the materials and the techniques than just looking at the art and enjoying it, just standing in its presence and taking it all in. So yeah, I looked for the craftsmanship and the details, and things like that. So it's a different way of looking at art, and just have a different appreciation for it. So I don't have the art history background that some of my colleagues do, but I appreciate it from a sort of a technical perspective, and the beauty of it, of course.

01-02:25:27
Eardley-Pryor: Well, from the sense of different perspectives on art, what would be different about the way some of that art would have been analyzed, in the early eighties, '83 to, say '85, before moving out of the Villa, versus today? You mentioned there's different techniques that were available then.

01-02:25:44
Schilling: Yes.

01-02:25:45
Eardley-Pryor: What would be normal analysis protocols then, versus today?

01-02:25:48
Schilling: Well now, in our Technical Studies Research Lab, that's the name of the lab that does the kind of work that I did back when I worked at the Villa Museum. In technical studies, I'd have something called a Raman spectrometer. It's a little bit of an offshoot of infrared spectroscopy, but it gives very specific information about the mineral form of pigments. So you know that if I were to analyze a blue with XRF and I find copper in it, I would infer that that might be azurite. Maybe azurite would have a unique—that mineral, azurite, might have a unique Raman spectrum. I don't know if it does, I don't do Raman, so I'm probably lying to you through my teeth right now. But you get the idea. That technique is better—

01-02:26:42
Eardley-Pryor: That wasn't available then?

01-02:26:41
Schilling: Correct. That just wasn't available to conservation scientists at the time. So the technology we're getting in our field, we're getting it from other fields. So we inherit all of the great technological developments that are in the plastics industry, and metals, and aerospace—you name it. We're actively looking for new tools. The pharmaceutical biopharma worlds now, just huge developers of new technologies.

01-02:27:16
Eardley-Pryor: Well, I'm thinking about the early eighties, as you're building the lab and you're thinking about what things you want to have there. What were your thoughts on that? Before the binding medium project to develop—before

using polymers and analysis tools for that, what were the things at that time that you said, "Here's what we need to have to be a fully-functioning, world-class laboratory?"

01-02:27:40
Schilling: At that time when it was just a few of us at the Villa, it would have been X-ray fluorescence to do the elemental analysis, microscopy—again, you learn a lot by looking at something under the microscope. But if you can take a small sample of a paint, crush the paint and disperse the pigment particles, put them into a liquid, coverslip it—kind of the way you would a biological specimen, looking for amoebas in water, but coverslip it and look—you can look and observe the crystalline properties of mineral pigments. You can say, oh, this one's angular, this one has a certain color under cross-polarizing filters. Polarized Light Microscopy—PLM—was, again, sort of cutting-edge. Making cross sections of a painting to look at the layers and see the way the artist built up a painting, layer by layer—that was, again, common. Infrared spectrometry gives sort of fingerprints a pattern that relates to the organic materials, or inorganic materials in a sample—those were the kinds of tools that you would have found at, say, the National Gallery of Art in Washington, D.C., the lab at the Smithsonian (Conservation Analytical Lab), the National Gallery in London, the British Museum, Canadian Conservation Institute—places like that.

01-02:29:05
Eardley-Pryor: You'd mentioned that one earlier. And that was sort of Frank's model?

01-02:29:09
Schilling: Yes.

01-02:29:08
Eardley-Pryor: Why do you think he was looking for the Canadian model after coming from the space in Germany, having these other examples in other heritage sites like D.C. or New York? Why did the Canadian model seem like something he wanted to recreate here?

01-02:29:24
Schilling: And again, I'll speak to you as an assistant scientist with a huge administrative gulf between me and Frank. So he would have related more closely and more intimately and revealed more details to senior scientists, who were the supervisors of the different research groups. But I can tell you what little I do know. Because the Conservation Institute has an international mandate, and we're looking at cultural heritage all over the world, not just museum collections, but also sites and monuments and historic centers, and things like that, the typical museum lab, like the National Gallery of Art, tended to have equipment that was made for those purposes, to look at museum collections. But if you're going to consider conserving the wall paintings in the tomb of Nefertari in Luxor, Egypt, you have to do a lot in the field. And you have to look at a wider range of materials than ever before, if you wanted to be

successful in proving scientific and analytical support to the conservation efforts. So you need another group of scientists who were experienced in, say, built heritage, right? Mortars, stone, the environment, because the environment interacts with art, no matter where it resides. If it's a building or an outdoor site, light, heat, relative humidity, pollutants can negatively impact works of art and cultural heritage. So you need someone that can understand climate and measuring, modeling of climate in spaces. Then again, just wider variety of disciplines engage for a project like that. Geologists, people with a background in seismology, because we're working in cultural heritage and earthquake sounds.

01-02:31:32
Eardley-Pryor: Were the Canadians—

01-02:31:34
Schilling: So you need a broad range of disciplines. That's kind of what the CCI, the Canadian Conservation Institute, their mandate is all of the cultural heritage in Canada.

01-02:31:45
Eardley-Pryor: Not just one museum that they're attached to. I see.

01-02:31:47
Schilling: That was the best model that Frank could look at that existed, where he could say, okay, let's kind of pattern ourselves roughly on the CCI model.

01-02:31:57
Eardley-Pryor: That makes sense.

01-02:31:57
Schilling: Yeah.

01-02:31:59
Eardley-Pryor: So they had that broader mandate, similar to the way that Getty was trying to build its mandate?

01-02:32:02
Schilling: The GCI.

01-02:32:02
Eardley-Pryor: The GCI was building that mandate?

01-02:32:04
Schilling: Absolutely. So the GCI had that mandate from the beginning. A lot of people say that the Getty Museum is the local face of the Getty Trust. The GCI is the international face of the Getty, because we work all over the world. In sites, monuments, places of cultural interest.

01-02:32:28
Eardley-Pryor: That's great framing. Let's take a break here before we talk about your first international endeavor to doing some of the work you did abroad.

01-02:32:33
Schilling: Okay.

01-02:32:36
Eardley-Pryor: Thanks, Michael.

Interview 2: April 18, 2019

02-00:00:00
Eardley-Pryor: Today is Thursday, April 18 [2019.] We are here for our second session of an oral history with Michael Schilling at the Getty Center. I'm Roger Eardley-Pryor from the Oral History Center at the Bancroft Library of UC Berkeley. Michael, last time we were speaking, you had shared some of your memories of the Villa years, while working in the Villa. And around that time, you had mentioned that Frank Preusser encouraged you to step further with your educational experiences. What was that experience? What did Frank come to you and say, "To help you with your career…?"

02-00:00:35
Schilling: So after about a year of working for Frank at the Villa location, he pulled me aside one day and said, "You know, Mike, if you want to promote here, you really need a graduate degree." And since we had just gotten married a few years before, and we were planning on having kids, Cherrie was pregnant with Nicholas—

02-00:00:52
Eardley-Pryor: Oh, she was pregnant at that point?

02-00:00:56
Schilling: Yeah. It discouraged me, in that I'd have to go back to school and do some work. And I knew I wouldn't be able to leave work and just do a dedicated PhD. That's what I would prefer to have, a PhD, instead of a master's. But I knew that I could at least do a master's part-time. And so I reluctantly agreed. But I was more motivated than any of the other kids in the master's program, because I had a total motivation to exceed, excel. So it went easier than I thought it would, I learned a lot of interesting things. But the thing that really made it happen was that I was able to find a graduate advisor, George Gutnikov, who is a hockey fan from Germany. And he is an analytical chemistry professor, and he was willing to sponsor a master's thesis on Getty-related research. So Dr. Gutnikov and Frank Preusser and I picked three projects that I was working on, and I wrote them up for the thesis. So it took a few years to do part-time, but I was able to accomplish that and still have children at the same time, and tackle the long commute to and from the Getty.

So I didn't realize how much stress I was under until after it was all over, and I remember vividly walking to my car one day, and I just felt so light. I just thought I was under a lot more pressure than I realized.

02-00:02:28
Eardley-Pryor: Once you had finally got your degree?

02-00:02:29
Schilling: Once I was finally finished. So it felt like I was really alive again. But I have a master's degree from Cal Poly Pomona, again thanks to the kindness of Dr. Gutnikov for doing that, and not just insisting on me working for him on thesis-related projects that meant something to his research portfolio. So he

was the only one there that was willing to do it and go out on a limb. But we did write two papers together, and a result. So I'm happy about that.

02-00:02:58
Eardley-Pryor: It sounds like Dr. Preusser was also advising you, overseeing your master's work in some way?

02-00:03:03
Schilling: That's correct, because I was using techniques that he pioneered in Germany, thermal analysis is something that Frank really brought into our field, thermal analysis, of just measuring properties and materials as you heat them up, and how they change in weight, heat capacity, expansion, contraction, things like that. They hadn't been used in the field before, and so it was something that Frank wanted me involved in from the very beginning. So that was my other area of research. So I had the research related to the Getty Museum collection, but also this pure analytical research, looking at thermal analysis, thermal behavior of polymers and materials.

02-00:03:38
Eardley-Pryor: How does that research, then, get translated into the cultural heritage field?

02-00:03:44
Schilling: So basically, the things that I did with Dr. Gutnikov in this master's project kind of related to Neville Agnew's work in developing consolidates for adobe. Adobe is the most popular building material in the world. It's cheap; it can be made into bricks and walls, and things like that. But again, it's sensitive to the climate, weathering, rain. It has to be made well, with a certain amount of straw as a binder. Eventually even the best-made adobe starts to crumble and weather, and so Dr. Agnew was looking at different chemicals that could be applied as consolidates. So I did thermal analysis research based on that.

02-00:04:23
Eardley-Pryor: And was that your first opportunity to work with Dr. Agnew?

02-00:04:25
Schilling: That was the first time we worked together, yeah. I can't remember what his capacity was, if he was a visiting—I think he was a visiting scientist. He was there for six months. He did work in Fort Selden, which is the site that Jim Druzik talked about in his oral history about putting up adobe walls. It's in a harsh area of the country, and we wanted to try different consolidants, wanted to try different ways of preserving it. So it was kind of in our backyard, more or less, at a historic site.

02-00:04:55
Eardley-Pryor: And you turned some of that work that you were doing into your master's thesis?

02-00:04:58
Schilling: Into a thesis, correct. I was measuring the amount of consolidant that Dr. Agnew was applying in his treatment. So you get into the thermal behavior to

kind of track that. So it was fun work. That was fun work. Again, I feel blessed in that I was able to another work-related project and get school credit. So it's two in a row now, the BS [Bachelor of Science] degree and the master's degree, both on work-related projects.

02-00:05:24
Eardley-Pryor: And both at Cal Poly?

02-00:05:23
Schilling: Yep.

02-00:05:24
Eardley-Pryor: Learn through doing.

02-00:05:25
Schilling: I'm a Bronco.

02-00:05:28
Eardley-Pryor: There was a story you wanted to tell about your time in the Villa of somebody coming in, perhaps to try to find out what it was that you were doing there?

02-00:05:34
Schilling: Oh, it was a comical story. It was one of the funnier memories of being at the Villa. So when we would get deliveries from companies, they would drive the truck up the cobblestone road, park out in front of the ranch house labs where I worked, and now the conservators were working, because conservation labs were also added to the ranch house when it was fully remodeled. So they moved from the basement up to the ranch house. So this chemical delivery guy came up, and he walked through the Antiquities Conversation lab before he came into our science lab. He wanted to deliver some solvent. So as we were walking out, I was explaining to him what we do. And he said, "Oh, is this where you bust up the statues to make them look old?" And I laughed. I said, "No, they already come busted up. We try to unbust them." So that was funny.

02-00:06:28
Eardley-Pryor: Working with the busters.

02-00:06:29
Schilling: Yeah.

02-00:06:31
Eardley-Pryor: You had mentioned that in the year 1985, this transitional year—not only were you moving and found a new place to live, but also moving the lab at this time—it was also when your son, Nicolas, was born.

02-00:06:42
Schilling: That's right.

02-00:06:42
Eardley-Pryor: What are some of your memories of that experience, becoming a father?

02-00:06:46
Schilling: Oh, it was just an incredible experience. Cherrie had a C-section, and it was just a wild night when he was born. He was born at Glendale Methodist Hospital. It was just so much happening in our lives at that time, you know? And Kate was born in '88, and she was born during the time that I was writing my thesis up, and doing field work, doing research, doing the master's degree, being a new dad. And wow, it was hairy. It was really hairy and exciting.

02-00:07:19
Eardley-Pryor: How did you deal with all of that?

02-00:07:22
Schilling: I have no idea. I think just being upbeat as much as possible helps, because you can—you know, people can cope with a lot if you just kind of approach it with a smile, and this is the way it is. I know I could do things better, but yeah, it was tough. It was just tough to fit it all in. But other people do amazing things, too. We have staff now that are working, senior scientists, they're raising a baby—so yeah, hats off to them that they could pull that off. Because Cherrie—

02-00:07:46
Eardley-Pryor: Because you already did it.

02-00:07:46
Schilling: —because without Cherrie, I couldn't do what I do, because Cherrie made the entire home life possible, the whole stability, raising the kids. She was there. She's the one that deserves the most credit for all of that. I'm bringing home the paycheck to keep our ship afloat, but I owe everything to her.

02-00:08:09
Eardley-Pryor: And that long commute that you had for those first few years, tell me about that commute. I mean, where were you coming from to get to the Villa?

02-00:08:19
Schilling: Yeah, I would come from either Temple City, then later a condo in Azusa, then finally a house in West Covina. And it was a long drive. It was 45 miles each way, so music was important, the radio. I listened to heavy metal music sometimes. I listened to talk radio, which was infuriating. I had to stop doing that, it was just too frustrating to add to the frustration of the drive. But I just loved to listen to music, so that's where I listened to it the most.

02-00:08:45
Eardley-Pryor: Was in these long drives?

02-00:08:46
Schilling: Yeah. And then later on, I found a Bible study program called Through the Bible, and they go through the Bible, every chapter of the Bible in five years. It was a twenty-minute show, and it was on one of the local Christian radio networks. And I happened upon it one day, and I got hooked. The teaching style is a man from Oklahoma, and he just had a really folksy way of talking

about the Bible. And the Bible is just full of so much fascinating history and people and events, that it really was captivating. And even though I had been a Christian for so many years, I never read all those books of the Bible; I'd just kind of pick and choose, whatever the pastor's talking about on any given Sunday. That show really was interesting, because it really made me think more about my own faith, and again, committing more time to studying all of the Bible, because it all has something to teach, different lessons. And so that was a really great seminary moment, in a way, those five years of listening to that show every day. So that, again, is something that distracts from the drive.

02-00:09:57
Eardley-Pryor: You had also said that you got into heavy metal music on the drive?

02-00:09:59
Schilling: Heavy metal music.

02-00:10:00
Eardley-Pryor: I would never have guessed that.

02-00:10:01
Schilling: There was a station, KNAC, that started. It was a local FM station, now they play Mariachi music, so it had a short lifespan, but it burned very brightly for those few years. And it was just the first metal station in LA, and—

02-00:10:15
Eardley-Pryor: What drew you to it?

02-00:10:15
Schilling: It just was fun, just the beat and the rhythms, and the musicianship of the guitar players, the bass player, the drums, things like that. Not so much the lyrics, but I just enjoyed the intensity. It just kind of matched the intensity of the drive, the ebb and flow of the traffic. And I carpooled for a number of years with a colleague, Herant Khanjian. He was into hockey and he was into sports. We listened to sports radio. We listened to Jim Healey, he was a local sports guy. He did all kinds of things with sound bites and clips and things like that. That was fun to listen to, too. So I carpooled with him. Another person who I worked with Shin Maekawa, Vinod Daniel, who worked on climate monitoring with Shin. So he was part of the carpool also, he's from India. And he went to Fuller. He studied Christianity at Fuller, and he was a chemist, and so he was an interesting man. So together, the three of us, one from India, one from Iraq, one from LA, we made quite a carpool team.

02-00:11:17
Eardley-Pryor: That's really fun.

02-00:11:18
Schilling: Yeah.

02-00:11:19
Eardley-Pryor: You made mention, faith is certainly an enormous part of your life experience. And so it's science. And oftentimes, there seems to be a tension between them. How do you understand the relationship of being a Christian and a faithful man, and also being a scientist, rooted in this natural, materialistic world? Is there a tension there for you?

02-00:11:42
Schilling: Not really. Not really. I think even the best scientists realize the limits of what we can do and what we can explore, and the questions we can ask, because we're looking at it from our perspective. And all of the physics research, like the high-energy physics that's happening now, is showing that there's a whole lot more to life and reality than we think. And it's not possible to put stuff in a box and keep it in the box, and not have it appear in the other box. So from that perspective, that's totally mysterious. That's totally in keeping with the mysterious creator, and whatever religion you profess to, there is mystery there that's untappable, that we're never going to get to the bottom of it. I just love a good mystery, and just love feeling that way, that connectedness. So I don't have a tension in that regard. I'm modest enough—

02-00:12:41
Eardley-Pryor: Do you see them as aligned? The mystery of faith and the mystery of scientific exploration?

02-00:12:43
Schilling: Yeah. Absolutely. Yeah, and new tools are developed so we can go a little farther. You know, if somebody explains why we have religious experiences, so what? You know? Does that mean it's creating them? No. It just means that that's the part of us that responds best to our creator. So I have no problem with that at all.

02-00:13:02
Eardley-Pryor: That's wonderful.

02-00:13:05
Schilling: And I know there are a lot of hard scientists who would say, "Well, this guy is not a scientist at all then, because they have a totally different perspective." Good for them. I'm very happy.

02-00:13:15
Eardley-Pryor: You're very good at what you do.

02-00:13:16
Schilling: I'm very happy. I'm not going to change that.

02-00:13:19
Eardley-Pryor: So you made mention that in '85, late October of '85, your son, Nicholas was born—

02-00:13:23
Schilling: Halloween.

02-00:13:23
Eardley-Pryor: Halloween. And that your daughter, Kate, was born in '88.

02-00:13:29
Schilling: On Father's Day.

02-00:13:29
Eardley-Pryor: Oh, how fitting!

02-00:13:31
Schilling: Yeah, it's fantastic.

02-00:13:30
Eardley-Pryor: Tell me, if you would, a little bit about who they have become and who they are.

02-00:13:35
Schilling: Sure. I'll start with Nicholas. Well, I'll start with, actually, Cherrie also, when the kids were growing up, we didn't want them to have computers and things like that. So they did crafts. And one of the things that she did with them after school and weekends and stuff like that—craft. Play-Doh and building stuff, and coloring stuff, and cutting out stuff. So they developed those skills to appreciate materials and use them, and creation. And to develop artistic sides that they wouldn't if, you know, because at the time when Nicholas was at high school and junior high, his peers all had access to computers. And we didn't. But now he's a computer programmer. Now he is a lead tech developer at Diamond, and they are a consulting firm that does web development work for entertainment industries. He is now a leader of a team of web developers, all over the world. And he's amazingly talented. So he was able to pick up the computer stuff pretty easily when we finally got a home computer. And he didn't get left behind at all. So I think those fears that parents have are really unfounded, they just have to have faith in their kids. And they develop more of their personality than just the technical part, because without all the crafts and things like that, you wouldn't have the sense of visual and textures and interactions. All of those things would be the soft side, you know, the right brain. He wouldn't have all of that if he would have just been given a computer when he was a child, and just started typing and programming and stuff. So I love that about him. Both Nick and Kate are creative in that regard.

With Kate, Kate grew up loving what I do in the lab. I would bring them into the lab and show them the lab, and we'd look at their fingers under the microscopes. And I'd talk to them about what kind of research I'm doing, and things like that. So they were exposed to science at a simple level from when they were very young. And again, Kate has a wonderful creative side that came out of all of the time that Cherrie poured into them. So that, you know, it's just such a big part of who they are now as adults. And I'm just so proud of

them as adults. And Kate now is doing conservation science at Yale IPCH, Institute for Preservation of Cultural Heritage.

02-00:16:24
Eardley-Pryor: She followed in your footsteps.

02-00:16:26
Schilling: Both of them went to state colleges. Nick went to Cal Poly Pomona, Kate went to Cal State Northridge. Kate got her degree in chemistry working for the husband of Karen Trentelman, one of our senior scientists. He's an analytical chemist there. And she did air pollution monitoring at the undergraduate level, and then she applied to Cal Tech. And she got an interview, and her eventual PhD advisor, John Seinfeld, the world leader in air pollution monitoring, said, "I really wanted to meet you. You were the only person I would consider adding to my research group, out of all the people who applied." So she was accepted to Cal Tech. She got a PhD there in 2014, I think it was, 2015. One of those years. And she worked for a while in forensic science in Georgia for the DOD [Department of Defense]. And then she got contacted by Paul Whitmore, who was her former supervisor. Paul accepted her as a student intern for three years, when he was at the Carnegie Mellon, doing cultural heritage research. Paul Whitmore was the guy who invented the microfader, that was used to measure lightfastness of painted works of art, colored works of art.

02-00:17:56
Eardley-Pryor: So she got to do an intern with him?

02-00:17:58
Schilling: She did summer internships over three years. So when a position opened up at Yale, and he found out that she was looking for a new job, he called her and said, "Would you like to work with me here?"

02-00:18:13
Eardley-Pryor: Wow.

02-00:18:15
Schilling: And she said, "Of course."

02-00:18:15
Eardley-Pryor: That's really cool!

02-00:18:15
Schilling: Yeah. Now she's doing conservation science, she's teaching at Yale. She's working with the conservators at the Yale University Art Gallery. And she's doing conservation science research.

02-00:18:32
Eardley-Pryor: That's really great.

02-00:18:32
Schilling: Nick and Kate are both well-rounded people. Just easy to get along with, nice people. And I'm not just saying that because I'm a dad. I think other people who interact with them would agree, also.

02-00:18:46
Eardley-Pryor: So Kate lives out East. Where does Nicholas live?

02-00:18:50
Schilling: He lives in Glendora, just maybe a half a mile from where we lived in Azusa.

02-00:18:58
Eardley-Pryor: Oh, that's great.

02-00:18:58
Schilling: So he got married the year that he graduated from Cal Poly, so he's been married now about eleven years. And they're expecting their first baby in July.

02-00:19:08
Eardley-Pryor: So, this will be your first grandchild?

02-00:19:10
Schilling: So that'll be our first grandchild, yeah.

02-00:19:11
Eardley-Pryor: That's exciting.

02-00:19:11
Schilling: So we're excited about that. Yeah, and his wife, Rhiannon, is a registered vet tech. She's always loved pets. She got a degree at Cal Poly, and then her degree as a registered vet tech [veterinary technician] for Mount SAC [Mt. San Antonio College]. And we're just super proud of all three of them.

02-00:19:31
Eardley-Pryor: That's awesome. They sound like great people. You made mention, around this time that you were making these transitions, you were moving to a new place, to Azusa. You were raising this family, you have this long drive in front of you, you were learning these new techniques in the lab. It's also the time when your father passes away. That just seems like that was—the mid-eighties seemed like an intense time period for you.

02-00:19:57
Schilling: It really was, yeah. The last half of the eighties was really tough. It was learning a new career, starting from scratch. Then like you said, all those things really piled on top of each other. And you know, it's a time of growth, too, honestly, when you're really stressed out. Sometimes it leads to deeper growth and you have to dig deeper.

02-00:20:16
Eardley-Pryor: What did you learn about yourself?

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Schilling: That I was easily frustrated, I think! And I think also that faith was really an important component of just kind of keeping it all together, and keeping the lid on the pot. But again, without Cherrie, I wouldn't have any of it, really. I mean, she's wonderful. And she takes care of everything. All I have to do is bring that paycheck home, and she does everything else. And we're a team. We're a team, and I feel so blessed to be her husband. In fact, I tell her this all the time, that she's the one that does the important work in the family, because she's the one who does ministry work, and she raised our kids. I just fund that. Fund that work. So that's my perspective.

02-00:21:06
Eardley-Pryor: I also have a note that in 1986 was some of your first international in-the-field work, in the Valley of the Queens in Luxor, in Egypt.

02-00:21:15
Schilling: Yes.

02-00:21:15
Eardley-Pryor: Tell me a little bit about that project and your role in it.

02-00:21:19
Schilling: Sure. Okay. And I remember the thing that we were talking about during lunchtime.

02-00:21:24
Eardley-Pryor: What was it?

02-00:21:26
Schilling: The Getty Museum had been around a long time. That was a well-established museum, small museum on the coast. The Getty Conservation Institute, it was brand new in 1985. We had no reputation. Again, we have an international mandate, our interest in art doesn't stop at the perimeter of our museum grounds here at the Center, it extends all over the world, wherever the cultural heritage is. So we needed a reputation. And the best way to get a reputation, according to our first director, Luis Monreal—and he was very wise in this—was to work in Egypt, because everyone is fascinated with Egypt. It has a long, rich history. Incredible stuff in Egypt that you don't see anywhere else. So he wisely picked them as our first international collaborator. So that led to this project concerning the wall paintings in the Tomb of Nefertari. I had two trips to Luxor, Egypt in the Valley of the Queens. And that was in '86 and '87. So, again, Cherrie's handling all the responsibilities at home while I'm away for three and a half weeks at a time. Again, no Internet, phone very limited—so I was able to call every fourth day or so, just "How are you doing, everything okay?"

02-00:22:57
Eardley-Pryor: How was she doing? How did she deal with this?

02-00:23:00
Schilling: I don't know. Again, her faith keeps her strong, through everything. She's had a number of challenges over the years, health issues that she's gotten through. And it's really a tribute to God and what he's doing in her life. But that was hard on all of us. It was hard for me to travel there. I had never been out of the country before my first trip to Florence in '84, just to attend a conference. So going to work, actually in Egypt, was really quite a challenge for this kid from California.

02-00:23:32
Eardley-Pryor: Or even the mechanics. I mean, you're there. What's the place like that you're staying at? How are you moving around?

02-00:23:35
Schilling: Sure. Well, let me tell you what I had to do there, first. So Frank Preusser worked with Luis to kind of craft a plan. So we didn't have any wall paintings conservators on staff, per se, that could tackle such a complicated, high-profile job. Certainly no one that the Egyptian would trust right out of the gate. So what we did is, we worked with the top wall paintings conservators from Italy, the Moras, Paulo and Laura Mora, they're a husband and wife team, had a stellar international reputation for big projects. So we worked with them, the Egyptian Antiquities Authority, and other experts. Hideo Arai was looking at microorganisms, Modesto Montoto was looking at the geography of the area. Luxor, Egypt is accessible from the city by a boat ride over the Nile. So every day, going to work to and from the hotel involved a little boat ride. And it was a little boat that was used in World War II to ferry soldiers across small bodies of water. So that was always interesting, and kind of jumping off the boat when it's almost on the shore, because these other people on the boat were really anxious to get off and get moving. So that was interesting, kind of staying with them in the hotel.

Then I had the good fortune of working with a photographer from the National Geographic, Guillermo Aldana. And he was a lovely, high-energy man. He was present in Mexico City when the earthquake happened, the devastating earthquake that happened. And as soon as it happened, he said, "I grabbed my film, I grabbed my camera, and I just went out and just went through the town to photograph the devastation and the sights of people helping each other, in coping with such a terrible natural disaster." But anyway, I had the good fortunate to work with him. So he and I went there twice together.

And I did my work, which was monitoring the color of the wall paintings; I used color measuring equipment to document the color before, then I went back after the treatment, so that Frank Preusser thought, let's show them that the colors haven't changed in a bad way by the Moras doing their treatment. That's an important thing to note, right?

02-00:26:10
Eardley-Pryor: So you could establish the baseline.

02-00:26:10
Schilling: You don't want people to come back and say, hey, you've really ruined the colors. Right? And you hear about that now in certain high-profile conservation projects, I won't mention them. But Frank had the foresight to send me there, with a colorimeter to measure before and after treatment. So that was my day job. And then my morning and evening job was to kind of be Aldana's assistant, and kind of go around with him, and just kind of just help him be his Sherpa and schlep stuff around, and just—it was fun to watch him at work. He would go to places on certain times of day. "Yes, the light was awesome here yesterday," he told me, "so we're going to go back there tomorrow morning at 4:45, because at 4:50, the sun's coming up." So I learned a little bit about National Geographic photography from him, of how they get those awesome shots that are, like, you look at those pictures and go, I wish I could take a picture like that. Well, this guy worked really hard to make it happen. So it was great. Those iconic pictures now of the Tomb of Nefertari, and the sights, and the surroundings were because of his hard work.

02-00:27:28
Eardley-Pryor: And you got to be there with him while he created those images.

02-00:27:32
Schilling: And I was there. We were going up and down the hills and getting dirt in our shoes—I started to dress like him. I mean, I wore shorts and a headband. This iconic picture of me, really embarrassing now, looking kind of like an Aldana clone, really funny. So every once in a while, when we have a staff meeting and they want to relive memories, take us down memory lane, that picture always comes up. But that was a fun time. And again, being in the desert wasn't a big deal. I'm from LA, I know weather, I know you get out of the hot weather, get into the shade when it's noon, and 2:00. All activity kind of stops in Luxor at the Valley of the Queens, until it cools off.

So just being part of that, watching Hideo Arai look at the microorganisms that are in the tomb, looking at the conservators at work, how they would examine. I have nothing but admiration for conservators. They have incredibly trained eyes, in picking out minutia that I would never in a million years see. They knew right where to look. "Oh, here's a crack. You see that?" No. No. "Get closer." No. No. "Get closer!" Oh, yeah. You know, I never would have seen that if they hadn't pointed it out. And I can tell you so many stories about that, just working with conservators, where they're training just is so complementary to conservation science skills. So we worked together well. Projects that do the best always have conservators and scientists partnering together, and bringing in an art historian to tell you more about the story of what it is the conservators are conserving, and the scientists are studying, just makes the picture complete.

02-00:29:17
Eardley-Pryor: Why do you think that storytelling aspect is such an important part of the work that you're doing, especially from the analytical side?

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Schilling: Yeah, it's because we're involved in preserving the cultural heritage for future generations. And every object, every sight, monument has a story to tell. Someone made it for a reason. And it's there for a reason. And it's been treated. And the treatments are part of its history. And the changes that happen over time—time ravages certain works of art. And all of that is fascinating to me, you know? It's people's expression, artistic creations. Now they're there for the world to see. And I love the fact that we're using science to help preserve it. Small role, but really vital. So it's really satisfying at the end of the day, knowing that maybe some analysis that I did helps inform something about how an object was made, maybe the materials that were used, how the materials are changing, how a conservator might want to go about treating it, if they know the chemistry of what's on the surface. So much of the treatment takes place on the surface, understanding the chemistry of the surface is really important for a conservator.

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Eardley-Pryor: As you're doing this chemical analysis work, what role does the story play in your mind, though?

02-00:30:43
Schilling: I think the story is just another aspect of the output, in a way. It really is. Because you can appreciate the art—let's just call it "art" to cover everything—you know, you can appreciate the art at one level. You can appreciate it from another perspective, knowing the history of it. And another perspective from the treatment and the material side of it. So there are different aspects to art that is really fascinating. It's not just to me, it's like everyone who comes through on a tour and we're touring the GCI [Getty Conservation Institute], we're showing them the labs, we're going down this long hallway that has photographs of our field project sites and research, and objects, and things like that—literally, they could stand there for hours, because each one of those places was carefully chosen because it represents something unique in the life of man, of mankind. And they're wonderful pictures, because they just draw you in. They're telling that story. And boy, it doesn't matter what age or what background, people are captivated by it. People like a good story. Yeah.

02-00:32:01
Eardley-Pryor: What was the experience like being in the tomb, the Queen of Nefertari?

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Schilling: I was blown away. It's like a time machine, honestly. The tomb itself was in multiple levels, so you start out at the ground level, you go down a staircase, you get into the first level of chambers. You go down another staircase into the main burial chamber, and there are niches. So the main age and the

damage of the wall paintings is salt. And the salt is insidious in certain strata of the rock the tomb was carved out of. And so there's more salt-rich veins in the lower level than there is the upper level. And it's the salt—I could talk for hours on the salt thing, so I'm not going to do that.

02-00:32:49
Eardley-Pryor: Or we can even revisit it later, too.

02-00:32:53
Schilling: But the salt is damaging. And the salt then damaged the lower level, the burial chamber, more than the upper level. And the columns that are supporting the ceiling in the burial chamber were disconnected from those walls of salt-rich deposits. And so they're pristine. So you walk into the burial chamber, where there is a lot of loss of wall paintings, and then there are these absolutely pristine pictures of Nefertari in life. And they're stunning. And you cannot believe they're thousands of years old, because the colors are so vibrant. The tomb's been dark, you know, most of those millennia. And it's just liked a time machine. I just couldn't believe it. So lucky to be there and have seen that so intimately, without barriers and without guards saying, "No, get away from that!" You know, just to be there daily with the conservators and having that privilege is just amazing.

And so that was such a wonderful site for a first field project. It went on for many years. The Moras did a beautiful job in documenting all the damage, they make these wonderful treatment maps, condition maps, that show where flaking is, where you have salt deposits, where you have loss. So from these maps that are hand-drawn over tracings and things of the images of the wall paintings, then they know what to do at each place. They can prioritize, so it's like diagnosing the problems.

02-00:34:29
Eardley-Pryor: And this was not just conserving the space, but actually treating it?

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Schilling: Yes. The conservation is an active process to mitigate the damage, and to stabilize the paintings. They didn't repaint.

02-00:34:45
Eardley-Pryor: Okay, that's what I was getting toward.

02-00:34:46
Schilling: Right. But they did re-attach flakes and remove salt crystals, and things like that. They did some injection grouting, kind of to consolidate the underlying plaster layers, because these were paintings that were done on mud plaster. And the mud was applied to the stone walls, and then the paint was applied to that. So they're a build-up of layers, and you can see that from a cross-section. We call that a cross-section, where you're looking at a painting from the side under a microscope, and you can count, here's the upper layer, it's red. Right below it there is like a ground layer, it's white. Now you see a fine plaster

layer maybe with hairs in it, as a way of binding the earth together. And then straw, and then you get to the rock. So the conservators are experts at kind of unpacking the information in those cross-sections. So it's fun to work side-by-side with them. You learn so much from each other.

02-00:35:42
Eardley-Pryor: The colorimetry work that you were doing there, this measuring the baseline color, where did you learn how to do that?

02-00:35:49
Schilling: I learned from Max Saltzman. So one of the things that Frank made sure, Frank Preusser made sure we had access to, was the best people to teach us. Because again, I'm a newcomer to the field, I knew nothing about color measurement, I knew nothing about XRF microscopy [X-ray fluorescence microscopy]. I had the good fortune to learn from the best. So Max Saltzman was a local color expert. Color is an obscure topic. It's hard to imagine that people could wrap their heads around numerical ways of expressing a color, but physicists worked together to come up with a way of doing that. Max was an expert at knowing all of that, and how to measure color reliably. So I kind of trained from him. And I had that good fortune. I learned XRF from Gary Carriveau, who worked at the Detroit Institute of Arts, he's a leader in that. I learned polarized light microscopy, identifying pigment particles, from Walter McCrone at the McCrone Institute in Chicago, on Lake Michigan. And I've had the good fortunate to learn thermal analysis from Edith Turi, paint technology from Zeno Wicks at North Dakota State University at Fargo—

02-00:37:00
Eardley-Pryor: And were these people that were brought to the Getty for the training?

02-00:37:06
Schilling: No. Gary Carriveau came out, Max Saltzman was local. He had a lab, actually, at UCLA in the Cotsen Center for Archaeology. But the other places, Brooklyn Polytechnic is where I went to learn thermal analysis from Edith Turi.

02-00:37:20
Eardley-Pryor: So you would go there for an extended period to train?

02-00:37:23
Schilling: Yeah. Yeah, depending on how long the workshops were. So it's just great to learn from the best. Because you can get past that steep learning curve quickly.

02-00:37:33
Eardley-Pryor: I think it's neat that that's how you came into the field to learn all of these techniques. And now, here you are today hosting workshops, teaching the techniques, so that people come to you for that expertise.

02-00:37:42
Schilling: Yeah, it's fun that it's gone full circle in that way, isn't it? It's pretty neat.

02-00:37:45
Eardley-Pryor: It's a neat way to give back.

02-00:37:47
Schilling: Pretty neat.

02-00:37:49
Eardley-Pryor: Around this time, the Tomb of Nefertari project lasts for several years. What was your involvement, aside from these two international trips that you were there to measure color baselines and support with the photography project, what was the other roles that you played in that project?

02-00:38:05
Schilling: That was pretty much it.

02-00:38:06
Eardley-Pryor: On-site?

02-00:38:06
Schilling: It was to do the color measurement and to write reports. Frank and I co-authored a paper on what we learned with Max Saltzman as a co-author also. That was more or less it for me. It was a limited role, but it was really significant because it was Egypt, it was seeing the Pyramids, being inside the Pyramids, the Sphynx, being on a felucca on the Nile, seeing Aswan—Egyptians are masters at hospitality. And they treated us like royalty, everywhere we went. So we just got the best experience in all these sites. And it was just wonderful. And again, going with these team members were really great. Really great people.

02-00:38:50
Eardley-Pryor: I have a note that even though the project in Egypt lasted through '92, Frank Preusser left his position in 1990?

02-00:39:01
Schilling: That's correct. He was the head of science for many years, and then he took the role as deputy director of programs, so, like overseeing the technical aspects of all of the projects at the Institute. Then he left the Getty. He started his own company. He did teaching at Tokyo University of Fine Arts and Music. He then became the chief scientist at the LA County Museum of Art. He worked on preserving the Watts Towers, which is a local landmark.

02-00:39:34
Eardley-Pryor: What a neat career.

02-00:39:36
Schilling: Yeah, he really had a wonderful career, absolutely. He passed away a few years ago. Quite sad. But it was an honor to speak at his funeral.

02-00:39:45
Eardley-Pryor: Also in 1990, I have a note that you were promoted to associate scientist.

02-00:39:49
Schilling: That's correct.

02-00:39:47
Eardley-Pryor: Was that in some ways a reflection of you having completed your master's training?

02-00:39:54
Schilling: That had something to do with it, yes. So Frank's vision for my career did pan out. I did get a promotion. But really, it had a lot to do also with the change in the focus of my job. So our research groups are headed by senior scientists, so I'm a senior scientist now, head of Materials Characterization. At the time, Dusan Stulik was a Czech scientist, who the GCI hired to head up what was then called the Analytical Research Group. So Dusan contacted me and asked me if I would want to leave working with the Getty Collection at the Villa, and start working at the Marina del Rey facility, where all of my colleagues worked, to do researching analyzing organic materials. So that involved Gas Chromatography-Mass Spectrometry, GC/MS. At the time, there had been a fair amount of work on GC/MS applied to organic materials, like paint binding media, the sticky stuff that the pigments are mixed in with, that sticks the pigment grains to whatever it is that's being painted. It's called "binding medium." And they're organic materials that artists have used over the centuries to do that. Most of them, up until the twentieth century, were natural products. So oils and tree resins and proteins and plant gums, things like that, waxes.

02-00:41:28
Eardley-Pryor: So if I'm hearing—

02-00:41:30
Schilling: So it was a complete shift for me when he said, "Would you like to do that?" It's quite a challenge. David Scott at the time was the head of the lab at the Villa. Where did he work before? Darn it. He was a university professor, and we hired him to head up our lab at the Villa Museum. So he was the person I worked for there, and Frank and Neville were the people I reported to on the Nefertari work and the adobe research. But Dusan dangled that carrot, and it was really tempting. And it was something new. But it was kind of going back, a little bit, about what I used to do at Sunkist, using GC [gas chromatography], LC [liquid chromatography] to analyze binding media. So that was too attractive to pass up.

So that, again, led to a promotion to associate scientist when I did that. That's when I moved to the Marina, and I worked there for a number of years. And that was an interesting transition, because again, I knew nothing about binding media and cultural heritage. So again, I'm facing another steep learning curve—there's a pattern in what my career is like. So that was a good challenge, working for Dusan. Dusan had this idea that—he was a physicist, I believe, or a physical chemist, and he was a lecturer at University to

Washington at Pullman, just before we hired him. Really a funny guy, great guy to travel with. Great *joie de vivre*, loved to do marathons and things like that. Just a crazy guy, just a great attitude.
But he was familiar enough with the literature to know that there hadn't been much work on identifying binding media in paintings. So he thought, this is something that GCI can do to distinguish itself. So all of the people in his team, Cecily Grzywacz, Herant Khanjian, Michele Derrick and I, Andy Parker—all five of us, then, were developing—Henry Florsheim was a visiting researcher—all of us had a certain instrument of expertise. We all applied what we were doing with our methods to studying the same binding media. And it led to the development of our reference collection of samples. So Dusan knew that he had to make up replicas of linseed oil mixed with lead white, and paint that out onto a glass support. Then we can test that later to see how it changes when it dries, and when it ages. So that's how a reference collection was born, out of the mind of Dusan wanting to do this project well.

Cecily did work on a master's degree actually at CSUN, Cal State Northridge, where my daughter graduated from. She did a master's degree in developing a method to identify proteins with HPLC [High Performance Liquid Chromatography], which is the method that I used at Sunkist. So Cecily developed a method for that. Michele Derrick did infrared spectroscopy, which her work in binding medium on FTIR [Fourier-transform infrared spectroscopy], the acronym for that, led to the development of a database that led to the foundation of an international organization of people that do FTIR in cultural heritage research. It's called IRUG, Infrared Users Group. So Michele's database then became the nucleus of this IRUG and the forming of that group, which still exists today. And it's always because of Dusan's wisdom in having us all work on the same stuff with our own instruments, and Michele's hard work and dedication in developing a high-quality spectral library that other people could use to identify these things in their works of art.

02-00:45:36
Eardley-Pryor: Those were a really forward-thinking addition to cultural heritage work.

02-00:45:39
Schilling: Absolutely, yeah. Dusan was, when he was here, a real visionary. He just did things that were just brand new. And talk about jumping onto steep learning curves, he had no trouble doing that. He must have had pitons, I think, and spikes and he was able to scale steep cliffs easily.

02-00:46:02
Eardley-Pryor: Well, tell me a little bit about your climb as well.

02-00:46:02
Schilling: Okay.

02-00:46:03
Eardley-Pryor: You transfer to working now at the Villa. It's a different—a change in location for you.

02-00:46:07
Schilling: Went from the Villa to the Marina.

02-00:46:10
Eardley-Pryor: I'm sorry, from the Villa to the Marina. Tell me a little bit of what the Marina's layout was like. What was that lab like?

02-00:46:14
Schilling: Sure. So that lab was basically a place that we leased for the better part of a dozen years. It was a building that was very nondescript in Marina del Rey, which is close to LAX [Airport]. And we started taking over the building. There was a Hollywood production company that was in there, and their part of the real estate got smaller and smaller. Eventually we took over the whole building. But all of our operations were there, our field projects people, our publications, dissemination, scientific research, training, administration, management—everybody was there.

02-00:46:51
Eardley-Pryor: Were you the last person to come from the Villa to then be based—

02-00:46:57
Schilling: Yes, I was. I was the last one.

02-00:46:57
Eardley-Pryor: So that was consolidating all of the scientific analytical work in one place finally?

02-00:47:01
Schilling: Except David Scott's lab, which remained at the Villa, because his mandate was to work on the Getty Collection with the conservators and curators. And that remains today. We still have that lab in our museum here, and we have another lab still at the Villa, where work on our collections take place.

02-00:47:18
Eardley-Pryor: For the collection itself, for the Getty Collection?

02-00:47:18
Schilling: That's the main place. Correct. It's not the only thing they do there, but it's a big focus on what they do.

02-00:47:26
Eardley-Pryor: I see.

02-00:47:27
Schilling: So that was an exciting time. So I was charged to do GC/MS, so we started with oils, drying oils, it's a popular paint medium, even today. And I worked with Andy Parker to develop a method that was better and more efficient at

extracting the oil from the paint, and then converting the oil to something that you could analyze with GC/MS. And GC/MS—

02-00:47:54
Eardley-Pryor: Tell me about that process of figuring out how the methodology should be done.

02-00:48:00
Schilling: We looked at different commercial products. To analyze something with GC/MS, it has to be a relatively small organic molecule, so under a thousand grams per mole. So a wax is about—beeswax—about nine hundred grams per mole. Oil is about nine hundred grams per mole, so you get the idea. It's kind of that range. And it can look at permanent gasses, all the way up to those big molecules. But to get big molecules through the instrument and have identifiable compounds from them, you need to make them volatile. So there's an oven involved, and it heats the column that the sample goes into. Many compounds benefit from chemical treatment prior to analysis. It converts them from compounds that are not quite as volatile, not quite well-behaved. It converts them into something that you can easily and reliably and accurately measure their amounts. And so that was what we did. We looked at lots of different commercial products that did this chemical derivatization, is the word. And we look at these derivatization agents, and we found the ones that work the best in the presence of pigments.

02-00:49:14
Eardley-Pryor: To pull out the binding?

02-00:49:16
Schilling: Yeah. Because paint is a mixture of the medium plus pigments. So if you had a great chemical, but it didn't work in the presence of pigments, it wouldn't be of any use. So Andy and I kind of went through all of those chemicals, and found the one that worked the best.

02-00:49:35
Eardley-Pryor: The right derivative.

02-00:49:37
Schilling: Yes. It makes a great derivative, Fatty Acid Methyl Esters, or FAMEs. You can analyze the FAMEs from oils with this reagent, it's a commercial product called Meth Prep. It's from a company that sold it for decades. They sold it to the food industry because the oils are made of saturated fats, and that's important because they're in your bloodstream, and your doctor wants you to control your glycerides. Those are those fats that are in our blood stream and in meats, and oils, seed oils, like linseed oil, walnut oil, poppy oil—those three are the ones that old masters would have used to make easel paintings; panel paintings, canvas paintings. So we wanted to have a method that did that.

We replicated the identification scheme that was developed at the National Gallery of London by John Mills and Raymond White, who were really at the leading edge of doing GC/MS in our field, and GC in our field. And we just used a different chemical to make the same products that they identified. And they had an identification scheme based on the relative amounts of the different fatty acids that you could analyze to differentiate those three oils; linseed, walnut, poppy—each had a slightly different saturated fatty acid composition. We used their numerical way of treating our test data from samples that were treated with our chemical. We were analyzing the same things, but they were just made from a different chemical process.

02-00:51:19
Eardley-Pryor: Let me share what I think I'm hearing, and you can tell me what I'm not getting right. So the methodology you started using for GC/MS.

02-00:51:26
Schilling: Yes.

02-00:51:27
Eardley-Pryor: You were attached to that point then. It wasn't GC and MS separately, there was—

02-00:51:29
Schilling: They were combined. One instrument, yes.

02-00:51:32
Eardley-Pryor: —one unit, one instrument when you started learning, applying at the binding medium.

02-00:51:36
Schilling: Right.

02-00:51:38
Eardley-Pryor: Once you have identified these three main binding mediums that are common, what you wanted to look at, you used the methodology that these folks in the UK had been doing to analyze, for at least their analysis, their numeric and quantitative analysis.

02-00:51:52
Schilling: Mm-hmm.

02-00:51:54
Eardley-Pryor: But the derivative that you were adding to the oils to pull the binding medium away from the pigments was different from their method?

02-00:52:00
Schilling: Yes.

02-00:51:59
Eardley-Pryor: Is that what the difference was?

02-00:52:00
Schilling: They used a different chemical. They used one that was really hazardous and explosive. And they had a couple of steps in the process, two or three steps, and we didn't want to do that. We were very concerned about safety here at the Getty, right?

02-00:52:16
Eardley-Pryor: With good reason.

02-00:52:17
Schilling: Good reason. We wanted everybody to be safe in the lab. So anyway, we opted for a safer, newer product that was available at the time that we started working, that wasn't available to our British colleagues when they were developing their method. They had a standard chemical process to convert the big oil molecule to the small chemicals that you could analyze, the saturated fats. We just used the different chemical that was developed for the food industry.

02-00:52:47
Eardley-Pryor: And how did you learn about this food industry chemical that you could use?

02-00:52:51
Schilling: Well, the great thing is, the catalogs are full of examples, so you can see how Meth Prep would be used to look at fish oil or seed oil, or animal fats, or lipids from any type of source.

02-00:53:04
Eardley-Pryor: And Meth Prep is methylating these acids?

02-00:53:05
Schilling: Yeah, Meth Prep is producing the same chemical that the Brits were producing with their toxic, flammable gas, and it was just using a different chemical. We were still making the same products, still analyzing the same products. We were still treating the product data the same way. We just used a different chemical that was more elegant, because it was available when we started working. We still use it. Everybody uses it around the world, and it's just a great chemical. You add a droplet of it to your paint sample. You heat the paint sample for an hour at 60 degrees centigrade, and it's ready to be analyzed by GC/MS. There is no extraction, there's no purification steps, there's no filtering steps. There's no transferring from one vial to another, the same way that this other protocol involved—none of that. So it was great. One pot. We would call it a "one-pot derivatization."

02-00:54:07
Eardley-Pryor: Yeah, it simplifies it and also makes it cleaner and just as efficient.

02-00:54:10
Schilling: Right. Exactly. Because you figure that if your sample goes from one container to another, any trace of contamination in each container that the sample is going to live in, those contaminants are going to be picked up and

added to the total thing that you're analyzing. So if the chemical derivatization can happen in one small vial, that's great. You minimize contamination. We've taken that approach, then, to a lot of our natural product analysis that we did with traditional GC/MS, where we are measuring the quantities of the marker compounds that allow us to differentiate the different types of paint media. So there's one set of marker compounds for oils, for fatty acids, for proteins it's amino acids, for plant gums it's carbohydrates.

02-00:55:03
Eardley-Pryor: And by "markers," you mean these are the items that you're really interested in looking at?

02-00:55:04
Schilling: Yeah. What we look for are chemicals that compose the paint medium, that if we identify them and we look at their amounts, we can then differentiate the different paint medium.

02-00:55:22
Eardley-Pryor: And then how does that, then, get re-applied? So you run the analysis, you develop this protocol, the mix seems more elegant. You get the information you want. What's done with that information? What's the next step in its use?

02-00:55:35
Schilling: That goes into a report on the object. So if it's a painting, it's an easel painting, maybe it's a Monet, and they want to know what medium Monet used. You could sample some of the different colors. They often would be taken—the samples would be taken by conservator, looking at the painting under a microscope. They remove ten micrograms, twenty micrograms of paint—not much. Like the size of a period on a printed page, tiny amounts. Then we would identify the paint medium in each sample, and then write a report. That goes into the history of the object, it's how Monet made that painting. These were the products that were used.

02-00:56:17
Eardley-Pryor: I see.

02-00:56:19
Schilling: Again, there were other marker compounds that we've and other people have identified that do this kind of work that indicate how oxidized the oil is, or the varnish, how oxidized it is, so we can see chemical changes in these organic materials, as they are responding to their environment. The light, the oxygen and the air, they're photo oxidizing, converting from original materials to a new set of materials that has a different distribution and marker compound. So the original ones go away, new ones form. So by looking at those, the distribution of the old ones and new ones, we can tell how much change has taken place in an organic material.

02-00:57:03
Eardley-Pryor: That's great.

02-00:57:03
Schilling: So that's our quest. All of the GC/MS we do is more or less the same. The treatments are different, the chemical processes, the way we put the sample into the GC/MS is different. Sometimes we use pyrolysis, sometimes that involves adding a chemical, sometimes not. But the basic idea is still that you're looking for compounds that chemists can identify, say oh, those chemicals always formed from this type of paint medium, linseed oil. These chemicals always formed from egg yolk. These chemicals always form from gum Arabic.

02-00:57:40
Eardley-Pryor: And those are part of your markers?

02-00:57:37
Schilling: Correct. Those are marker compounds. So the better you are at GC/MS, the more marker compounds you have in your head.

02-00:57:50
Eardley-Pryor: You can identify them just from—the way a conservator can look and say, "I see a crack," that maybe an unexperienced eye wouldn't see that crack?

02-00:57:56
Schilling: Correct.

02-00:57:58
Eardley-Pryor: You can see that through your GC/MS data?

02-00:58:00
Schilling: That's correct. So our struggle is to get the most information we can from the smallest possible sample. That's the great challenge. That really was what attracted me to doing this GC/MS work, to leave behind XRF, PLM [polarized light microscopy] as a regular part of my work, and do something new. How can we get the most information out of the tiniest sample? Again, I mentioned invasive analysis, this is an example of invasive analysis. Someone has to take a tiny speck of the artist's material, but our job as analytical chemists, then, is to get the most information. So that's where we tried to go.

What Dusan wanted in the end was one method—he called it the "ultimate method"—that could identify all five classes of natural products in a single sample. We could do four really well, and we needed one more sample to do plant gums. So Joy Mazurek has worked really hard developing a method that could do oils and proteins and resins and waxes, all from a single sample. Three different analyses, sometimes four, depending on what else you want to learn about the oil. So you get four different chromatograms, four different results. You can interpret that data from each one, until something about oil, something about protein, something about waxes, something about resins.

02-00:59:26
Eardley-Pryor: All from this thing the size of a period on the end of a sentence?

02-00:59:28
Schilling: Correct. Yeah, twenty micrograms, thirty micrograms. Now what we've done more recently is tried to use pyrolysis GC/MS as a way of doing that, to get as much information as we can about natural products and synthetic materials. The types of materials that were formed by chemical industries in the twentieth century. So synthetic polymers, like acrylics and vinyl acetate, and epoxy and polyurethane, and alkyds—all of those things that the industry was churning out as better replacements as house paints, car paints, and paints for tools and things like that. Artists started using them. We had to expand our range of techniques in order to be able to identify those new materials, right?

02-01:00:25
Eardley-Pryor: The twentieth century creations?

02-01:00:26
Schilling: Yeah. Because for millennia, artists had access to such a small set of natural products, the twentieth century changed all of that. The modern synthetic organic chemistry labs just belched out an incredible range of new products that we had to deal with.

02-01:00:43
Eardley-Pryor: Well, before that industrial era began, what was it about plant gums? In the local methods, weren't somehow needed to be a different—

02-01:00:51
Schilling: Separate sample. So in Joy's work, that built on what Andy Parker and then later Herant Khanjian and I developed, Herant and I developed the method for identifying proteins from amino acid compositions. "Essential amino acids," you hear about that when you look at your vitamin supplements. But anyway, so Joy kind of combined all of these methods that we developed into one series of tests. But plant gums, the chemicals that we use and that process that we use would totally destroy plant gums. They would never survive that process. So we needed a second sample to do plant gums well.

02-01:01:38
Eardley-Pryor: I see.

02-01:01:39
Schilling: It needs milder conditions.

02-01:01:42
Eardley-Pryor: Tell me a little bit about the development of the amino acid protocol that you created.

02-01:01:44
Schilling: Yeah. Herant and I started working on that many years ago, when we were at the Marina. It was the second binding medium that I started tackling. Cecily was doing it.

02-01:01:57
Eardley-Pryor: What was the first?

02-01:01:59
Schilling: Oils, with Meth Prep. Cecily was working on a parallel project, again, doing it with HPLC, so liquid chromatography. Herant and I were looking at gas chromatography mass spectrometry. And so we found a paper by a guy named Petr Hušek, I think was his name. And Hušek had a nice, simple procedure to convert amino acids to volatile derivatives that could be analyzed by GC. It took two minutes. So the only other thing we had to add to that protocol was a way of converting proteins to amino acids. And the traditional way of doing that is, put it hydrochloric acid, and heat it to just above boiling for twenty-four hours. It's kind of the reactions that are taking place in your stomach; your stomach has hydrochloric acid in it, and it's what breaks down your food in the presence of enzymes to form nutrients that your body can absorb. We're just using a similar chemistry, then, a standard way of doing that. You just get a small vial, put your sample in it, put some acid in it, cap it, and put it on a hotplate, basically.

02-01:03:15
Eardley-Pryor: For a day?

02-01:03:13
Schilling: For a day. Then you evaporate away the acid, amino acids remain behind. You add the chemical that Hušek used, and we added a couple of extra steps to get a little bit more information out of it, to scale—sorry. We added a couple of extra steps to Hušek's procedure, because we wanted to test the smallest paint sample possible. We had to do a little bit more in the way of extraction. But we developed that protocol, we published that protocol. It is part of that process that Joy uses now to analyze those four media.

02-01:03:49
Eardley-Pryor: To combine them all?

02-01:03:49
Schilling: Yeah. And at the time, Herant was doing FTIR analysis, so it was a step for him to do that.

02-01:03:57
Eardley-Pryor: Did you teach him how to do the GC/MS, if he was doing IR before that?

02-01:04:02
Schilling: Herant has the most amazing skills in sample preparation. Herant and Joy are just incredible in what they can do, and they do it really well and reliably, and with minimum risk of contamination. So he was the best preparer of samples. At that time, Joy hadn't started working with us yet. So Herant was just fantastic at that. He's just immaculate. And he can work in clean room settings. So then I did the GC/MS, the data workup. He had the hard job of doing all the sample prep, and then I had the easy job of doing the injection, the data treatment. But together, again, we're a good team in that way. So that

led to a method, again, that is still used today in labs. Like you said, we teach workshops on binding medium analysis.

So that was a great start to my GC/MS career. We had GC at Sunkist, but no GC/MS, so it was nice to add that extra dimension. The MS allows you to identify the compound so very specifically. You get a mass spectrum—again, you can think of that fingerprint analogy—that mass spectrum is unique for each chemical.

02-01:05:18
Eardley-Pryor: We probably should have done this a little earlier, I apologize for not asking you to explain GC/MS and how they work together. Can you tell me a little bit of what the GC is doing, what that instrumentation process does? And then what MS adds to it, to offer the complete picture that you were able to use?

02-01:05:32
Schilling: Sure. GC/MS is still the best way, I think, of identifying these products in paints and coatings. There is really no other—there's no non-invasive way that's as sensitive. And it gives a lot of specific chemical information. The basic idea is, all types of chromatography involves some kind of tube, stationary phase it's called, it has some kind of absorbent material in it. You pass as mixture of chemicals into that tube, and the chemicals in the tube interact with that stationary phase. Some of them don't interact very much with that stationary phase, and they make it out of the tube quickly. So the amount of time they're in that tube relates to the retention time, how long they're retained by that tube. So all chromatography works in more or less the same way—mixture goes in, and pure chemicals come out one at a time, separated by time, okay?

02-01:06:36
Eardley-Pryor: As they travel through the tube?

02-01:06:38
Schilling: Correct. So in the case of a GC, the GC has a very long, thin capillary tube, and inside of that is a coating, and that coating is the stationary phase in that description.

02-01:06:55
Eardley-Pryor: The coating itself inside the tube?

02-01:06:56
Schilling: Correct. So the coating is inside the tube. Our work as chemists is to convert large molecules into molecules that have just the right size, under a thousand grams per mole, so that they can have enough vapor pressure, be in the vapor phase when that column is warmed in an oven, so that they can slowly make their way through the tube, interacting with that stationary phase coating as they go, and coming out of the tube one at a time, more or less based on their size. So the small molecules come out first, water comes out very early, and then methanol and ethanol and propanol and butanol, all of those all differ by one carbon number. So ethanol has two, propanol has three, butanol has four,

pentanol has five—so they come out in that order. Again, that relates to their volatility. The bigger they are, the less volatile they are, so they're hung up in that column a little bit longer.

02-01:08:09
Eardley-Pryor: In order to put that—

02-01:08:10
Schilling: So that's the separation process that the GC does, the gas chromatograph. So you have a gas mixture going in, and pure gaseous compounds coming out the other end, to be detected.

02-01:08:24
Eardley-Pryor: That have been separated.

02-01:08:24
Schilling: But how you get the gas in is critical. So that's where you need to either dissolve the chemical into some kind of chemical reagent, and then use a syringe to inject that solution. Or you have to add a reactive chemical that actually degrades the organic molecules into a reliable set of marker compounds; it can't just be breaking it up at random. It has to be a purposeful chemical degradation, so some kind of chemical treatment converts larger molecules into a set of smaller molecules that are volatile enough to go through the GC column. If they're not volatile, they just sit at the very beginning of the column, and they stay there forever. And if they're too volatile, if they're all too volatile, they all go through the column more or less at once, no temporal separation, so they're still coming out a mixture. So our job as chromatographers is to find the best way of converting the molecules in the sample to something that can exist in the gas phase long enough to make it through that column in the GC.

02-01:09:37
Eardley-Pryor: In a measurable way.

02-01:09:36
Schilling: Correct. Then so it's kind of controlled chemical degradation, and conversion into volatile molecules.

02-01:09:46
Eardley-Pryor: The choices you would make before you would insert something into the GC column for it to be measured, those sound like those are the real analytical chemical choices that you need to make.

02-01:09:56
Schilling: You bet. Yeah. A lot of the chemicals come from the synthetic organic chemistry world. The synthetic organic chemistry is the fascinating thing, like how do you make LSD? How do you make designer drugs? How do you make a new molecule that has a certain shape, right? Drugs. How do you make them? How do you put small molecules together to make bigger ones? So they have a whole range of chemical reactions that they can subject their starting

material to. So those processes are interesting. They usually involve highly-reactive chemicals, but they produce something that's well-known at the end. So our process is called derivatization. We're converting a less volatile form of a marker compound into one that's more volatile, that will go through the GC column well, and separate well into a nice symmetrical shaped peak that's narrow at the base and really tall, because the taller the peak is, the easier it is for the detector, whatever the detector is, to detect.

02-01:11:04
Eardley-Pryor: On the chromatogram? You want that peak on the chromatogram?

02-01:11:05
Schilling: And the detection of that peak makes the chromatogram. And each peak in the chromatogram relates to one, say, marker compound that ultimately we, as chemists, then would go back and say, these marker compounds come from linseed oil, these marker compounds come from collagen, these marker compounds come from gum Arabic, these come from shellac.

02-01:11:29
Eardley-Pryor: Do you link those markers to their original organic material that was used as the binding agent from the start?

02-01:11:34
Schilling: Correct. And that's one of the challenges then, too. Not only coming up with these chemical derivatization procedures to get the most information from the smallest sample possible, but then how you treat the data, how you interpret the data. That's another challenge. So finding the best analytical method and finding the best way of getting information from that chromatogram.

02-01:11:56
Eardley-Pryor: They analyze it—

02-01:11:53
Schilling: And the mass spectrometer is the last step, is the detector. It's a really good detector. It operates in a vacuum, so this molecule exits the GC column, it goes into a vacuum. And as soon as that molecule gets into the mass spectrometer, it gets zapped by a current of electrons. And the current of electrons have high energy, and it breaks that molecule up into fragments. So it's kind of like breaking apart something like a Tinkertoy thing, you know? Or a Lego giraffe. You'd break it up into pieces, the mass spectrometer measures the mass of each peak, so how much each peak weighs, and you get a bar graph. And the bar graph, the x-axis, is the mass of that ion fragment that's formed from the molecule, and the intensity of it is how much of it forms. So that bar graph, then, is a mass spectrum that is like a fingerprint for that molecule. Because when that molecule enters the mass spectrometer, it always breaks apart into the same set of fragments that are then weighed by the mass spectrometer. And it always gives you the same bar graph.

02-01:13:15
Eardley-Pryor: And that's what creates its—that fragmentation, the mass of that fragmentation is what creates its unique signature?

02-01:13:21
Schilling: Correct. That's correct.

02-01:13:26
Eardley-Pryor: So the gas chromatograph, after you've gotten the peak from it on the chromatogram of what that molecule is, you've identified this as one of your markers, it then gets ionized and shattered into bits.

02-01:13:36
Schilling: Yes. Mm-hmm.

02-01:13:38
Eardley-Pryor: The shattering of that marker compound that the gas chromatograph told you, then, is measured to find its identity based on its mass.

02-01:13:48
Schilling: Right. You get a spectrum of the weights of each fragment that forms, reproducibly, when that molecule gets zapped by that current of electrons.

02-01:14:03
Eardley-Pryor: That's great.

02-01:14:02
Schilling: Yep.

02-01:14:03
Eardley-Pryor: That's how, together, you get not only what the markers are and how much of it is in there, but also what exactly those compounds are.

02-01:14:12
Schilling: Right. The GC is good at measuring them out. The peak area relates to how much of that marker is present, and the mass spectrum tells me what molecule that is.

02-01:14:22
Eardley-Pryor: That's great.

02-01:14:23
Schilling: So one without the other is less useful, isn't it? If you know that things are coming out and some are big and some are small amounts, but you don't know what they are, okay. There are ways of getting around that. And again, if you don't have the GC and all that vapor just goes in as one big cloud into the mass spectrometer, then all those different chemicals are ionizing at the same time, and you get this really confusing-looking mass spectrum that's a composite of all of the mass spectrum of the individual chemicals that are in that cloud.

02-01:14:54
Eardley-Pryor: So you need the GC to separate them first, before you start trying to identify what those molecules are?

02-01:14:58
Schilling: Right. You get specific. So the great thing about the mass spectrometer is the specific detector. There are non-specific detectors, or non-selective detectors, that just measure some kind of signal. But the mass spectrometer is like a selective detector, because it gives you compound-specific information.

02-01:15:20
Eardley-Pryor: You mentioned before FTIR spectroscopy, Fourier-transform IR. As another identification technique, why not use that in addition, to GCIR? Why GC/MS?

02-01:15:35
Schilling: They have. Good job! You're a little late, but somebody did beat you to that, they had that good idea, too.

02-01:15:40
Eardley-Pryor: Why is that not something that you use as one of your leading identifiers?

02-01:15:45
Schilling: There are just different reasons. For infrared, you have to pass that gas through some kind of cell that contains it. Infrared light has to pass through that cell. And these compounds tend to get a little gunky, you know? They start to weigh a few hundred grams per mole—it's a little oily, right? Yeah.

02-01:16:07
Eardley-Pryor: They start sticking to the cell.

02-01:16:09
Schilling: Fatty acids, a little greasy. Doctor doesn't want your arteries to grease up, and your cardiologist is concerned about that, right? These things get a little greasy. So if that grease starts depositing on the walls of that little area where the infrared light passes, now you're starting to get interference. So it's just not as good. So it's been around a while. There is a lab that has one in our field, I think it's in—where is it, Norway, maybe? Can't remember. Maybe Norway. But not as useful. But it is possible—the nice thing about it is, unlike the mass spectrometer that totally obliterates the molecule by that electron beam, you pass infrared light through it—no problem. That molecule will come out again. And then it could go into the mass spectrometer. So when you link one analysis technique to another, it's called a "hyphenation." So you have GC-MS. So if it was GC-IR-MS, you'd get GC separation, infrared spectrum, mass spectrum.

02-01:17:28
Eardley-Pryor: And you'd just get a different kind of data output, and different identifiers.

02-01:17:29
Schilling: Yeah. Now you'd have multiple sets of data.

02-01:17:34
Eardley-Pryor: The front of end of this, when you're making your choices about what kind of chemistry you'll do before you enter the sample into the GC, where are you getting your ideas for that? You mentioned reading the literature from somebody—

02-01:17:46
Schilling: Oh, definitely, literature. You just find out what other people are doing, and you learn a lot. And not just from our field, but also related fields. So food chemistry. There's natural products, or food. That's probably how they (food) started becoming binding media, somebody had a cereal bowl that had sticky milk in it, and somebody dumped dirt in it, and wow, look at that really sticks well to that bowl. I can't get rid of it. Well, let's start painting with it, you know? You could imagine some stupid thing like that actually happening in some kind of real life, where sticky material, let's mix it with a pigment, put it on the wall. Put it on this piece of wood. Put it on this canvas. So the food industry is actually a useful place to get information, or mechanical literature, you know, if they're interested in tree resins, or waxes. You know, they were used at Sunkist, they're used in candles. They're used in making those stationary phases in GC columns. They're used as lubricants. So a lot of related literature has value for us. So we just have to be aware of the related literature.

02-01:18:58
Eardley-Pryor: How has that changed over time? From the early eighties doing this work, the beginning of your work in binding media, to the work that you're doing now in looking for ideas to inform your processes, how has that changed?

02-01:19:11
Schilling: Now I think there's just so many people that have a GC/MS or a pyrolysis GC/MS in our field, that now we can actually look at our own literature, which is kind of cool that it's—

02-01:19:21
Eardley-Pryor: Within cultural heritage?

02-01:19:21
Schilling: —that it's—yes. Now there are many more cultural heritage journals specifically for that topic. So now we can look at what each other are doing. So that's really great that we've matured to that level. One of the—certainly our work has played a role in the adoption of GC/MS by their labs, but a big project that came out of Holland some years ago was the MOLART project. And the Dutch government gave Jaap Boon, a researcher at their Cal Tech, basically, the FOM, the Molecular Physics Lab in Amsterdam [the FOM Institute for Atomic and Molecular Physics (AMOLF)], $5 million euros to study art. The man is an absolutely genius, at doing mass spectrometry. He is an absolute genius in just applying mass spectrometry to materials like coal and peat, and you name it. So he just started getting interested in art. So he got this money and produced so many PhDs, and they really revolutionized the

way oil paint chemistry is understood, because they had access to a range of techniques that none of us did. So they learned a lot about it, and they had a lot of graduate students, and undergraduates and post docs working on this project.

So that was a real turning point in our field, where some really high-quality science was done for a sustained amount of time, led by a well-respected researcher with impeccable credentials. And it just took all those observations that conservators have, like why are these little crystals growing? What are these little indentations in the paint? All these things that conservators are great at finding. He was actually able to come up with a new expression of the way oil paint changes when it ages. So it was really a breakthrough—

02-01:21:22
Eardley-Pryor: When was a lot of that work done?

02-01:21:25
Schilling: That was done in, I want to say, the late nineties is kind of when it started. So we were already well into doing kind of traditional GC/MS work, developing our quantitative methods. But those quantitative methods wouldn't have answered the questions that the people at the MOLART were asking, because it needed a whole new set of tools. So they, again, being a well-funded basic research institution, they threw the whole kit—whatever they had at it, they threw it at it. And they had the really bright people there, and they learned a lot. So the model of oil paint agent now is thought of as an ionomer. It goes from a glyceride-based oil matrix to an ionomeric matrix. So you have lead basically coordinating soaps of fatty acids, so fatty acid soaps form, and it's the lead pigment grains that are linking the fatty acids together. So it converts in a space of about a hundred years from a glyceride backbone to a lead pigment grain backbone.

02-01:22:40
Eardley-Pryor: And that allows it to, I imagine, last through time longer.

02-01:22:42
Schilling: That's why it lasts, yeah. I mean, those old masters were using materials that it just turned out were super durable. They had no idea what they were doing, of course.

02-01:22:51
Eardley-Pryor: Yeah, hundreds of years later.

02-01:22:52
Schilling: Yeah. So when a paint has lead in it, that's a good thing. So lead white, red lead, orange primers that we would see as kids—those make really durable paints. But again, lead is a health issue. Have to get rid of it from house paints, you know? So moving away from lead for health reasons and safety reasons has led to problems, then, with modern oil paint formulations that lack the lead pigment that will coordinate the fatty acids from the oil.

02-01:23:31
Eardley-Pryor: So the long-term vision is that the modern art is more ephemeral?

02-01:23:35
Schilling: Yes and no. Because then, you know, oil is just one medium that modern artists have. I mean, acrylic paints are the most stable medium that we have. You just cannot measure change of them. They're just wonderful, durable things. Yeah. So the military doesn't use lead and oil paint to cover their aircraft, right? Not going to happen. It's going to burn off. But they can make high-tech coatings. So that's one of the interesting things that's happening. Not in my lab, but Tom Learner has worked with researchers in aerospace, basically, to see if some of those really highly-durable coatings that they apply to aircraft could be used to paint sculpture, outdoor sculpture, that gets beaten to death by the elements. And they work. They work really well.

02-01:24:28
Eardley-Pryor: That's fascinating.

02-01:24:30
Schilling: And their proprietary formulations, and we just kind of get them from them—yes, thank you very much, and we try them out on sculpture, and sure enough, they're really durable. Yeah, it doesn't have to be made from linseed oil and lead white to be durable.

02-01:24:42
Eardley-Pryor: That's really great.

02-01:24:46
Schilling: But it's just a different set of challenges. It would require different kinds of analytical protocols to look at things like that.

02-01:24:54
Eardley-Pryor: Do you mind if we take a little break here?

02-01:24:56
Schilling: I'm fine.

02-01:24:56
Eardley-Pryor: I'm going to take a little break.

[Break in audio.]

02-01:25:03
Eardley-Pryor: Okay, Michael. So tell me about the work that you're doing, and then also in this moment in 1996, you have a new location for doing your work.

02-01:25:08
Schilling: Yes.

02-01:25:08
Eardley-Pryor: Tell me about that.

02-01:25:11
Schilling: One of the things that we were all anticipating at the GCI was when the Getty Center would open. That's when all of the individual institutions that were living out their lives in leased buildings would suddenly have one campus. It was really a great moment in the life of the Getty Trust, and all of the Getty Institutes, to finally come here in '96, to move into Richard Meyers's beautiful building. And it was a big moment. It was really the culmination of the dream of the original board of trustees, and our original president, Harold Williams, who had the vision to do this, to have this campus where we have a vibrant academic life. And bringing everybody together, except the Antiquities Collection—Antiquities Collection will be where it's best on display at the Getty Villa. But that was a big moment in the life of the Institute. And it was soon after we moved here that Mr. Williams retired. We had a new president of the Getty Trust, Barry Munitz. But it was an exciting time for us to have that transition; leaving the old behind, coming to a new location, and picking up where we left off, and having new challenges.

One of the challenges that we decided to tackle in binding medium research then, we had developed these wonderful methods for identifying the different binding media with GC/MS. We developed all those protocols. And the head of the Science Department at the time, Alberto Tagle, thought—he pulled me aside one day, he said, you know, people don't get a chance to read scientific articles as much as they could, so you might have these great protocols described in the literature. Let's do this, let's go ahead and have an analytical workshop, and you and other GCI scientists teach these methods, then, at these workshops. So the first one we did, I think it was at winter in 1998. And it really started the trend for us working with our education department to put on a workshop; education would put together all the materials, do all the logistical planning, the announcements, help in the selection of the participants in the workshop. Then the scientists would teach it. And we've been doing that ever since. And we've slowly developed a reputation for delivering high-quality workshops in that way. So it's been a nice feature of our life, where we're giving back to the community. We've taken a lot from the community, looking at articles, working with people. Now we're giving back these new methods that we've developed. And—

02-01:27:48
Eardley-Pryor: That was something Alberto was keen on making sure was a part of the GCI's mission.

02-01:27:54
Schilling: Yes, absolutely.

02-01:27:53
Eardley-Pryor: And came to you to help make that possible?

02-01:27:58
Schilling: Correct. Yeah, our website is Getty.edu, so we're an academic institution. And we try and live up to that by delivering the best training that we can, no matter where. Training is involved in lots of different aspects of our life here and our culture here. And it's exciting to be a part of that. I like teaching, I like to talk about what we do. I like to let everybody know about the great work that takes place here, because so many people put so much of their lives into it, that I really want to make sure that—and we all want to make sure that everybody gets a chance to experience all of that hard work and creativity and passion that's gone into our work.

02-01:28:37
Eardley-Pryor: What were some of your memories of that first workshop?

02-01:28:38
Schilling: It was in Delaware, at the Winterthur Museum. It was very much a workshop with the training wheels still on. We were still learning how best to do it. We taught a number of different techniques, so it was different than what we do now. Now we do very focused workshops. At the beginning, it was really analytical techniques for conservation scientists, so we had a large number of scientists participate in it, each talking about their own area of expertise. Now they tend to be focused on one particular type of method, or analysis of one type of thing. So we'll certainly talk about the lacquer workshops that we do in China at our field sites, but that was really the first. I really credit Alberto for having that idea to do that, because it was really true.

As a scientist, if I'm used to analyzing something a certain way, I'm a little reluctant to change that and do it a different way, even if somebody writes a paper that says, "Yeah, this works really well." Because like I said, sometimes all those details can't fit into an article, in a journal article. You want to talk to the person who developed the method. That's the chance for the participants to do that, and see, "Okay, this really is a better way of prepping samples and analyzing the data. So I've got just enough motivation now to change, and start doing it this way." And by doing that, they become part of an analytical community that uses these tools that we develop. So community building has been a great offshoot growth from our workshops. It's just been a wonderful experience to be a part of that, forming these communities.

02-01:30:25
Eardley-Pryor: You framed the work that you do here so nicely, in a way that's complementary to the other aspects of the institution—that the analytical work is complemented so richly by the conservators who are also then working together with you.

02-01:30:39
Schilling: Yes.

02-01:30:41
Eardley-Pryor: I know that's part of the workshop model now, to have scientists and conservators come together to collaborate. In these early workshops, was it strictly just scientists?

02-01:30:51
Schilling: It was just the nerds, yeah. Yeah, just the lab rats like me.

02-01:30:55
Eardley-Pryor: Tell me what's—

02-01:30:54
Schilling: And it was more effective that way, because we were really teaching the geeky stuff that the conservators wouldn't benefit from. The other workshops where we involve conservators gets more related to studying an object together—to kind of pattern it after the work that we do on an object. So we'll definitely talk about that when we get to lacquers. And that was the key defining feature, I think of the lacquer analysis workshops, is that partnership to try and recreate the partnership that we have with Arlen Heginbotham, a Decorative Arts and Sculpture conservator in the Getty Museum Conservation group. So that was to recreate that. But this was strictly geekdom. Let's get the nerds together and show them what we do.

02-01:31:43
Eardley-Pryor: Great. Also, so binding medium workshops arose out of this. I want to revisit a little bit this transition to the Getty Center location. The work that you were doing, you said, didn't really change much. You were still moving through your analytical methods and doing processings.

02-01:31:59
Schilling: Yes.

02-01:32:00
Eardley-Pryor: But what about the broader experience of your work environment? How was being here different for you?

02-01:32:08
Schilling: I think being here has been great, because first of all, we're close to the museum, we're close to the Research Institute. This is where the Getty art is stored and displayed and cared for. So we have much closer ties now to the conservators and the curators. So it makes that connection much easier. When we were all alone in Marina del Rey, we were closer to the Marina, which is a great view, but it was kind of a lot to get to the museum, to get to the conservators, who were still working at the Villa site. And again, it was harder still to reach the curators. Now we're all on the same campus. We can now start working with the Facilities department, if they're interested in monitoring pollution levels, or particulate levels in the gallery spaces. We're here to do that, if there are questions related to display materials in the museum, when they're making display cases, storage cases, we're here. So it's just much

easier. And the food's better. It's nice being here and treating ourselves at the Getty Café to lunch every day.

02-01:33:11
Eardley-Pryor: It is delicious!

02-01:33:12
Schilling: But one thing that was a real turning point then, was when Tim Whalen became our director. So we had a change in leadership at the GCI, Miguel Angel Corzo resigned, and Tim Whalen, who was the head of the Foundation, the Getty Foundation, was introduced to us by our president, Barry Munitz, as his Christmas gift to us. And he's been everything like that and much more. He's been so supportive as a director. And he fosters and encourages a friendly, collegiate, relaxed, collaborative atmosphere. And we all thrive under that, so we're blessed from that.

02-01:33:54
Eardley-Pryor: What had changed from before Tim's time at the helm? What was different?

02-01:34:02
Schilling: Well, that's a very good question. Miguel Angel was a gifted director. Each one of our directors have had different skills. Maybe part of it is because Tim has been the longest-lasting director, you know? We've been blessed for twenty years to have his leadership. And there's a lot to be said for stability at the top. And we had a better-crystalized identity at this point. When we moved in here, we'd already been around for fifteen years or so. So now we have a solid reputation, it was a little less random and chaotic, in kind of responding to the quirks of field projects and things like that, where we really wanted to make our name. Now we were moving into a more stable phase. We're all together on the campus. And that, undoubtedly, contributed. But Tim is just a really great person to work for. Yeah, he's just a great person to work for. I could go on for two hours about that.

But we've been blessed with that, and that stability at the top. He's brought in good people to work for him; Jeanne Marie Teutonico as associate director of programs—fantastic. So she has a great grasp on the field, especially field projects, built heritage—she's the best. And so our head of science then reports very much to her, because again, programmatic issues go through her desk. So that's just—they're a great team, Tim and Jeanne Marie, as a leadership team. Again, they've really made a stable environment in which we can all thrive and feel confident.

02-01:35:42
Eardley-Pryor: The confidence in the Getty itself, you had mentioned, was built up in part because of these outside projects, working in Egypt, for example. Another one of those signature projects was beginning work in China, and the Mogao and Yungang Grottoes. Can you talk a little bit about your experience working in those projects?

02-01:36:00
Schilling: Absolutely. It was a great time in my career. It was, let's see, it must have been the mid-nineties, I guess, '97, right after Tiananmen Square happened, so it was a traumatic time in the history of China.

02-01:36:15
Eardley-Pryor: After '87, is that what you're thinking? Because Tiananmen Square was '89.

02-01:36:17
Schilling: Sorry, '87, yes. Yes, '87. So 1990 is when we started our first project in Mogao, and we've been there ever since. And Mogao is a site, it's in the Gobi Desert. It's on the ancient Silk Road. It has five hundred and fifty cave temples; they were carved into a cliff. The cliff is about a kilometer long. The cave temples were various sizes and shapes, they're painted with wall paintings—again, similar technique to what we encountered in Egypt in Nefertari's Tomb. So earth plaster with straw and hair fibers, then colored with pigments that were actually peddled along the Silk Road. So it has a history from about 400 to 1400 A.D., so a thousand years of dynastic paintings are represented at this one site.

One thing I hadn't mentioned is, these field projects often were selected as the UNESCO World Heritage sites. So UNESCO recognizes them as having unique value in the world, for the world's cultural heritage. So it's a great place for us to hang our hat. We're working in those world heritage sites, then we know we're using and deploying our resources in a wise way, at a place that's significant, and usually at places with tremendous partners, because the strengths of our partnerships define how far we can go in a particular project.

And we've been incredibly blessed to work with the Dunhuang Academy, which is the organization that started sometime in the forties, late forties-early fifties, in Dunhuang, to care for the art at the Mogao Grottoes, this ancient site along the Silk Road. And there are these grotto sites all along the Silk Road. One of the things that was attractive for us to get involved in Dunhuang especially—and I'll talk more about Dunhuang and Yungang—Dunhuang was attractive, because again, whatever we learn in this one grotto site location could be applied at the other grotto site locations that were made in the very same way. So if we find conservation solutions and we learn material aspects of the sites, that can be applied everywhere. So education was a big part of that.

I came in, again, with skills in using color measuring in Egypt. I was able to apply the same tool, then, to the wall paintings in the Mogao Grottoes. And the Dunhuang Academy, much like the GCI, had the wisdom to hire scientists. So we had scientific counterparts working at the Dunhuang Academy, at their Conservation Institute; wall paintings conservators, historians—they're all there. Kind of like our Chinese counterparts, in a way. But they were responsible for this wonderful site, this unique site. And we were coming with our own perspective on how to study. And all these tools that we had access

to, some of them we could then start applying to studying the wall paintings there.

02-01:39:35
Eardley-Pryor: Tell me a little bit about that collaboration. With the scientists that are there, they have their own methodology. It's in their backyard, so they have a deep attachment to it. And these outside Americans come in with other different forms of methodology. What was that collaboration like in practice?

02-01:39:50
Schilling: I think one thing that I really admire in the Chinese psyche is their willingness to engage other people and learn from them. They have no problem saying, yeah, come teach me what you know. And that's a real strength. And people in the West are kind of loathe to admit that they want to know something, that they don't know this, and "Gee, I'd really like to learn it, but I don't want to look stupid," right? They have no trouble just saying, "Could you teach me? This looks really interesting, and I can use this."

So much like us at the GCI, when we started, they were just starting their labs when we started working there. So they had very little equipment. They looked to us, then, as experts in cultural heritage analysis and conversation, and what should we buy? What kinds of lab equipment should we buy? We started making recommendations, and given the facilities and infrastructure that they have there in the Gobi Desert, remember, they were able to replicate some of what we do right there in Dunhuang. So they didn't have to send samples to us, they could analyze them in situ. They got the color measuring equipment. They got the polarized light microscope to identify mineral pigments. They could take cross-sections and look at the layering, a stratigraphy of the wall paintings. There was a lot they could start doing there, even before they bought more high-tech equipment like the FTIR. So that was a great collaboration for us.

It's always fun to go out in the field. It's challenging to work in the field. We're in the ivory tower here, we're in the castle on the hill, you know, in the West side. We have everything at our disposal because of the vast resources that we have access to, because of the fiscal wisdom and responsibility of our money managers at the Trust and, ultimately Getty's legacy, in making all of this happen. It's a little different when you're working in the Gobi Desert. So things you take for granted here, it's, like, how can I get distilled water? "Ooh, that's a little bit of a problem." Where can I get a hotplate? Little things that make a difference to the success and failure of our work, suddenly now become more of an issue. So really, we were helping them build up in much the same way that I was involved in the building up of what we have here now, at the very beginning, starting from scratch. That was fun.

02-01:42:11
Eardley-Pryor: How does that work mechanically—actually, how does that work financially? The Getty's bringing expertise. Are they providing their own resources to provide—to build up their lab?

02-01:42:24
Schilling: Yes. Absolutely. The Chinese government funds that. They have a cultural heritage group, SACH, State Administration for Cultural Heritage. And the Mogao Grottoes gets funding from the state. They have a cultural heritage agency that provides the funding. Then they also get funding from the receipts from the visitors, who buy tickets to see the site. So they have multiple revenue streams. But a lot of it comes from the state. And they were very generous, and they fund our travel and our accommodations there. All we have to do is show up, right, and work, and they'll take care of the rest.

02-01:43:02
Eardley-Pryor: Tell me a little bit about that travel experience.

02-01:43:02
Schilling: Oh, it's so long to go from LA, we used to have to fly to Tokyo, and then we had a stopover there, and then the flight to Beijing. You get to Beijing at 10:00 at night. Then you get up early the next morning to catch a little commuter plane that would take you halfway to Dunhuang, you have to spend the night halfway. First time we stayed at a guest home for the Chinese Communist Party, that was kind of cool.

02-01:43:31
Eardley-Pryor: Whoa!

02-01:43:34
Schilling: Very nice. Very clean, but simple. Then the next morning, we get up early again and get that last connecting flight to get you to the sites. It was a long, grueling experience, two to three days to get there—

02-01:43:45
Eardley-Pryor: To get to the Gobi Desert.

02-01:43:46
Schilling: And you're there for three weeks, then you come back, kind of repeat your route.

02-01:43:50
Eardley-Pryor: Who is "we," whenever you say "we?"

02-01:43:52
Schilling: So "we" would be the project team. Neville Agnew was the project head. He's still the head of our projects that remain today in China, and then we had conservators; Leslie Rainer, Lori Wong later, Po-Ming Lin is our translator, or facilitator, makes things work. Shin Maekawa, I mentioned, did climate monitoring. I know I've left people out. But it was a big team.

02-01:44:22
Eardley-Pryor: This whole contingent would go?

02-01:44:22
Schilling: Would go, absolutely. And Jonathan Bell was in there. We had other people, a China fellow at one time. So it was a real Getty team. And they gave us accommodations at different hotels, the Capital hotel, Dunhuang Hotel. And it was a drive to get to the site from the city. It was an oasis city, agriculture was key, you're in the Gobi Desert, you'd better grow your own produce, you'd better raise your own animals for food. So there's a lot of agriculture going on, which connected with my Cal Poly roots. And then also, there was a petroleum refinery, in a nearby city where a lot of the workers would work.

But anyway, you would go past an ancient graveyard, which really was a nice transition, seeing the reverence for the dead that they had there, and then you'd get to the site. And it's just a really picturesque site. It's in the convergence of mountain ranges, sand dune, and then this fertile valley, where you have the oasis and the runoff from these snowcapped mountains. So there are places where you can climb and you can get a view of these three different landscapes. Really unique, really lovely, remote. Such a great place to visit, great place to work, wonderful collaborators. And our first project there was really to help them get started, to build confidence working with us. Again, you mentioned we were outsiders coming in doing things differently—

02-01:46:09
Eardley-Pryor: Right in the wake of Tiananmen Square, at that.

02-01:46:11
Schilling: Yes, exactly.

02-01:46:13
Eardley-Pryor: Was that an issue that came up?

02-01:46:15
Schilling: Hush-hush about not saying anything about Tiananmen Square to anybody. That was sensible. It didn't get them in trouble, it didn't get us in trouble. And it was totally immaterial to what our mission was, which was to help conserve a world heritage site.

02-01:46:34
Eardley-Pryor: You mentioned you did similar to work that you had done in Egypt, the color measuring you also did in Mogao and the Grottoes.

02-01:46:37
Schilling: Correct.

02-01:46:39
Eardley-Pryor: At the same time, weren't you also developing your binding medium research?

02-01:46:43
Schilling: Yes, that's going on at the same time, back home.

02-01:46:48
Eardley-Pryor: Were you applying some of the binding medium research into your work in China as well? Or was it strictly—

02-01:46:52
Schilling: Absolutely.

02-01:46:53
Eardley-Pryor: You were?

02-01:46:55
Schilling: Yeah. So those techniques, it didn't matter where the binding medium originated, wall painting medium, it was the same kind of materials that would be used on easel paintings. So everything we developed for the binding medium project was relevant. And they used particular binding media that performed well, so it tended to be animal glue-based materials, so collagen materials, bones that they could extract collagen from. Collagen's a really stable organic polymer, it's a great adhesive—hide glue, things like that, skin glue. So it's always called "glue," but it's collagen, basically. And it can be extracted from those products, and it's a wonderfully durable, binding medium. It produces a very matte surface. And that's what you see when you walk into those caves. They're not glossy wall paintings, they're matte, and they're lovely in situ, in that diffuse light that's coming in through the doorway, kind of bouncing off the sand dunes and the mountains. It was really lovely.

So we could apply the same techniques. And it was a good thing that we took a lot of time to develop methods that could extract the most information from a small sample, because the amount of binding medium after, say, eight hundred years of aging, twelve hundred years of aging, is not much. So it's in the neighborhood of a percent.

02-01:48:25
Eardley-Pryor: So the pigment remains, but the binding medium disintegrates over time?

02-01:48:28
Schilling: And it can move around. It can kind of move into the plaster a little bit—lots of things happen. We're still not sure exactly what happens, we'd like to do more research on wall paint media, just to see if we can understand it better. But microorganisms can play a role, chemical degradation, things like that. So that's an interesting aspect of it. And we got into that later, in a later phase of the project. But at the beginning, that first years was really, let's learn about the site. And Po-Ming Lin and Neville and our colleagues at the Dunhuang Academy came up with a way of stabilizing the top of the cliff. They had a lot of sand from the dunes running off, so they came up with a fencing that was renewable, with a vegetation fence, and a wind fence that reduced the flow of

sand, that endless cascade of sand over the cliff. So now the cliff looked much better, it was more stable. Did a lot of that, documentation, forging those partnerships, doing some teaching, and just getting to know the conservation methods that were being used there, many of which were kind of influenced by Russian restorers who also worked at the site decades before we started. And they had their own way of doing the conservation work.

02-01:49:51
Eardley-Pryor: Oh, that's interesting.

02-01:49:54
Schilling: Yeah.

02-01:49:53
Eardley-Pryor: The Soviets, aligned with the Chinese Communists, were preserving the sites then?

02-01:49:57
Schilling: Correct. That's correct. Because geographically, it's close.

02-01:50:00
Eardley-Pryor: That's right.

02-01:50:02
Schilling: But anyway, that was more or less what we did in that first project, where we worked in a number of caves, kind of documented them. What are they like? The styles and techniques were different because they were painted in different dynastic periods. So, interesting place.

02-01:50:18
Eardley-Pryor: You'd mentioned when you spoke about Egypt that it felt like a time machine. What was the feeling like, being in this space?

02-01:50:23
Schilling: Like another planet, because it's such a stark environment, you know? Sand dunes and these really rough-looking, jagged mountains, and this fertile valley. Just geographically, it's so unusual there, that it's like, "What do you want to do today?" "Well, let's like hike up a sand dune. Well, let's walk along the river"—just endless recreational diversions that you could do. Shin and I would go on long walks after lunch, just to explore and climb, and look at the site from different perspectives. So it was a different feeling, you know? It's only about a thousand years old, the ones that we were in, fifteen hundred years old. Egypt, double that. I know. So, less of a time machine. And again, maybe it was just because I was a new conservation scientist. That was my first exposure to antiquity in situ. That will engender a different emotional response, absolutely. I don't think I'm jaded yet about those experiences, but you can imagine that— "See it again? Okay." Now I'm starting to feel more comfortable in it.

02-01:51:44
Eardley-Pryor: Do you have any stories to share about your travel experiences in China in the early 1990s? All these different stops to come through.

02-01:51:48
Schilling: Definitely.

02-01:51:49
Eardley-Pryor: I can't imagine all that went smoothly.

02-01:51:55
Schilling: Yeah, it's interesting, the travel mercies, kind of going from point A to point B, it was just challenging, all of those stops and hiccups and, you know, having to stay overnight at a hotel that was really run down, sewage leaking into the lobby.

02-01:52:12
Eardley-Pryor: Wow!

02-01:52:13
Schilling: Pretty unpleasant. But great bonding experiences. Those are stories that we can share, you know? We did it together. And we experienced it together, and we thrived, and we did something really great at that site. And we continued to work there. Neville has just been that really inspirational leader, a mentor to me, in just the way he goes about thinking about a project and planning it, and working with people, bringing the right people together. He's diplomatic. He has so many great qualities. He never realized he was mentoring me. It was just me observing him, you know, doing his Neville thing. And it was just great working under him in that capacity, in a very different environment. Different country, different language, different social attitudes, different mores. But everyone convened around the art. Everyone convened around these beautiful wall paintings that have been so well-cared for by the Dunhuang Academy staff. Their leadership, just such great stewards. You know, I can't say enough good things about them. They're very careful, they're very measured. They take a very solid approach in how they deal with this priceless treasure that's out in the middle of nowhere.

Now, we've seen the whole country transform economically, as the economy developed. And then life started changing; materials started changing, what you could buy changed. The town changed. The level of affluence changed.

02-01:53:57
Eardley-Pryor: In what ways?

02-01:54:00
Schilling: It just started to feel more and more like home, in a way, you know? Suddenly now it didn't seem so remote, where you used to have ox-drawn carts, now you had cars and tractors, you know, more automobile traffic, different kind of clothing. It was very much like the China—when we started going there—that Nixon exposed us to. Didn't look that different to me at the time. Sun Yat-

sen jackets, you know? I bought one. I thought, "I'm getting a Sun Yat-sen jacket, absolutely." I wore it to a banquet. They're big on banquets. You arrive, they have a banquet in our honor. We leave, they have a banquet in our honor. And I had to wear that, had to do that to respect my friends there, and give them a laugh because it looked just crazy that some idiot from the West would be wearing one of those things. But anyway, just great friendships that started there, and continue even after the many decades of being there.

But that first project was a success. It culminated in a symposium, it's the first Silk Road Conference.

02-01:55:07
Eardley-Pryor: What are your memories from that?

02-01:55:10
Schilling: It was great to have experts in different aspects of cultural heritage, so we had people from tourism—kind of looking at the writing on the wall and warning us in advance, decades before it started happening, that "Hey, has this economy improved? There's going to be much more tourism, so get ready for it now. Start planning now." Robbie Collins.

02-01:55:39
Eardley-Pryor: We can fill it in.

02-01:55:43
Schilling: I'll think of it. But anyway, he told us all about what was going to be happening in the next ten or twenty years. And he was right. Tourism really has increased in Asia, all throughout Asia. And we had other people who worked at other sites. We had people that worked on Chinese objects, wall paintings that were actually removed from sites and put on display in Western museums. There's a whole range of art historians and Sinophiles, and scientists and conservators, and just you name it. It was a really great experience. And we talked a little bit about what we did in our project, too. So that was great. We had tours afterwards that went out, and we went to a Uyghur village. Uyghur is a minority population.

02-01:56:32
Eardley-Pryor: What was that like?

02-01:56:33
Schilling: That was just very different. People looked different, you know, they're a different ethnicity. They have different traditions, farmers are very welcoming. Big, big men, huge hands. I had like a child's hand when I shook the man's hand who hosted us. And we sat in his front room on cushions on the floor, and we had this feast. It was wonderful. Children were performing music for us. We went on tours of different sites, a city called Turfan, where they actually have a wine industry now. It was just starting back then. And it was just great, seeing the landscape, it's just so different. But kind of reminiscent of the Southwest, and what you see in the desert states and the

Rocky Mountains. Some of it's there, you have a little bit of connection back home. So that was just a great experience, that first China project.

02-01:57:30
Eardley-Pryor: When you had come home from these trips, what were the things that your family was most interested in hearing about?

02-01:57:38
Schilling: Kind of what we ate. Because what we ate was very different. It's not the kind of Chinese food that you would normally get at a Chinese restaurant here, especially thirty years ago. Now I think it's more authentic, because there are many more Asians that had moved to Southern California, and it's really transformed the dynamic and the lifestyle that we have here, and the different cultures bring just definitely different food. But the food there was wonderful. And again, magnificent hosts. So they had a special chef cook just for us at the site, every day. And he did a wonderful job. He'd always come out, "How was it?" We'd clap, and, "Oh, this was wonderful!" So things that we liked, he always had more of the next day. And it's just great. But we would eat really exotic things. You know?

02-01:58:33
Eardley-Pryor: What are some of your memories of, you know, like, "I've never had this."

02-01:58:36
Schilling: Oh gosh, what could they be? Ox head, that was an interesting one. Really nice vegetables that were grown in greenhouses in Dunhuang, you know, with that water that's coming from the runoff from the snow-packed mountains. We had donkey meat, dog meat. We had different parts of bulls that I don't even want to talk about. We've had snake, we've had all kinds of things. It was really interesting. They eat everything there. And they all have different textures and flavors, and they're all cooked really well. They really did so—again, they spared no expense. And they treated us like royalty.

02-01:59:20
Eardley-Pryor: How did the project itself change you as you transitioned away from the site conservation work to the next phase, that was more the wall-painting conservation?

02-01:59:32
Schilling: Yes.

02-01:59:32
Eardley-Pryor: How did the project change in your experience?

02-01:59:34
Schilling: So once we knew more about the site itself, then Neville thought, "Okay, now we know kind of the conservation practices and protocols. Now we know the level of science. Now we know some of the background about the site, kind of a little bit about how the wall paintings were made." Now we felt like we had enough knowledge to work with our partners there, and with wall-paintings

conservators from the Courtauld Institute from London, who knew a lot about wall-paintings conservation, diagnosing, things like that, treatments, to now start tackling kind of representative problems.

So what are the big problems in Dunhuang? It would be salt, just like it was in Nefertari's Tomb. Salt is present in this cliff. It worked its way into the plaster, because the plaster was applied wet, and it acted like a poultice, it pulled salt in. And salt, like sodium chloride, table salt, deliquesces. So above a certain relative humidity [RH], the salt becomes saltwater. For sodium chloride, that critical RH is 75 percent, so above 75 percent RH, you have saltwater. Below it, you have crystals of sodium chloride. So you know, when crystals grow, they grow from solution, and then they start taking on a three-dimensional structure. If that three-dimensional structure is just taking place on a dish and the crystals are growing like that—no problem. But if those crystals start to grow inside of a porous plaster, and now they start exerting forces as they grow, they start slowly and inexorably breaking down the plaster.

02-02:01:26
Eardley-Pryor: Which is what the paintings were on.

02-02:01:27
Schilling: Correct. And the salt can get into the paint and start disrupting the paint and making the paint pop off. So deliquescence and recrystallization of hydroscopic salt is a major problem at sites and monuments and wall painting sites around the world. The Sphynx is suffering from salt deliquescence problems, because there's a lot of salt in the stone that the Sphynx was carved out of, for example.

So we had to understand that, and what is the composition of the salt? What is that critical RH above which deliquescence takes place? How can we keep the RH from getting above that RH, so that we don't have deliquescence happening, right? Those are environmental issues. Those are site management issues. Those require weather stations to be put up by Shin Maekawa, our resident engineer and expert in that, and monitor the environment carefully. You only get about an inch of rain a year in Mogao, but it's concentrated in a short time period. So you get this intense rain, spikes in RH, above the deliquescence RH, and these cycles happen. And you can imagine, we picked one cave that was large, that had the range of problems. The caves are numbered there—cave number 85, Late Tang Dynasty, so from around 800 or so A.D. So it's been there for twelve hundred years, right? Still surviving, has problems from deliquescence mainly, and some light damage from that Gobi Desert sunlight streaming in the doorway. But in general, still in good shape.

And we wanted to work with our colleagues at, again, the Dunhuang Academy Conservation Institute, and the Courtauld Institute to come up with a strategy for doing the analysis, documentation and treatments. And it's flaking salt problems, crystalline salt problems. It's powdering plaster,

because the solid plaster starts to become powdery as the salt crystals grow inside, and then dissolve and grow, right? So how to consolidate flaking plaster, or powdery plaster, and how to re-attach plaster to the wall if the plaster has kind of pulled away from the rock. All of those complicated things that conservators had to handle with some analytical assistance from us, the scientists.

02-02:04:04
Eardley-Pryor: What was the analytical addition that you brought to that?

02-02:04:07
Schilling: Pigment identification, binding medium identification, characterizing the salts, measuring the salt concentration in the different layers. Identifying organic pigments, which was a new discovery, that organic dyes were used there. Fiber identification, plaster characterization—I think that was it—and then a little bit of coating identification, because again, the Russians showed them how to use certain types of synthetic polymers to kind of treat flaking paints, so some of the walls still had that on it. We wanted to know where it was, and what it was. So that's kind of a range of analytical problems that we've covered. And we worked there for years, again, working hand-in-hand with the conservator teams to find areas where we could take representative samples that would give us a meaningful understanding of this entire cave, which was probably about this width of the room we were in, and maybe twice as tall, so it's a huge space.

02-02:05:19
Eardley-Pryor: And these are all hand-carved caves into the stone?

02-02:05:23
Schilling: Yeah. Hand-carved, hand-painted, even up at the ceiling levels.

02-02:05:25
Eardley-Pryor: Remarkable.

02-02:05:26
Schilling: Yeah. Really a wonderful place. And all of the dynasties had different ways of making the structure, the shape of the structure, the type of roofing, the size, and then, of course, the art painted onto the walls was different, depending on the dynasty.

02-02:05:28
Eardley-Pryor: Tell me about how analysis happens in a field site like this. Do you take your sample and return to Los Angeles with it?

02-02:05:52
Schilling: Yes. The kinds of tests that we would do required equipment that we had here, and at the time there was very little way of imagining that they could install a GC/MS in the Gobi Desert, with electrical power that was a little bit flaky at the beginning, because they were still developing. So you have to have a stable power supply—that's something we have here in the West. But we

would bring scientists from Dunhuang, and they would spend a month with us. And they would see how we do the analysis, so they could go back and inform their bosses, "Hey, this is how they do the analysis. So if we're going to grow in this area, this is what we would need to do." So those training exercises here were quite helpful for the staff to grow and develop and promote.

02-02:06:47
Eardley-Pryor: It's almost like a workshop, but specifically with those particular scientists coming here for training.

02-02:06:50
Schilling: Correct. That's correct. That's correct.

02-02:06:54
Eardley-Pryor: Tell me about how you keep a sample without contaminants traveling from the Gobi Desert all the way back to Los Angeles.

02-02:07:00
Schilling: You put it either into a vial or a foil pouch, or you could put it into a plastic bag, depending on, again, what you want to do with it. Yeah, those are the main ways, so vials, pouches, foil. Yeah. Not so hard.

02-02:07:18
Eardley-Pryor: What are some of the other memories you have about that experience, specifically with cave 85, this emblematic cave that kind of served as a marker that could be replicated throughout the site, and then other places along the Silk Road? What are some of your thoughts of that experience, working in that cave?

02-02:07:34
Schilling: My admiration for conservators grew by leaps and bounds, because I really had a chance to work with the top people, both at our own Institute and at the Courtauld, and at the Dunhuang Academy, who really knew wall paintings. And honestly, when I started working in there and they said deliquescing salts are a problem, I laughed, because I thought there is no way that humidity is a problem here, because it's the Gobi. And it just didn't make any sense to me. But sure enough, yes, there really was a problem. And you can see the crystals. And if you take salt and go [blows] and just blow your hot, steamy breath on it, you'll see it dissolve. It happens in real time. And the other thing was that the conservator spotted traces of organic pigments. The Dunhuang Academy had the kinds of techniques to identify mineral pigments, but they didn't have the tools to identify organic pigments. If they were mixed together in a sample and then analyzed by their technique, they could identify the inorganic pigments, no problem, but that they would be completely invisible to those techniques.

02-02:08:49
Eardley-Pryor: They didn't know those markers.

02-02:08:50
Schilling: So they never realized that those organic pigments were there. When we got there, again, I naively thought, well, they've already studied the pigments for years. We're not going to be able to tell them anything new. But sure enough, those conservators knew what they were talking about. And they slowly convinced me that there really were organic colors there that have changed from sunlight exposure and chemical degradation over twelve hundred years.

02-02:09:16
Eardley-Pryor: And they could see that visually, without having done the scientific analysis?

02-02:09:20
Schilling: Absolutely. Because they're looking at the color and they're looking at the texture. They have little magnifying loupes that go over their eyes or their glasses, and they can see a magnified view. They have bright lights, and they learn so much, and I learned so much working with them. And I really feel dumb now, just thinking back to how proud I was, and how sure I was that they were wrong. It was such a great example of the place for modesty, when you're approaching a challenging problem, you know? Let's take the same kind of approach the Chinese have. Please show us how to do it. Please tell us what you know, you know? And that's really what I had to learn, working with the conservators, is that humility of, I don't know everything. Even if it doesn't make sense, it doesn't mean that it doesn't happen. It means that I don't have all the facts, and maybe somebody else does. So that was a great experience to learn that, side-by-side. I feel sorry for them now, what I subjected them go, the ridicule and the teasing. And they were absolutely right. And we learned so much about it, working together.

So we got samples of those places where they suspected we had organic colorants. And we had an expert in dye analysis from Belgium, Jan Wouters, worked with Cecily Grzywacz, who was in my group at the time doing HPLC, and Anna Claro, who was a Portuguese researcher, and they worked together to identify the organic colorants. To make a long story short, they developed an HPLC technique to identify organic colors that were used in China at that time. And sure enough, they found traces of them in those wall paintings where the conservators said they would be. They published that. And it's a really important publication in the area of Chinese wall paintings research.

02-02:11:18
Eardley-Pryor: Because it adds to the story of it.

02-02:11:19
Schilling: Yeah.

02-02:11:22
Eardley-Pryor: We talked earlier about the role that the historians and the story that the conservators know can add to the scientific analysis, and for you trying to know what to look for. And, of course, it works both ways.

02-02:11:35
Schilling: Yep.

02-02:11:34
Eardley-Pryor: What you're discovering in the lab adds more to that story and the meaning of the art itself.

02-02:11:39
Schilling: Exactly. Exactly. And again, that project went on for a long time, because conservation work is grueling. And it takes years to do it well. It's painstaking. They don't want to make any mistakes, they want to know everything before they do any what they would call "intervention," when they start working on the paintings and intervening and consolidating, and cleaning and treating. They want to know exactly what they're going to use, how it's going to perform under these adverse conditions. So that development work took them years. And they tried different grout formulations, and they tried different everything; all these things that might be applied in treatments.

That work then culminated in the second Silk Road Conference. That was another really monumental time for the GCI, because that was a significant milestone, helping our colleagues at the Dunhuang Academy, working together with the Courtauld experts side-by-side in this very challenging environment, on this very challenging wall painting conservation project. And it was really quite a moment in the life of our Institute, and in the life of the Dunhuang Academy, and the Courtauld. Ultimately now because of our long-term commitment there, the three partners then partnered with Lanzhou University, which was the closest big university to Dunhuang, to start a wall paintings conservation program. I have not been a part of that, but that's been another culmination, another educational outreach where quality researchers devote their time and talents to teach aspiring wall paintings, conservators—all of the ins and outs of treating wall paintings along the Silk Road sites. So it's really great to have been a part of that.

02-02:13:36
Eardley-Pryor: And that second Silk Road—International Silk Road Conference, I have a note that it took place in 2004, so about eleven years after the first one.

02-02:13:43
Schilling: Yes. That's how long these projects take. And again, they were divided up with a few years in between, while we were formulating our plans and working with our colleagues in China, to start figuring out what to do.

02-02:13:52
Eardley-Pryor: Right. This seems like a great point for us, I think, to pause, and then to start the story again at our next session.

02-02:13:59
Schilling: Okay, sounds good to me.

02-02:14:00
Eardley-Pryor: Thanks, Mike.

02-02:14:03
Schilling: You're welcome.

[Brief break in audio.]

02-02:14:04
Eardley-Pryor: So there's another story you wanted to share before we end today?

02-02:14:06
Schilling: I have just a few short stories about just life there, living in Dunhuang. There's a local beer, it's called Xiliang, so they kind of call me Xiliang instead of Schilling. That's my local beer. Oh, it's good. I learned how to use chopsticks in China, so one of the techniques I had to learn was picking up shelled peanuts with chopsticks, one at a time. Then again, Shin was trying to teach me how to pick up multiple peanuts on the chopsticks, catching flies out of the air with chopsticks.

02-02:14:43
Eardley-Pryor: Really?

02-02:14:43
Schilling: That was a thing I never got, never figured out how to do.

02-02:14:48
Eardley-Pryor: I always thought that just something in Karate Kid that Mr. Miyagi could catch the flies.

02-02:14:51
Schilling: It's pretty trippy, isn't it?

02-02:14:53
Eardley-Pryor: People actually do it?

02-02:14:53
Schilling: They really do go for it. Yeah, they're very gifted with those chopsticks. There was one day one of the Getty conservators, Francesca Pique became good friends all throughout the China projects and other projects that we worked on, one of the people whom I learned from greatly in China, and again, that lesson in humility, and what she saw in the wall paintings. Just a great colleague. She and I were walking through the site, and the prevailing winds at the site—everything was great when the winds blew toward the cliff face, toward this Grotto site where all the caves are. When it's blowing in that direction—great. Sand dunes are over here. When the winds change and they blow from here that way, it means there's a sandstorm coming, and the sky becomes red. You can feel the wind direction change. And we were there one day at the site and we saw a change, and we said, "Run!" Right? And we ran into one of the caves and we closed the door. It was like a red blackout curtain

was lowered. And it got dark, this fierce, brick red color was streaming in through the door around the cracks. And we just stayed there until the sandstorm subsided. It was really scary.

02-02:16:21
Eardley-Pryor: Trippy!

02-02:16:24
Schilling: Because if you get caught in one of those sandstorms and you're away from shelter, you're in trouble. You are in big trouble.

02-02:16:29
Eardley-Pryor: What did that do to the site, then?

02-02:16:32
Schilling: Oh, fortunately, all of the caves have doors on them, so the doors were closed. But we were lucky, we got to a cave where we could open the door and get in. So that was a scary time.

When we traveled, we always went in the best times of year for climate, so that's always spring and fall. It was never too cold, it was never too hot. You don't want to be in the Gobi Desert during the winter and the summer. Just stay away from it. But so we had our campaigns, we called them campaigns, so we would go out in the field. We had our spring and fall campaigns. And during the campaigns, it was always Neville Agnew's birthday. And they always made a birthday cake for him. And we were going out, so we had a birthday party for him. We had about half the cake, and we thought, "Okay, the next day we're going out to a site, we'll bring the cake with us, and we'll give it to the site manager there." We were going to a place called the Jade Gate. Now in my mind, I'm thinking "Ooh, Jade Gate, this is going to look really pretty," right? Just thinking lustrous jade everywhere. So driving out to the Jade Gate in a Jeep on a really rough road, boom, boom, boom, boom, boom—some of us were getting carsick, kind of roll the window down. And we get to the Jade Gate and we open up the trunk, and the cake had attached itself to the top of the box, it was kind of embarrassing to bring the cake out and say, "This will be brought to feed you." But the Jade Gate is an adobe wall.

02-02:18:14
Eardley-Pryor: That does live up to its imaginative name.

02-02:18:16
Schilling: It's the Western end of the Great Wall. It's the oldest end of the Great Wall. It's where jade, evidently, was pedaled through there. Not made of jade. It's just an earthen wall. But really cool aspect of it, when you get past that disappointment of not seeing beautiful jade everywhere, it had bundles of straw that were hundreds of years old that were tied together, and they were there in order for watchmen at the site to light a signal fire if there were

marauders coming. And they're hundreds of years old, these bundles of straw. They survived perfectly in the dry Gobi Desert climate.

02-02:19:01
Eardley-Pryor: And then someone from the distance would see the fire lit and then say, "Marauders in the distance."

02-02:19:05
Schilling: Yep. "They're coming. The invaders are coming," exactly.

02-02:19:07
Eardley-Pryor: That's really cool.

02-02:19:07
Schilling: So that was really cool. Those are my travel stories.

02-02:19:11
Eardley-Pryor: Those are some great experiences.

02-02:19:15
Schilling: Yeah, it was really fun. It's fun to do that together with your friends and colleagues.

02-02:19:16
Eardley-Pryor: I can imagine that bonds people that you work with in a different way to have those kinds of experiences.

02-02:19:20
Schilling: Absolutely. Absolutely. It really does.

02-02:19:25
Eardley-Pryor: Well, thank you.

Interview 3: April 19, 2019

03-00:00:00
Eardley-Pryor: Today is Friday, April 19, 2019. I'm Roger Eardley-Pryor from the Oral History Center of UC Berkeley at the Bancroft Library. We are in session three of an oral history with Michael Schilling. Good to see you again, Michael.

03-00:00:14
Schilling: Good to see you, Roger. Thanks.

03-00:00:16
Eardley-Pryor: Thank you. Yesterday, you were sharing some of your thoughts on Tim Whalen's leadership, and you had some additional pieces you wanted to add to help flesh that out a bit more.

03-00:00:24
Schilling: Yes, I thought about it. You asked a really good question about what makes Tim Whalen a unique director, what—

03-00:00:36
Eardley-Pryor: Of the Getty Conservation Institute.

03-00:00:37
Schilling: Of the Getty Constitution Institute. Thank you. And I felt like I didn't really capture everything that I wanted to say about him. So I thought about it on the drive home, and this morning eating breakfast. And I think the one thing that Tim does very well that we staff members respond to is, he's very caring and appreciative of our work. He's always giving us credit for everything, making sure that we know that we've contributed to the mission of the Institute, that we're responsible for the successes of our projects. He never takes the limelight for himself. He's always deferring the praise back to us. He'll leave me a voice mail. He comes in very early to work also. And I'll get in and there'll be a voicemail from him, just thanking me for something that I worked on, telling me that it was, you know, good quality, really represented the Institute well. When he's traveling, he'll send a photograph of an object that he's looking at in a foreign country, and he'd say, "Just thought you'd want to see this lacquered object." So, so many little touches like that that make Tim the kind of director you really want to support completely with, you know, everything you have.

03-00:01:56
Eardley-Pryor: Considerate leadership.

03-00:01:56
Schilling: Yeah.

03-00:01:58
Schilling: He's just a great leader.

03-00:02:00
Eardley-Pryor: It sounds like he helps create a great environment to work in.

03-00:02:02
Schilling: Absolutely. You just feel like part of the team.

03-00:02:05
Eardley-Pryor: And from my conversations [conducting preparatory oral history] research on your behalf, I've heard the same thing from people that you work with. You help create that environment, never taking the limelight on yourself, and really talking about the team's effort. So I can see that it creates—

03-00:02:19
Schilling: It all starts from the top, and it really filters down to all of us. And it's because of his leadership that that happens.

03-00:02:22
Eardley-Pryor: That's really nice, that's good collective leadership there.

03-00:02:28
Schilling: Mm-hmm.

03-00:02:29
Eardley-Pryor: Yesterday, we spoke about your use of GC/MS [Gas Chromatography-Mass Spectrometry] binding medium, and there's a story of getting—using binding media, and GC/MS—the work you did in binding media with GC/MS that leads to your next phase of research on modern paints. Can you talk to me a little bit about the story of how that happened? I understand there was a lecture you were giving at a conference, and it led to some next steps for your work, and modern media.

03-00:02:56
Schilling: That's right. It was an interesting moment in our work, because our analytical methods for identifying these natural products that have been used by old masters to make easel paintings was very mature. We didn't really have anywhere else to go with it; we'd conquered all of those analytical challenges applied to old master paint media. So I gave a lecture at an international conference, about one of our methods for analyzing oil paints, which is probably the most popular and commonly-known and appreciated binding medium, I think, in easel paintings; everybody knows an oil painting when they see it. And I was approached after the talk by a conservator from the Hirshhorn Museum and Sculpture Garden, Susan Lake. She was a paintings conservator at the time, and she thanked me for the talk, and she asked me a really interesting question. The Hirshhorn Museum is a modern and contemporary art gallery, and she asked me if those analytical methods we developed could be developed to modern and contemporary oil paintings. I said, "Absolutely. The pigments might be different, the medium itself is younger because it's modern and contemporary," so one hundred years or less. I said, "Absolutely. What we do, the test method that we made, should be applicable completely to modern paint media. She asked me if the Getty

would want to collaborate with her in studying paintings by the Dutch American artist, Willem de Kooning. Susan was working on a PhD at the University of Delaware at the time on Willem de Kooning's paintings. They have a fine collection of them at the Hirshhorn.

03-00:04:41

So I came back to the Getty and I talked to the department head at the time, Alberto Tagle, and he was very enthusiastic in supporting that collaboration. Alberto, as head of Science, was very enthusiastic, very supportive, very much a supporter of our work and promoted it whenever he could. So his job, then, was to talk about and promote that project to his peers, the other department heads and the administrators at the time and the management team. The people there at the time were a bit reluctant to start doing contemporary art research, because the Getty Museum doesn't collect contemporary art. Well, that's kind of sham argument, because we don't collect tomb paintings, we don't collect Grotto paintings. So it's opened up the possibility, then, of extending what we do to a broader swath of cultural heritage throughout the world. Since there are so many contemporary art museums, collectors are passionate about collecting contemporary art. There is a big interest, I think, at many different levels throughout the Getty writ large, in us getting involved in contemporary art. So he had that bit of a challenge, but he was able to overcome it. The arguments were fairly easy to overcome.

03-00:06:13

Eardley-Pryor: What is Alberto's background? He was the head of the Science Department, where was he coming from and where was his research based in originally?

03-00:06:20

Schilling: Alberto actually was born in Cuba, and got a degree in Chemistry, I believe, there. He got his PhD in Germany, that would have been East Germany at the time. Then he moved to the United States. I believe he took a position right away at the Winterthur Museum and Sculpture Garden.

03-00:06:44

Eardley-Pryor: Was his research in contemporary modern media?

03-00:06:49

Schilling: No, just analytical chemistry. So I can't tell you too many details about exactly what he did. I know he did a lot of scanning electron microscopy. He looked a lot at mineral pigments. And he taught there. Winterthur Museum is associated with the University of Delaware Conservation Program, the graduate program, so there's a close collaboration in Delaware between Winterthur Museum and the University [of Delaware].

03-00:07:20

Eardley-Pryor: Where Susan Lake was getting her degree.

03-00:07:21

Schilling: And Susan was getting her degree there, yes. That's an interesting connection.

03-00:07:27
Eardley-Pryor: So Alberto took it upon himself to say, "Yes, Michael, this is a great idea. We should apply this to modern media."

03-00:07:34
Schilling: Mm-hmm.

03-00:07:33
Eardley-Pryor: And it went forward from there. How did things progress?

03-00:07:37
Schilling: Then it went very well, actually. He still had the occasional battle in staff meetings about planning and projects, "Are you sure we really want to have a project on contemporary art?" He said, "Yes. It's easy to do. We already have the tools developed, let's just apply them." So the collaboration went very well. It took a number of years of Susan working with me to do the GC/MS analysis of these oil paints by de Kooning.

03-00:08:06
Eardley-Pryor: What was the process?

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Schilling: De Kooning was actually an interesting artist, in that he was very experimental with his approach to painting. And he never was completely satisfied with what he was painting. So he would paint his subject. He'd look at it for a while, and then Susan told me he would take a cheese grater and kind of grate off the part of the painting that he didn't like, and he'd start over.

He experimented with adding other things to the oil paint to change the drying rate. So the anecdotal story was that he added mayonnaise and whipped mayonnaise into his oil paints. Susan's work showed that that was false; she never found a painting with protein from mayonnaise. But she did find evidence of water being whipped into the oil paint. She could see little air bubbles kind of dispersed throughout certain colors. Some of de Kooning's paints today still are a bit soft and sticky, because he, again, intentionally modified the drying rate. The faster a paint dries, the harder the final dried paint is. If it dries slowly, it tends to retain a certain amount of flexibility.

03-00:09:25
Eardley-Pryor: Still today his paints should reflect that flexibility?

03-00:09:27
Schilling: Even today. Some of them, some of the colors that had their properties altered might be sticky in some areas. So he was a fascinating artist. He was well worth the PhD that Susan did on him, and our work, then, contributed to a technical appendix in her thesis. So our work helped provide the analytical foundation that Susan needed to better interpret his painting style, painting technique, and dispel some of the myths.

03-00:09:56
Eardley-Pryor: Well, let's dive in a little bit to figure out how that interpretive analytical piece happened. What was the process like, your collaboration with Susan? Would she bring you a piece of his sample and bring it out to you in Los Angeles, and then you'd run it through your analytical process? How did that happen?

03-00:10:14
Schilling: The great thing about what we do in our lab, the Materials Characterization Lab—and it's had other names over the years, Analytical Lab, Organic Analysis Lab—the great thing about it from our perspective is that we analyze samples from works of art. So if someone sends us a sample, a container, a glass vile, snap-top plastic vial, a package of aluminum foil, foil pouch, paper pouch, trapped within a couple of microscope slides, we can test it. And we've received samples like that, literally thousands and thousands of samples from all over the world, all types of materials that have been sent to us for analysis. So Susan did just that. She sent us samples from paintings that she sampled.

So again, invasive tests are great for us, because we can collaborate, then, with anyone around the world. Our lab is the permanent fixture, and then the art comes to us, in a way, little bits of it. Curators are not necessarily as excited about sampling paintings, but they know the value of the scientific information that comes about as a result of sampling and careful analysis, and interpretation of data. So they know that it's worth the risk. Again, if we do a good job, that area never has to be sampled again, because we've answered all of the questions that the curator or the conservator has, the conservator might be treating a painting by de Kooning, and he or she would want to know what medium he used for each area, each color—

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Eardley-Pryor: What was different—

03-00:12:01
Schilling: —because the treatments might vary, depending on the chemistry of that material, and especially the chemistry at the very surface, the outermost surface, because that's the area that changes the most, it's the part of an object—we'll just talk about an object in general—the surface of the object is where it's exposed to light, which can damage the materials at the surface. It's exposed to oxygen in the air, which can oxidize materials at the surface. It's exposed to humidity. We talked yesterday about the damaging effects humidity can have on objects that have salts in them, so water vapor in the air can also interact with the surface of an object. So the surface is where all the action chemically takes place, and it's also where dirt then becomes embedded and trapped, that ultimately has to be removed by a conservator when that object is cleaned. It's also then what gets treated with, say, a protective coating; the coating would be applied on the outermost surface.

So as an analytical chemist interested in organic materials, they're the reactive ones in those paintings, especially. We want to know the most about what's

happening right at the very surface. Some of de Kooning's paintings were quite thick, so the surface, then, kind of skins and dries more thoroughly, because it's exposed to the most light, the most oxygen. You go a little more deeply into it, and it might not have the same chemistry, because the surface has reacted differently, because it had a different environment than what's immediately beneath the surface.

03-00:13:44
Eardley-Pryor: When you're doing this work, and your methodology is the quantitative GC/MS, what was different about working with these modern media that de Kooning was using, and trying to identify it, versus the work you had done on the master's binding medium? How did your process differ?

03-00:14:01
Schilling: Well, one thing for sure, in the twentieth century, and continues through today, artists have access to a much wider range of materials. So old masters had access to linseed oil, walnut oil, and poppy oil. And the original GC work that was done at National Gallery of London by John Mills, and then later with the addition of Raymond White, they were able to identify those three types of oils in old master paintings, because they only had three to pick from. But now de Kooning started adding safflower oil to his paints; that was another modification. Safflower oil has a different composition, has a different distribution of fatty acids. It's those fatty acids that are used to characterize the type of oil, the relative amounts of a couple of them, especially, are key markers.

So now, modern oils and modern artists have access to just an incredible range of oils, and oil containing products. So the people, the companies that manufacture tube colors, they might add different oils, whatever is commercially viable and kind of cheap, even, and affordable at the time. They'll mix them together, so there is no fixed set of ratios anymore that can be used to positively identify the oil in an oil paint that's used by modern and contemporary artists. It just can't happen anymore. So it was simpler times, when all they had was three oils to choose from. So now it's more complicated. We can still tell that it's a drying oil. We can still tell how oxidized the drying oil is, and again, oxidation kind of relates to how dry and hard the paint is. But in terms of saying exactly, this is the type of oil that de Kooning used—that's really not that possible anymore. So we can tell sort of what it's not. We can't really say what it is. I think that theme came up yesterday, also.

03-00:16:13
Eardley-Pryor: It did. There's synthetic oils, also in the twentieth century, the explosion of the oil age and the industrial age. Are synthetic oils also being used by modern artists as well?

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Schilling: The drying oils tend to be seed oils, so they're just squeezed in a press. The oil comes out, it's dried, it's filtered, maybe it's bleached or treated in some way to alter the thickness or the drying rate. And then it will be mixed with pigments.

03-00:16:37
Eardley-Pryor: But not petroleum-based products?

03-00:16:40
Schilling: No. No, that's a different kind of oil. That's petroleum, that's hydrocarbons, chemically very different. Drying oils are triglycerides. They're the kinds of chemicals that the doctor wants you to control, the amounts in your bloodstream.

03-00:16:58
Eardley-Pryor: So even as modern media has changed in the twentieth century, the drying binding medium is still naturally-based?

03-00:17:04
Schilling: Still natural products, yes. There are certainly modifications to that. Manufacturers, especially industrial paint makers, have done to oils, seed oils, to make them more durable, make them glossier—those things would be called alkyds. And they're chemically different than just the oil that they started from. They added another chemical, polyester. It radically alters the drying rate. So when you're walking, you know, walking down the road and you come to a crosswalk and you see thick white lines that you can walk safely between, that's probably an alkyd paint. So it's an oil-modified polyester. So chemically, it's like a cousin of a drying oil paint. But that's a modern and contemporary type of paint medium, that we've also analyzed with a different process. We'll talk about that later, I think. But anyway, oils can be modified in different ways, and made into different types of polymers.

03-00:18:05
Eardley-Pryor: So the difference between the work that—

03-00:18:05
Schilling: But de Kooning didn't use those alkyd paints. He still stuck with drying oils, and what we would call "semi-drying oils," like safflower oil.

03-00:18:15
Eardley-Pryor: Safflowers.

03-00:18:16
Schilling: Yeah. Castor oil.

03-00:18:19
Eardley-Pryor: So these natural oils, the methodology wasn't much different from what you had done with the old masters. The difference was essentially identifying these new types of more diverse types of oils that were still natural oils?

03-00:18:31
Schilling: Yes. Correct. Kind of seeing if we could understand a little bit about why the paint still might be soft. We did a reasonable job in understanding that, kind of looking, again, for those oxidation products, and their amounts. Again, we did look for other things. But by and large, it was just a question of same analytical method on the same size of sample, but just a different way of interpreting the data, because the oils that de Kooning had access to were different from what Rembrandt had access to.

03-00:19:13
Eardley-Pryor: What was that process, then, of the data interpretation? Because that becomes a really essential part in differentiating work that happens from this point forward over the next twenty years of your career, that sort of data analysis. What was different about this type of data analysis, from what you had done—

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Schilling: Really, very little. Very little was different. We were looking, more or less, for the same marker compounds that would allow us to identify the material, but we were looking maybe at different proportions of them. So it's just different relative amounts. Really, the interpretation was more or less the same. It's just that we couldn't be quite as definitive as, say, our colleagues at the National Gallery of London, who only had three oils to choose from. Now there is a wider range, mixtures of oils can happen. Again, it makes positive and verifiable identify of an oil impossible.

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Eardley-Pryor: I see. And Susan was able to, with your help, publish this work eventually in 2010, in a book *Willem de Kooning: The Artist's Materials*. But that first publication you said, actually, of your collaborations together happened in 1999.

03-00:20:22
Schilling: Yes. That's when the initial articles started coming out in the literature. And then Susan, again, tackled her graduate degree in much the same way that I did, part time. So it took a while to really get all of the amazing art historical information together, all the literature that she combed through, the interviews with de Kooning, and getting all of that synthesized into a thesis. It's, I think, still today one of our most enjoyable reads in terms of that series, The Artist series, that the de Kooning book was the first in that series.

03-00:21:04
Eardley-Pryor: You also used, from my understanding, similar methods on the artist, Jacob Lawrence. How did that process begin?

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Schilling: The Jacob Lawrence collaboration started -- we were contacted, I can't remember exactly who contacted whom, and when and where. But I know that we were approached by—oh gosh, I'll think of his name—he was the head of

the Jacob Lawrence Catalog Raisonne project, Peter Nesbett was his name. And he was working with Lilli Steele, who was a paintings conservator at the Phillips Collection, which is a contemporary art museum in Washington, D.C. They were tackling the vast number of paintings that the African American artist Jacob Lawrence did throughout his long career. And I think he died toward the end of the Catalog Raisonne project, somewhere around there he passed. But the project was fascinating; I had never participated in a Catalog Raisonne before—

03-00:22:09
Eardley-Pryor: What is that, then?

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Schilling: Basically—and again I'm giving you the scientific interpretation of it, so it is completely inaccurate, I'm sure—but the basic idea is, some group of people examine and study all of the works of art by an artist. And for a prolific painter like Jacob Lawrence, it was a daunting task. I think it was actually broken up into two in the end; he had such an enormous output. Really influential painter, American painter. Lovely paintings about when after slavery was abolished, the migration of people from the South into the industrial North where they settled, he has lovely paintings of those moments, and they're really heart-rending. Many of them are heart-rending, they just portray such dramatic scenes in the life of these people.

But he was different than de Kooning, who was really using oil paints that he modified. Jacob Lawrence was using tube colors. He did start mixing his own paints, at the beginning he was using a wider range of paints. He was using casein, which is a protein for milk, and anybody who has let milk dry in the bottom of the cereal bowl knows that it is hard to get that casein resolubilized and cleaned up. That's why artists use casein as a binding medium, because it dries through a nice, hard film, and it holds pigment grains together really well. It is used in poster paints, and things like that. But Jacob Lawrence used a wider range of paints than just oils, so he used protein-based paints—casein is a protein. And these are other media.

03-00:23:57
Joy Mazurek, we hired her as a temp from a temp agency to work with me on GC/MS method development. We loved her so much that a couple of years later, we offered her a job. She just is a great colleague. She has an incredible aptitude for working on laboratory equipment. She is absolutely fearless in repairing them, and keeping them running at the kind of peak performance. She is just a great team member in our Materials Characterization group.

So Joy and I started working on these paint samples again by Jacob Lawrence from his paintings, from tube colors, from tubes that were in his artist studio, because that's another interesting thing, when you're working especially with contemporary artists. You still have access to their studio. So you can get samples, Shiva casein red, you know, crimson red, and then you can analyze

that. And you can try and match up your analytical results to the reds that you're seeing in some of Lawrence's paintings. So that's an interesting aspect of doing contemporary art analysis.

03-00:25:16
Eardley-Pryor: When you do that, are you still also doing an invasive sample?

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Schilling: Yes.

03-00:25:20
Eardley-Pryor: And then comparing it to what's in the studio, in the tubes?

03-00:25:24
Schilling: Yes. Yes. So again, he painted hundreds and hundreds of paintings. So the likelihood of us matching a particular tube color to a particular colored area on a painting is, you know, I'd have better luck winning the lottery, I think. But at least we have access to those materials. And again, it shows off kind of a range, then. If we know what he bought, then the curators who were piecing together his career know when he started making transitions from handmade paints that he mixed himself up in the studio to using tube colors that often had additives and things like that, things that the paint makers add to improve the working properties. Maybe the additives that the paint makers add might make the paint thicker. It might dry more quickly. It might be more glossy. It might be more matte. It might flow more readily. It might be mixable with other media more easily. So those additives are a key difference between old master paint media and what artists use today.

03-00:26:37
Eardley-Pryor: In the modern paints?

03-00:26:40
Schilling: Correct.

03-00:26:39
Eardley-Pryor: I'd love to hear a little bit more about how these collaborations happened and the toolsets that you are able to bring, and the data that you're able to provide with your sampling, and the knowledge that these curators have about processes and the collection, and the meaning of the art to the artist. How that collaboration will come together. How you benefit from each other to tell a broader story.

03-00:27:02
Schilling: Sure.

03-00:27:03
Eardley-Pryor: Because the way that you explain Jacob Lawrence's work or de Kooning's work and their methodology is not something you get just from the data. There's more to that story. You're adding to that story, but there's more to it. So I'm wondering if you could talk a little bit about that sharing that the

curators bring, that you also then contribute to, and add to their understandings.

03-00:27:26
Schilling: Okay. We liked to use an analogy of a three-legged stool to describe our work here in cultural heritage. Curators and art historians are one leg of the stool. They understand the artist, the environment that he or she was in, attitudes and motives and meanings, the life story of the artist, and traumas that artists go through that affect the art that they make, all of that, their history. They're history lovers. They tell captivating stories about artists. Again, relating their life back to the art that they create during different time periods. So there's that vital understanding of looking at the art deeply and meaningfully, with a broad history, a broad database of everything that they've seen is all up here. No way to put that into a database and simplify it and crunch numbers out of it. But what they contribute, then, provides incredible depth and breadth to a study of a particular artist.

Conservator, then, is—they're artists in another own right, they're studio artists. They work to preserve, clean, protect works of art. That's their job. They're like a doctor, in a way, caring for a patient. So they have to respect the art. They have to treat it with care, not damage it, not alter it in any significant way. What they do, ideally, could—in whatever they add, whatever processes to clean or coat, protect, in the ideal world could be reversed by the next conservator who works on that object. So that idea of reversibility is sort of an ideal in conservation, that's sometimes difficult to realize, just depending on what treatment an object needs. So conservators have a lot of that artist training, the Art History background, so they know what they're working on. They know what types of materials that particular artist used at that time in his or her life. But they also know how he or she would have made the art, because they make art. They know what that process is like, and they can then recreate the processes, if they were making, say, replicas that they were going to use for study, maybe they'd want to age them and see how that replica ages. Try out potential cleaning methods, treatment methods, dirt removal—things like that.

Then again, they need to know to do the best job. They need to know the chemistry of what it is that they're treating. That's when they come to conservation scientists like me.

03-00:30:39
Eardley-Pryor: That's another leg of the stool.

03-00:30:43
Schilling: That's the third leg of the stool.

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Eardley-Pryor: Tell me the three again.

03-00:30:46
Schilling: Art history, conservation, conservation science—we all work together to understand cultural heritage better. We're each bringing our own unique backgrounds and perspectives and points of view to bear when we're sitting in front of a work of art, saying let's understand it better.

03-00:31:05
Eardley-Pryor: Why do you think you need all of them together?

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Schilling: Because objects are almost living and breathing things. They have a history. They were birthed at a particular time, in a particular place, time period. They were created with materials that were available at the time. Then much like people, they undergo the ravages of time. Some were made with more sensitive materials and they don't weather the storms very well. Others are made from more durable materials and processes, and they are around longer. Stone sculptures are around for thousands and thousands of years. But works of art on paper, with light sensitive dyes, they fade very rapidly. We know that from just looking at old photographs, the colored photographs are fading. So some objects are durable, some objects less so.

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But so understanding the art, and how it was created, why it was created, where it was created, for what reason is important. Understanding how it's changed, what its chemistry is, what's happening right at the surface where a lot of the conservation treatments happen—that's necessary in order to come up and devise with a safe and ethical treatment that can be applied to protect it, and restore some of its original appearance, make it more durable, last longer for future generations. You need all of that knowledge to really tell the entire story of an object or an artifact.

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Eardley-Pryor: Where, in your entry into that collective effort, when do you start running your samples? Is it right from the start? Or is there a process of learning that you go through with the conservators and with the historians, before you start running samples?

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Schilling: The dialog's important, actually, because the type of analysis we do depends on what question the curator, or we often—we most often work with the conservators, because they're the ones that need intimate chemical knowledge about what it is that they're going to treat. There's always this dialog. The best dialog happens when we're all in front of the objects together, because we can share information and our own perspectives. I mentioned that process happening in Mogao and the caves, where we were all looking at the cave paintings and trying to understand what they were made of, how they were made, how they changed, why they changed. What are the causative agents that are making the change happen? So those dialogs usually lead to a series of decisions, what questions there are. We would then, as scientists, decide what kinds of analysis will provide information that will answer those

questions. We can get to the answers more quickly if we have those dialogs at the beginning.

But the questions that we often answer—what is it made of? How has the material changed over time? Those are the two questions we answer over and over and over again, and they're valid questions. Even if the information isn't used right away in a treatment in a catalog or an article, it's part of the record of that object. Every museum object has an incredible file somewhere in the Registrar's office, or the conservation offices, or curatorial offices about their collection. They have all the documentation relating to that object in one place.

03-00:35:10

So there's a rich record of archival information on each object that museums have, and they care for that information. You see a lot of exciting use of some of that information today, and, say, online catalogs of the collection. If you were to go to the Getty.edu website and click on the J. Paul Getty Museum link, you would then be able to access information about our collection. You could see high-resolution photographs of them, zoom in, zoom out, get some of the background about the object. There's a lot of that happening these days, where that knowledge that's sitting there and being cared for, is just as important, almost, as the collection itself, because it represents the life and history of the object, and how it's been conserved over time, and what scientists have learned about it. Some of that's being made available to the public, and that provides the public with a broader perspective of art—what they're seeing when they go to the Getty Museum.

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Eardley-Pryor: And researchers themselves, who might not be able to be here in person but can do that research, dive in. Is your analytical work also being added to these online information packages?

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Schilling: Some of it is. Some of the information is just reflected by the description of what the object is. It might—now we can say oil paint, "an oil painting on canvas," instead of— "here's the painting." Right? That information would be fleshed out in a little more detail, so there's that. There's other types of information that we've learned about our lacquered furniture collection that we'll talk about later, where we have more complete knowledge about the materials and the lacquer after our work.

03-00:37:11

Eardley-Pryor: I have a note that in 2002, you were promoted to senior scientist of the Analytical Research Group. What changed in your responsibilities within the lab, within the GCI [Getty Conservation Institute] with this promotion to senior scientist?

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Schilling: It was quite a change, actually. When Alberto left, he took a job in the Netherlands—

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Eardley-Pryor: That same year?

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Schilling: That same year. So he wanted to make sure that the analytical group had a senior scientist heading up the group, so that we could continue to function effectively during the interim period, until we had a new head of science. That was the reason for the promotion. So my responsibilities then brought in to include supervising the people in the group, so Herant Khanjian, Cecily Grzywacz, and Joy Mazurek were all working, then, for me. And the former head of the group, Dusan Stulik, had a new project to work on, so he was then leading up research on photographs, chemical photography. So he was no longer the head of our group. So again, Alberto made that decision to promote me at that time, just so our group could continue to function, and I could represent all of the projects that we were working on in our group to management.

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Eardley-Pryor: How did that change the role that you played within the lab itself, then?

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Schilling: Just more oversight and supervisory responsibilities, budgets, promoting our own work in staff meetings and in discussions with colleagues. Then when we're having these conversations with conservators and curators about what tests need to be done in order to answer questions, I'd be working on those over a broader range of topics than just what I was working on at the time.

03-00:39:22
Eardley-Pryor: Around that same time, I also see the Modern Paints project began, this collaboration with the Tate Modern. Can you tell me a little bit about your experience in that as well?

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Schilling: Sure. I can't remember exactly when Tom Learner started working with us when he came to the Getty Conservation Institute—

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Eardley-Pryor: Oh, as a research fellow?

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Schilling: As a visiting scholar. He worked in my lab for—it was either three or six months. Tom is a conservator and a scientist, so he can wear both hats. Or he's got two legs of the stool; he really needs a degree, I think, in Art History, then he'll have the whole stool—

03-00:40:07
Eardley-Pryor: He'll be the full stool.

03-00:40:14
Schilling: But he worked at Tate Modern in London. They're a modern art gallery. So that was his mandate. And Tom has an outstanding quality of being able to understand what people are doing at different institutions, really keeping abreast with presentations and conferences, publications, meeting people, connecting, and knowing what's happening in the field of modern and contemporary art research. So he wanted to come as a scholar, work in our lab, and see what our analytical equipment could learn about modern paints, especially. He was most interested in modern paints. They have many fine modern, contemporary paintings at Tate Modern.

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So he wanted to see what a scientist at the GCI could do, looking at modern paints, so we all worked with him closely. He brought samples with him, things that he painted out and let dry on glass slides. Then he allowed us to sample those and study them. We just, again, learned a bit more about a broader range of this modern paint media. I mentioned alkyd is one of them, epoxy, polyurethane, vinyl, acrylic—those are other types of modern paint media. The results of his visit with us and working with us, and we wrote publications with him, but also then we started thinking about collaborating intentionally with Tate Modern, and adding another partner, the National Gallery of Art in Washington, D.C., and the three institutions could start looking at modern paints in a deeper, more meaningful way, in looking at different aspects of modern paints. Cleaning the materials themselves and their history, and do this in a sustained effort in a collaborative project that went on for a number of years. So it was an exciting time.

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So it's interesting to see that transition between the GC/MS work that we developed for old master paints, where there was a limited number of natural products. Then those first steps in apply some of those techniques, then, to study paintings by de Kooning and Jacob Lawrence, and then now looking at a wider range of materials by a broader number of artists, and working in a well thought-out collaboration

03-00:43:00
Eardley-Pryor: How did that collaboration happen in practice? Would you go to different institutions? Would everyone come here? How did that go about?

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Schilling: We did have visits to the different partner institutions, where the host would share information, and could show us results and samples, and things like that. We could strategize that way. So that happens often in these research collaborations. Sometimes we host them. Sometimes we go to our partner labs, or partner institutions.

03-00:43:26
Eardley-Pryor: And I understand that collaboration coalesced into a symposium in 2006 at the Tate Modern, called "Modern Paints Uncovered."

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Schilling: Yes.

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Eardley-Pryor: Could you tell me a little bit about that?

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Schilling: Well, that was a really key symposium for us, for the GCI.

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Eardley-Pryor: Why?

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Schilling: I think because it really set the tone for a lot of what was going to happen later on. One very exact—or one outcome of it was hiring Tom Learner to head up a new research initiative in GCI science, modern and contemporary art. So it was a research initiative that Tom was the best person to head up, because as a conservator and a scientist, he has a good understanding of kind of the range of issues that come to bear when you're conserving modern and contemporary art. So we poached him from Tate Modern. They're doing okay. [laughter] But it's been great now having him in the house, and having that knowledge in-house, because now I don't have to travel to London in order to meet with Tom and have meaningful conversations. So then he's able to muster those vast resources available here at the Getty Center campus, to tackle modern contemporary art issues in a much wider range of topics.

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Eardley-Pryor: And by that time that Tom came on board here in 2007, the challenges that Alberto had faced earlier in moving into modern media, it sounds like they had been overcome?

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Schilling: Absolutely overcome, yeah, because we demonstrated with those early projects that we could make meaningful contributions, and that we would be sought out by recognized experts in the field, like our colleagues at the National Gallery of Art in Washington, D.C., and Tate Modern. So it really put us on the map, I think, in that regard. It was our first hesitant steps that really have led to this massive research initiative that cuts cross, I think, all three of the main institutes here at the Getty, the Getty Museum, the Research Institute, the Getty Conservation Institute—even the Foundation. Kind of all of the institutions have collaborated in many different ways, beyond what I could describe right now.

03-00:46:08
Eardley-Pryor: Yeah.

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Schilling: Talking to Tom and getting his perspective on the kind of the birthing of the modern and contemporary art initiative would be a valuable use of your time, I think.

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Eardley-Pryor: We'll make a note to share that.

03-00:46:20
Schilling: Yeah.

03-00:46:22
Eardley-Pryor: Other people that joined the team around this time, too, even earlier, Giacomo Chiari comes in as the head of Science in 2003. Jim Druzik joined your lab in 2006 to do some work with you there. It seems like there's a lot of personnel changes that are happening in the early 2000s.

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Schilling: Absolutely. It was a time of transition growth, flux. Giacomo was our third official head of Science. We had a couple of interim leaders for a while. Neville Agnew, David Scott. So Giacomo came from Italy. He is an X-ray crystallographer, so he's an expert at using XRD [X-ray Powder Diffraction], it would be called, to identify crystalline materials, mineral pigments. He's an outstanding, world-recognized expert in that. As the head of the department, he really was passionate about continuing to work in the lab, and continuing in his own research interests, which was interesting. It was kind of a unique take. None of the other departments' heads, before or after, have made time to do that, to prioritize that. He really did meaningful science while he was the head of the department. So that was interesting. That was interesting to work for him. A lot of important projects happened under his leadership then.

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Eardley-Pryor: Then Jim Druzik's role. So he joined your lab, what kind of work was he doing under your supervision?

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Schilling: Jim Druzik—really a bright guy, about just an incredible range of topics. He's very well-read, and very articulate. He could talk for days about things. Give him a subject, and he can expound on it. He's that bright and that well-read. He was the head of what was called the Extramural Research Program, and it was started by Frank Preusser. Jim was hired to head it up. So in essence, Jim oversaw money that was used to support research at other cultural heritage institutions. It was our way at the beginning of the GCI, when we didn't have a reputation, it was our way of establishing a reputation and establishing meaningful projects with important institutions, like Cal Tech is one of them. Jim oversaw a research program at Cal Tech that was related to cultural heritage. Jim did that for many, many years.

But again, as in the life of any institute, it undergoes changes, and different directions and things like that. We just decided at one point we don't need to do that anymore, because we have such a strong reputation. Everybody knows that if they partner with us, they're getting a solid partner who contributes a lot more than just finances. That program ended, and I offered Jim the chance to work in my lab. He demonstrated himself to be an incredibly gifted researcher. Everybody recognized that from the very beginning. Jim and I were both senior scientists, he really didn't need my supervision. He just needed a place to work, some equipment, gave him that, and he just took off with looking at air pollutants, measuring them.
Then that led to a large project that Jim headed up when he left my group completely, and started a project, in looking at the effects of light on museum objects. So the Museum Lighting project went on for many years. Jim forged a research consortium around one analytical technique that was especially important, it's called microfading, or using a microfadometer. It's a device—it's really one of the only devices I know of that was made in cultural heritage research. So it's a tool now that can be used by other people, even outside of cultural heritage. It's a low-cost device that was developed by Paul Whitmore, who was the head of the lab at the Carnegie Mellon Institute in Pittsburgh.

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Eardley-Pryor: Who your daughter now works with?

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Schilling: Who Kate works with now, exactly. That device, then, is one of those devices that is relatively inexpensive, that a conservation scientist could buy the parts, assemble it, and start using it and getting meaningful data on lightfastness of fugitive colors. It has the best application, I think, to watercolors. Watercolors, you want to protect them from the light so they don't fade and change color, so the microfader can measure how quickly each color on a watercolor fade. So Jim put together that research consortium, kind of around the microfader as the key analytical tool. I think there must be at least a hundred members of the international community using that device. Then Jim, once that project got to a point where it was mature, and other groups were doing research in it, they were actively—then Jim tackled an even bigger challenge, and that is to monitor works of art in museums as the climate changes. So he was looking specifically at dimensional changes of, say, wooden objects, as humidity and temperature rise and fall. So the Museum Environment project is a really important project at the GCI, in that it probably has the biggest implications in the cost of running a museum, because museums spend enormous amounts of money each year in carefully controlling the temperature and humidity of gallery spaces.

Jim and his research group were interested in knowing how tightly the temperature and humidity needed to be controlled. Did it have to be within certain tolerance limits, or could those limits expand a little bit and the objects inside of those spaces still be safe, still be considered safe? So it's an ongoing project. It's still going on even after Jim retired a few years ago. It's headed up

now by Michal Lukomski, who is a Polish researcher that, again, we poached from a lab in Kraków. But that's an interesting project. Again, it's something that museum managers are keenly interested in the results of, because again, if they don't have to spend all of that money to control temperature, humidity and gallery spaces to really tight levels, they can allow those levels to expand a bit, and the objects still be safe. They can use that money in other areas which, again, is a plus.

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Eardley-Pryor: Expands their role. I would love to hear, speaking of instrumentation and methodologies, that lead to new consortium and collective work, I would love to hear how you began doing pyrolysis GC/MS work.

03-00:54:14
Schilling: Okay.

03-00:54:15
Eardley-Pryor: And I understand that that began in 2006, with some of your work around amber. So what's the story behind that?

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Schilling: Sure. We talked before about GC/MS, and if you want to analyze something by GC/MS, you have to put it into some kind of vapor state, turn it into a gas. All of those quantitative GC/MS procedures we mentioned involved using chemicals and low temperatures to break down the large molecules, and the small ones that are amenable to GC/MS analysis. There is another way of doing that kind of degradation—

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Eardley-Pryor: Rather than adding chemicals to the sample?

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Schilling: Correct. What you're using, then—

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Eardley-Pryor: To make it volatile.

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Schilling: —is high temperature. So when you treat a sample at high temperature in order to turn large molecules into small ones it's called "pyrolysis." It's a Greek term, to cleave with heat; pyrolysis. And a pyrolyzer is an accessory that sits on top of a GC/MS, right on top of where the samples would be introduced into the GC. There are different manufacturers of those pyrolyzers. Some of them work better than others. We bought a pyrolyzer that was commonly used at the time in labs, commercial labs. We started using it to study Baltic amber. Baltic amber is a fossilized resin, a fossilized tree resin, like amber—we saw Jurassic Park—similar kind of stuff. Baltic amber came from the resin from a certain species of tree in the Baltic region, and it produced stuff that, again, looked beautiful, it had an amber color, transparent

often. It could be carved easily. It was used in the Roman times to make small figures and beads and objects.

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Eardley-Pryor: Why did your lab get involved in the Baltic amber research?

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Schilling: Our museum then, the Villa Museum, has a collection of these amber objects. They were curious about them. One of the questions that always comes up in amber research is the amber Baltic, did it come from this particular geographic location, or did it come from amber deposits from other countries? We didn't look very much at the other ambers. There are research groups that do nothing but that. But all we were interested in is answering the question, is this particular object made from Baltic amber, or not? There's a certain chemical marker in there that's a marker compound for Baltic amber, it's succinic acid. You can form succinic acid if you pyrolyze a small sample of amber.

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Eardley-Pryor: Now how did you learn that method would be—the pyrolysis methodology, adding that to your GC/MS—how did you learn that that's what you needed to do in order to get your answers to the questions about Baltic amber?

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Schilling: Publications. So there are researchers that studied Baltic amber, and they showed chromatograms of their sample results. You could see, they report a large peak in their chromatogram for succinic acid for every sample of Baltic amber that they analyzed. So you can still excavate—

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Eardley-Pryor: And they were doing the pyrolysis method?

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Schilling: Yes. They were using a pyrolyzer to do that. Baltic amber is a high polymer, so it has a large molecular weight. You can't really dissolve it. It's not volatile, you know, to any significant extent. The succinic acid is part of the polymer. So you can't just simply extract it. You have to use some kind of method to break it down and release the succinic acid from the amber.

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Eardley-Pryor: In order to get it to run through your GC column?

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Schilling: Correct.

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Eardley-Pryor: Did you have a [pyrolyzer] before that?

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Schilling: We did. I think we bought this pyrolyzer to look at residues from removing varnishes from easel paintings. So that was a project that went on for a number of years. And pyrolysis again seemed like a sensible way of pretreating the samples prior to GC/MS analysis. GC/MS is just a really versatile and accurate method for analyzing organic materials, measuring their amounts. You just have to get stuff into it that's in the volatile, in the gas state. So pyrolysis is a good tool for that. It's been used now for many, many years now in forensic science. Forensic literature has a lot of information about application of py—we call it "Py-GC/MS" [pyrolysis–gas chromatography–mass spectrometry]. And we access that information. And there are researchers around the world that have looked at amber. So the same instrument, Py-GC/MS, can be used to look at a wide—now a much wider range of organic compounds. If you didn't have pyrolysis, you're limited to relatively small molecules, or molecules so you could easily degrade chemically.

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Now pyrolysis is usually done around, say, 600 degrees centigrade—that's enough thermal energy to break bonds between carbon atoms, so enough temperature to break carbon-carbon bonds. And if those carbon-carbon bonds are linking together to form polymer chains, then the temperature is breaking those bonds. And every pair of breaks is producing a small molecule that can be analyzed by GC/MS.

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Eardley-Pryor: Hmm. It's almost a miniature version in what's done in oil petroleum manufacturing or refineries, cracking those carbons.

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Schilling: Cracking. It's exactly the same process.

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Eardley-Pryor: By heating it. You'd mentioned that the original pyrolyzer you had acted differently than the one you currently use now. What's the story on how you transitioned between your different instruments?

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Schilling: Yeah, so the pyrolyzer that we used for that gel cleaning study, to look for cleaning residues on paintings, the pyrolyzer that we used for amber, was the first pyrolyzer that we bought. It just had a different design. You have to heat the sample in a controlled way, to a precise temperature. So different instrument companies have different ways of doing it. There are companies that have, say, a metal ribbon, and the ribbon is what's heated electrically. If you were to pass current through it, you'd see it glow. The more current you pass, the more it glows. If you heat it high enough, it will even turn a kind of white-hot, really hot. You put your sample on it, maybe use a little solvent to dissolve it a little bit, stick it down onto the filament. Then again, that filament would go into a little heated box. Then you'd turn the current on, the filament gloss red-hot, vaporizes a sample. The vapor goes into the GC. That's one

design. There's another design where you put your sample into a small tube, maybe half an inch long, maybe two millimeters in diameter, or something like that—pack it into some quartz wool, or glass wool, and then put that tube into a coiled filament. So a wire that's wound into the shape of a coil, and the tube figs snuggly into that coil—that's the one that we used. We used that one.

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Eardley-Pryor: Why is that a different—or a better methodology for your needs than the filament, placing the sample on the filament? Why is [it better] putting it in this glass vial that's heated by the coil?

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Schilling: Well, neither one is actually the best.

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Eardley-Pryor: Oh, is that right? Why?

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Schilling: Yeah, neither one is actually the best. A lot of reasons, a lot of mechanical and instrumental reasons. But I guess you can get the most information from a Py-GC/MS analysis if the heating process is done reproducibly. So if that sample undergoes a very carefully-controlled temperature program, to start at a low temperature and heated in a very controlled way, in a very reproducible way to a final pyrolysis temperature, then those carbon-carbon bonds are going to break in a very reproducible way, and you'll get the same set of marker compounds each and every time you pyrolyze another sample, another piece of that sample. Okay?

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Eardley-Pryor: Was the filament methodology not reproducible?

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Schilling: So there are problems in designing it so that you don't lose the organic molecules that you've just vaporized, because they're in vapor. But you can't put that filament down into the column, it's physically impossible to do that. It has to go into a box that's heated. So now the box itself could start reacting with the sample vapor; that's not good. Not reproducible, right? Some of the sample might get stuck to the box. If the box starts to get dirty from use over and over again, testing samples, the reactivity of the box is going to change. Different amounts of compounds will stick to the box. So you want the pyrolysis to take place in a very reproducible way, in a very inert place, a very inert kind of chamber, that is heated. So the pyrolyzer that we use now is different. It's based on a micro-furnace, and the samples drop into a zone that's already at the pyrolysis temperature. So it's heated ballistically then, because the sample is dropping by gravity into this hot zone and staying put inside of a glass tube that's been deactivated, so that you don't have samples sticking to it. The pyrolysis temperature program is extremely reproducible, from low to high temperature very quickly, very reproducibly, and in a very small volume.

So again, the smaller the volume, that means you don't lose sample to a larger volume. And you can test smaller and smaller samples.

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Eardley-Pryor: Which the curators must love.

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Schilling: They love it, exactly. And we love it as scientists, because that means then that we can do more tests on a single sample. We might take another piece of the sample and do FTIR [Fourier-Transform Infrared spectroscopy]. We might do XRD, XRF, scanning electron microscopy, Raman spectroscopy, and on and on and on.

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Eardley-Pryor: Because it's not all vaporized.

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Schilling: Correct. If we don't have to use it all up for Py-GC/MS, that means there's sample left for other tests. So we can learn even more information about a sample, hence we know even more about the object from which it came. And we can answer more questions. So that micro-furnace pyrolyzer is what we use now, routinely. And it provides very reproducible results. And we can really capitalize on the reproducibility of the results in the way we interpret the data.

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Eardley-Pryor: And the provider of that micro-furnace? What's the name of that instrumentation company?

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Schilling: It's Frontier Laboratories. They're based in Koriyama, Japan. And we heard about the Frontier Micro-Furnace Pyrolyzer a few years ago at a conference. Someone was talking about using it at the Metropolitan Museum of Art in New York, and it sounded like a good technology. It had the potential to be more reproducible than the pyrolyzer that we were using at the time for our gels project, and for our amber project. So we made that transition.

03-01:07:14
Eardley-Pryor: It sounds like the Py-GC/MS really opened up a whole new avenue for the expansion of your analytical capabilities. You can have the same amount of sample, but run a number of different tests to get a wider range of data from it.

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Schilling: Absolutely. And I think just in terms of my own career, it's really opened a brand new chapter of my career, where it's become a major analytical focus for me, using Py-GC to test a wide range of organic materials that are used in cultural heritage.

03-01:07:46
Eardley-Pryor: And especially the way that you can then share that data, different ways that you can allow the interpretation of that data, which we'll get into later today.

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Schilling: Right. Absolutely.

03-01:07:58
Eardley-Pryor: The next phase of projects that I'd love to hear about is POPART, work on plastics, which I imagine Py-GC/MS had enabled you to work on, because you're vaporizing these hard polymers.

03-01:08:12
Schilling: Mm-hmm.

03-01:08:14
Eardley-Pryor: Can you talk to me a little bit how that project began, and what sort of things came out of it?

03-01:08:17
Schilling: Sure. We've talked so much about paint media that it's actually nice to talk about something other than paint media. We got into amber a little bit. Oh, by the way, all of those amber objects at the Getty Museum were made with Baltic amber.

03-01:08:29
Eardley-Pryor: They were Baltic?

03-01:08:31
Schilling: Yes, they were. And we could tell something about how they oxidized and changed over time. And we could see that some of them were actually coated to protect them and restore some of the luster. So that was an interesting kind of conclusion to the study. It actually—

03-01:08:48
Eardley-Pryor: But they were coated over—?

03-01:08:49
Schilling: That analytical work, then, ended up being put into an online catalog of the amber collection. So you can actually find that from the Getty Villa website, which is interesting. It was a curatorial catalog that we contributed analytical information to.

03-01:09:05
Eardley-Pryor: Here's an example.

03-01:09:06
Schilling: Faya Causey was, I think, one of the main people working on it. I believe she's an art historian, interested in amber, passionate about amber. Could talk to you about amber for days. She was just a great collaborator in that project. Jeff Maish, we worked with him. He is an antiquities conservator at the Getty

Villa Museum. Herant Khanjian did FTIR analysis of the amber. I did Py-GC/MS of the amber. So together, our collective wisdom and what we learned about amber was put into that online catalog. So it's a rich resource of information about, really, a fascinating material being used in an important time in the Western culture.

03-01:09:53
Eardley-Pryor: It's an example there of your work being embedded in the catalog that people can access online through the Internet?

03-01:10:00
Schilling: Exactly.

03-01:10:00
Eardley-Pryor: That's great.

03-01:10:02
Schilling: Exactly right, yeah. But you mentioned POPART.

03-01:10:05
Eardley-Pryor: Yeah.

03-01:10:06
Schilling: So another three-dimensional material—I'm starting to really appreciate the third dimension, I have to admit. Paintings are mostly two-dimensional, so it's nice to have another dimension to expand our work into. Plastic was really a revolutionary material for artists, because there is really nothing else like it, other than glass. And glass is a little tricky to work with, and it's very fragile. You are limited to what you can do with glass. But plastic can be easily deformed and colored and shaped, and fashioned and adhered to itself and other types of plastics, other types of materials. So it opened up a whole range of expression for artists who make sculpture. Some plastics can be problematic in terms of caring for them. Some are a bit more reactive than others, and anything that's reactive doesn't last quite as long as things that are more inert.

03-01:11:17
Eardley-Pryor: Which, in our minds, often goes against what we think about with plastics—"They last forever." We were told they go in the landfill and they'll be there for centuries.

03-01:11:25
Schilling: Mm-hmm.

03-01:11:26
Eardley-Pryor: That's not necessarily the case. They do degrade over time. They change their chemical structure.

03-01:11:29
Schilling: Yes, that's true. It's interesting. We have a different kind of timeframe in cultural heritage. We want things to last forever. And now bottle makers and plastic makers want them to degrade more rapidly. But even if it takes ten years to degrade in landfills, that may be too long. We don't want these gyres of plastic waste to be churning out in the oceans. But we want things to last forever, and certainly not all plastics can be described in that way. Rubber bands—good example—natural rubber, latex—rubber bands don't last very long, even though it's a natural polymer. Some artists use latex—Eva Hesse put latex coatings onto fabrics. She liked the way that the latex enhanced the drapes and folds and appearance and gloss, and kind of would freeze the fabrics into certain shapes that she liked. They're beautiful things to look at, but again, latex is an ephemeral material. So the problem with storing those objects is what kind of environment to put them. Do you put them into inert environments? Temperature-controlled? Humidity-controlled? —just challenges. Again, that's one of the problems in conserving and preserving latex objects.

03-01:13:02
Acrylic objects, on the other hand—very stable material. It's Plexiglas—Lucite, Perspex, depending on what country you're in, they have different trade names. But acrylic—like plastic windshields and windscreens on visors, and things like that. Very stable, synthetic material, synthetic plastic. Sculptors love it. Again, it can melt and be deformed around a hundred degrees centigrade, even less, I think. Easily colored, easily glued to itself. It's a beautiful material, and it's very much like glass, which is why everybody likes it. Plastic tumblers made out of acrylic are good tumblers. But the—

03-01:13:52
Eardley-Pryor: How did the POPART project begin?

03-01:13:55
Schilling: The project basically started in France, Bertrand Lavédrine at the Graphic Document Center in Paris, really a great collaborator. He started this research consortium, he got EU [European Union] funding for it. So a number of European labs joined this research consortium to study plastic art. The GCI was an unfunded partner; we had our own funding from the Getty Trust. We didn't need EU funding, nor could we even legally receive it. But we decided to join that consortium. Tom thought, there is our first big step into studying plastic, because we'd be partnering with the top labs in Europe to study plastic art.

03-01:14:45
Eardley-Pryor: That speaks to your comment about Tom being such a great networker, knowing what other institutions are doing, and finding opportunities for GCI to collaborate with that.

03-01:14:54
Schilling: That's right. That's right. Incidentally, Tom was one of the pioneers in using Py-GC/MS in our field. He got his PhD studying modern paint analysis. Py-

GC/MS was one of the tools that he used. His analytical information from that thesis, then, was written into a Getty publication analysis of modern paints. It's one of our best sellers, because it was so well-researched, it was part of a PhD thesis.

03-01:15:23
Eardley-Pryor: Oh, so Tom was doing Py-GC/MS separately from your work on the amber project, and your introduction to it?

03-01:15:29
Schilling: That's correct. That's correct.

03-01:15:29
Eardley-Pryor: Now here they come together for this plastics analysis.

03-01:15:34
Schilling: That's right.

03-01:15:33
Eardley-Pryor: That's great.

03-01:15:35
Schilling: Yep. So we started working in POPART. So a number of us worked on plastic specimens that were produced and distributed by Bertrand and the project team. The collection of reference samples was called "Samco," Sample Collection. There are about a hundred specimens in all of plastic, different types of plastic, so nylon and acrylic and urethane, and you name it, on and on and on. Polystyrene, polypropylene, polyethylene, cellulose nitrate, cellulose acetate—you name it, it was represented in that collection of reference samples. So all of the partners received a box of these reference samples to study with their own analytical tools. Well, we have a lot in GCI, in the Materials Characterization group. So we had FTIR; we had Py-GC/MS, we've talked about those two. Another tool that was useful was elemental analysis. So you can use it to precisely measure the percentage of carbon, hydrogen, oxygen, nitrogen and sulfur in a sample. Joy Mazurek did that work, studying the sample collection with CHNX [Carbon Hydrogen Nitrogen and heteroatoms (X) like sulfur] analysis. So we had those results that—

03-01:17:05
Eardley-Pryor: How is that different from doing the analysis that comes out of a mass spec or an IR for identification?

03-01:17:08
Schilling: All you're getting is percent carbon, hydrogen, hydrogen, oxygen, sulfur—it's used in pharmaceuticals a lot, you know, to express the purity of the sample.

03-01:17:18
Eardley-Pryor: I see, hence the name, CHNX.

03-01:17:22
Schilling: Yep, CHNX. Anyway, we did Raman spectroscopy, which is, again, a non-invasive point and shoot type of device, that gives you material-specific information. I think those were the main techniques that we used—yeah, CHNX, FTIR, Raman, Py-GC/MS. Yep.

03-01:17:46
Eardley-Pryor: And what was the result of some of that work, this consortium's research?

03-01:17:52
Schilling: One of the things that we learned from Samco was just that now we made our own database of those reference samples, the results from the tests of the samples. So that was beneficial to labs that didn't have access to those databases. Samco became the source, then, of that database. We had a lot of databases here. We already had some software tools to interpret plastic data, and that was helpful to us.

03-01:18:27
Eardley-Pryor: What were some of those tools, the software?

03-01:18:29
Schilling: Well, one of the tools that I used for Py-GC/MS was actually made by Frontier Labs, it's called F-Search. F-Search is software that basically allows chemists like myself doing Py-GC/MS to identify polymers and additives that are mixed together to make plastic. Plastic is a mixture of polymers and additives. Sometimes there's not very much additive, sometimes there's a lot. PVC [polyvinyl chloride] is an example. PVC pipe is rigid. But PVC can also be flexible and turned into inflatable things. You can make rigid PVC into flexible PVC by adding plasticizers.

03-01:19:17
Eardley-Pryor: Those are the additives?

03-01:19:17
Schilling: Like phthalates. Plasticizers are a type of additive. Antioxidants are another type of chemicals that reduce the rate of oxidation of the plastic. If plastics oxidize, they change in the grade. Plastic manufacturers know that, and they'll load a certain amount of antioxidants into the plastic to make them last longer. So again, in cultural heritage, we like antioxidants, but the green people don't like them, because they want the plastics to degrade more rapidly. But anyway, those are some of the additives that you can then identify with Py-GC/MS, using this program called F-Search, "F" for "Frontier."

F-Search is a way of producing a single mass spectrum that represents the entire Py-GC/MS chromatogram. All it does, basically, is it adds up the mass spectra from each of the peaks in the chromatogram. For peaks that are big, the mass spectral signal is big for that one, so it'll contribute a lot to the weighted average of the total mass spectrum. Small peaks add to the mass spectrum as a low intensity. They won't contribute in a significant way to the

overall mass spectrum. So what's produced by the software is called an "INT-SUM spectrum," and the INT-SUM spectrum, then, is one spectrum that represents the entire Py-GC/MS chromatogram.

03-01:21:01
Eardley-Pryor: All of the material that went through?

03-01:21:03
Schilling: Correct. And so that one combination of chromatogram and mass spectrum can be stored into a database. So when we bought F-Search from Frontier Labs, we also bought the polymer and additive databases, right? So now we have the databases of the INT-SUM spectra for the polymers, and the mass spectrum of each of the additives that might be present. So the combination of the chromatogram and the INT-SUM spectrum, and the individual mass spectra for the additives, allow us researchers to fully characterize a plastic.

03-01:21:47
Eardley-Pryor: Let me share with you what I'm hearing, and if I'm hearing correctly. So the chromatogram tells you—the GC column, that result of the chromatogram tells you, "Here are, based on a time lapse, here are the different peaks that we get of different materials," and it'll tell you the relative amount that that material shows up.

03-01:22:04
Schilling: Yes.

03-01:22:04
Eardley-Pryor: And we get that by how quickly it moves through the GC column. The mass spectrum element of it, once you ionize those different molecules that are coming through, they shatter, and you get a signature of what those molecules are. So the F-Search software, and this database of all these different polymers and additives, then present a collective story that combines both the information from the chromatogram and the mass spectrum, relative to what your sample was. It combines all of that. Am I getting that correct?

03-01:22:34
Schilling: You're ready to work in the lab.

03-01:22:36
Eardley-Pryor: You did a great job explaining it, then.

03-01:22:36
Schilling: We'll get you trained on F-Search very quickly. Yes, that's exactly right. Exactly right.

03-01:22:41
Eardley-Pryor: So F-Search is essentially allowing you to put a whole picture together of these different plastics that you are sampling.

03-01:22:48
Schilling: Yes. Because if you pyrolyze a plastic, you may end up with hundreds and hundreds of peaks. And it's very difficult to make sense of a complicated pyrogram like that. What F-Search does is, it streamlines all the information into a single mass spectrum that well-represents the weighted average amounts of each of the peaks, whether big or small. So it uses the same kind of spectral library search technology that we use to identify single components in a normal GC/MS chromatogram. So it's the same little sub-routine that's used to give you a library match between your polymer and a reference polymer that's in the library database.

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Eardley-Pryor: That's great.

03-01:23:33
Schilling: So it's an elegant tool, and it has a nice feature that you can toggle between looking at the mass spectrum of your INT-SUM for your plastic, and the INT-SUM for the polymer from the library. Or click on the chromatogram button, and you can overlay the chromatograms of the two.

03-01:23:49
Eardley-Pryor: And see how close of a match you get.

03-01:23:52
Schilling: And you can see how they match. There's that second dimension of information that you can easily display on the screen with F-Search.

03-01:24:00
Eardley-Pryor: It's so visual, the comparisons.

03-01:24:02
Schilling: It's a wonderful technique. Exactly.

03-01:24:04
Eardley-Pryor: It's almost like—I'm thinking of the way the conservator—you've talked about a conservator analyzing these cracks by eye, and their years of training to be able to pull that information out. You have that same kind of skillset, visualizing and seeing the data that comes out of your instrumentation, your chemical analysis instruments, and being able to visualize the data to know what you're looking at.

03-01:24:26
Schilling: That's right. Yep. It really opens up a whole new level of interpretation, because now as a scientist, I don't have to bother identifying each and every peak in the chromatogram. That's just not needed, because this one mass spectrum represents this whole material.

03-01:24:43
Eardley-Pryor: And visualizes it.

03-01:24:46
Schilling: Visually and analytically. Yep.

03-01:24:49
Eardley-Pryor: That's wonderful.

03-01:24:48
Schilling: Yeah. It's a great tool. So then how would I convince someone that it really works? There's a question, right? Are there skeptics out there who think maybe it works, maybe not? So to do that, you look at unknowns.

03-01:25:08
Eardley-Pryor: Tell me the story behind—I understand there was, in 2009 or so, a reputable plastics collector who was questioning whether these analytical tools really were getting answers that he could rely on.

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Schilling: Mm-hmm.

03-01:25:22
Eardley-Pryor: What's the story with that?

03-01:25:22
Schilling: Colin Williamson is his name. He calls himself a "plastician," and he is a historian of plastics. He has an extensive collection of plastics, literature, from plastic makers and people who analyze plastics. He's just a great resource on plastics, which is an important material, again, in twentieth and twenty-first century art. Colin was brought on by Bertrand Lavédrine, the head of the Pop Art project, to review our progress. So part of the stipulation of getting this money from the EU was, we had to produce quarterly reports, progress reports, that were reviewed by an impartial committee. So because Colin had such a good reputation as a plastician in Europe, he was a logical candidate to get on board. So Colin did ask that question: "Well, great, you've got a lot of great scientists here, and they have great equipment that they're using, and they're making these claims—I'm not sure I necessarily believe everything that they're saying," because plastics are so complicated, right? There can be so many formulations. "And I think it would be much harder to identify real unknown plastics." He said, "If I gave you a set of plastics, I wonder if you'd be able to identify them all." We said, "Bring it on. Let's do it."

So he gave us about three dozen or so—

03-01:27:00
Eardley-Pryor: And "us" is everyone in the consortium?

03-01:27:02
Schilling: Correct.

03-01:27:04
Eardley-Pryor: All of the EU members, and the Getty?

03-01:27:06
Schilling: Correct. Everyone got a box of these unknowns. There's some term in science that when you're going to send a sample around to a set of labs and have the labs analyze it, produce a result, and then someone looks at all of the reports of the results and kind of compares them, and see how they compare and contrast, it's called a "round robin," okay? So a round robin test has value to see how reproducible analytic results are from lab to lab to lab.

So these were certainly round robin samples, because we all got them. But they were also unknowns to us.

03-01:27:45
Eardley-Pryor: But Colin knew?

03-01:27:47
Schilling: But Colin knew. So Colin called them "blind robins," which was a really weird term. But it fit. It was an apt term to describe these things. So they were standard materials, they were standard plastics. He knew what they were. And they represented, in the end, we showed that they represented a wide range of plastics, both kind of the original ones and new ones. They were kind of space-age type.

03-01:28:17
So we were all given those. There were three Py-GC/MS labs that work on these, they're part of the POPART consortium. There's the C2RMF in Paris, and they're based at the Louvre. They're in the quarters of the Louvre, but they're not part of the Louvre. They're the national lab of France in cultural heritage. I can't tell you what the acronym stands for, but I like the fact that it has a two in it, C2RMF. So we had a colleague at the C2RMF who's an expert in Py-GC/MS. An expert at the Netherlands Cultural Heritage Agency in Amsterdam, who has a Py-GC/MS. And GCI. So all three labs tested the blind robins. And Herant tested them with FTIR and Raman spectroscopy. Joy tested them with CHNX. We wrote our reports. And all of the reports were sent to Colin. He reported back to us at the very next meeting. He was astonished that GCI got them all right. So we were very happy about that.

03-01:29:37
Eardley-Pryor: What a great moment!

03-01:29:37
Schilling: We were very happy with that. And that really is a testament to the skills, certainly, of Joy and Herant—

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Eardley-Pryor: And yourself.

03-01:29:46
Schilling: —who had a lot of experience in doing the data interpretation. But what it did for me, as the person who did the Py-GC/MS, was that it gave me confidence in F-Search. Because even for me, I'm still a bit skeptical. I didn't have any way of proving to myself that it did what it claimed it could do, right?

03-01:30:11
Eardley-Pryor: And here is your proof.

03-01:30:11
Schilling: So here's my 30-odd blind robins, got them all right. And here's just a bit of an aside—one of the advantages of FTIR is, you can identify a wide range of materials from a single sample, okay? The detection limit is not always great. So it may be, if there are components in the plastic that are below, say, 5 percent, there might not be enough signal for the infrared to identify it.

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Eardley-Pryor: Even with the Fourier transform boosting the signal?

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Schilling: Correct. That's correct. So there's just a physical limit to what can pass through optically, and then—

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Eardley-Pryor: Being identified.

03-01:30:58
Schilling: —just make features in the IR spectrum. But the other thing is, the infrared light has to be able to pass through the sample. So for light colored materials, not a problem. But black materials are a real problem, because light won't pass through a black substance. So you actually get more information from the Py-GC/MS than you would for FTIR when the material is black. So again, it's a good example of why you need more than one type of analytical tool in your toolkit in order to answer the range of questions that we tackle routinely from conservators and curators, especially in the what-is-it category. You want to have more than just one.

03-01:31:48
Eardley-Pryor: All those instruments allow you to have different sets of eyes on that material.

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Schilling: That's correct. So I was really impressed, then, with F-Search. I became an F-Search believer.

03-01:31:57
Eardley-Pryor: Now did the other institutions—the one that's affiliated with the Louvre in France, or the Dutch organization, and the Getty—

03-01:32:04
Schilling: Yes.

03-01:32:05
Eardley-Pryor: —were they also using F-Search? Or was it only you?

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Schilling: No. We were the only ones using F-Search, even, at the time, in the world, I think we were the only ones using it.

03-01:32:17
Eardley-Pryor: Who else would have been using that? Not in cultural heritage, but just outside of that?

03-01:32:20
Schilling: Oh, plastic makers. Frontier actually put together the libraries that you buy, the commercial libraries, then, of the polymers and additives. And plastic makers need that kind of information. Also, then, it provided kind of an example of what F-Search could do. Okay, here's a way of simplifying a complex—we would call it—let's call it a "pyrogram" from now on, instead of a Py-GC/MS, so a little faster. So simplifying a complex pyrogram and producing a chromatogram and a mass spectrum to represent that sample is a great idea. It's a great way of simplifying a complex dataset. But what they were doing at the other labs—and honestly, what you would do if you didn't have access to F-Search—is you'd just have to start looking for marker compounds and kind of patterns in the chromatograms, kind of the way they looked. It's hard to do that. And you need a lot of experience doing that. So here I am, a newbie to Py-GC, right? But I'm using an expert system that Frontier made, F-Search, that took all of their combined wisdom and expressed that information in a simplified, clear format that I could then access. So I didn't need the expert knowledge of our partners, because I had access to a database that represented it in a meaningful way to me as a newcomer. So it was a real learning experience seeing that in action, and seeing the value of those software tools, and kind of summarizing complex data.

03-01:34:18
Eardley-Pryor: Was that experience—in being able to capitalize on this F-Search tool and sharing it, and being the only institution that got them all right, and partially as a result—was that informative in your later experience in creating ESCAPE [Expert System for Characterization using AMDIS Plus Excel]?

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Schilling: Absolutely.

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Eardley-Pryor: How so?

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Schilling: Could we talk about that later?

03-01:34:42
Eardley-Pryor: Yeah, we'll bring it up later.

03-01:34:43
Schilling: Okay, great.

03-01:34:43
Eardley-Pryor: Yeah. Great. Great.

03-01:34:44
Schilling: That would be good. I want to mention one other thing, then. So the project POPART was a total success—

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Eardley-Pryor: It sounds like it.

03-01:34:49
Schilling: —because the conservators tackle conservation challenges, scientists tackled analytical challenges. Conservators also tackled things like condition surveys. That's a hugely important aspect of conservation work. I think I mentioned it yesterday from the context of Mogao, and being in cave 85 and looking at these condition maps the conservators make, because a conservator, one, let's say, a conservator of plastic sculpture will go through, say, the Victoria and Albert Museum galleries, where the plastic objects are on display. They'll look at them, and they'll look for a science of degradation and change; discoloration, blanching, cracking, distortions, tackiness, dirt pickup—and they'll make notes about what they see. This happens in museums all over the world, not just on plastic objects. They're very keen watchers of their collections. They are caretakers of them. And they're at the front line of spotting when change is starting to happen. So a big aspect of POPART, then, was getting the conservators together who do these surveys of condition, and to come up with a set of guidelines that would be part of a routine condition survey. So what are the things that they should notice? What should they look for? Can they, as a group, agree on a set of terms and terminologies, and things, observations to look for? So that was a big part of it.

03-01:36:47
Eardley-Pryor: It amalgamates the knowledge and standardizes how to do that kind of care for plastics.

03-01:36:51
Schilling: Correct. Correct. Standardized terminology is just a huge part that underpins conservation. If everyone is looking for the same thing and expressing it in the same way, and documenting it in the same way, now information at the Victoria and Albert Museum might be relevant to what's happening at another museum, like the National Museum of Denmark.

03-01:37:21
Eardley-Pryor: And they're able to share that knowledge now.

03-01:37:23
Schilling: They're able to share it. So that was a neat part of POPART, for scientists to watch that happen. It was interesting. It was a little jargon-heavy, but hey, science is the most jargon-heavy discipline of all, so I'm not going to knock them. But it was interesting, just seeing and hearing about those results at the symposium that Bertrand put on that culminated POPART. Another checkbox that needed to be done to satisfy the grant makers was to write a book on what we found, so there's a lovely publication of all of our collective efforts in Pop

Art. There was a DVD, videos of the talks. And there was a little doll that was made, called Poly, and Poly was a doll that was made up of different common items, like cups and yarns and things like that, different polymers were assembled by a few of the conservators on the team. And Poly then ended up being a dosimeter. A dosimeter is something that measures the exposure in an area to, say, light and temperature and pollutants, and things like that.

03-01:38:49
Eardley-Pryor: So the dolly became the canary in the coal mine.

03-01:38:50
Schilling: It is the canary in the coal mine. And Poly was a great name, because "polymers." So little Poly dolls were given to all of the partners to put somewhere in their galleries or in their labs, just to see what happens to these materials. Some of them were a little more sensitive to the environmental conditions than others. The urethanes, there were two types of urethanes, one type was more sensitive than the other. So one of the feet, I think it was, degraded more rapidly than the other. It was interesting. The hair was orange, the orange was fading, and all of that. So Poly was an interesting idea.

03-01:39:30
Eardley-Pryor: Almost like a time capsule, because you'll go back to Poly after being in their conservation space to see how that degradation happened compared to another conservation space.

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Schilling: Right. Exactly. Exactly. And if when Poly is deployed in some place, the scientist or a conservator also deployed, say, a light meter and a temperature like a thermometer, and had that data go to a data logger to log the temperature and humidity and light levels over time, you get kind of a numerical expression of what Poly was exposed to. Then Poly itself was a visible witness, then, of what she was exposed to.

03-01:40:14
Eardley-Pryor: That's a really neat idea.

03-01:40:17
Schilling: Yeah, it was really cool. Yvonne Shashoua, I believe, came up with that idea. She's a conservator from Denmark, a conservation scientist from Denmark. It's an interesting—

03-01:40:25
Eardley-Pryor: I'm really struck with cultural heritage, how collaborative internationally it is, particularly on the science side of things, as well. Today in science, a lot of information, especially if it's coming out of industry, is considered private. It's something you don't want to share for competitive reasons. And the ethos throughout cultural heritage is collaborative and sharing for collective knowledge. And it really elevates the human spirit. It's almost what international science began as—really open collaboration, collective

knowledge-building for human sake, for our own betterment. The way you describe cultural heritage in these consortiums and the way resources are shared, it gets to that ethos of what knowledge-building and human excellence really is all about.

03-01:41:19
Schilling: Absolutely. Yeah, cultural heritage, it's human expression. And those things are expressed in different ways, in different materials, or different times, but they're for all of us. And they can be enjoyed by all of us, no matter how old we are, no matter where we live. I think the collaboration just reflects that we all need to work together to make this cultural heritage last. We want to pass that along. That's who we were at some point in time, and we want to be able to share that.

03-01:41:57
The fire at the Notre Dame cathedral just happened a few days ago. Really awful. Really moving. I've been there, it's one of my favorite places. It's—wow. It was like looking at a death in the family. But you know that, as we all get together as a community, to roll up our sleeves and get together and study it, study what happened, and study how to restore it, how to preserve it, and how to understand what happens to, say, the stone when it gets heated—we're going to learn more. Good will come out of that tragedy. And there's enough resources being mustered now by well-intentioned, well-meaning people around the world, that Notre Dame will rise again. There's no question. It has to. It represents who we are. And seeing good come from a tragedy is always encouraging, you know, that we're making the best of a horrible situation.

03-01:43:09
Eardley-Pryor: Mm-hmm.

03-01:43:13
Schilling: But we all need to work together on something like that, you know? The floods in Florence—again, it was an international response to that horrible, horrible tragedy. When the Seine River recently, the last few years, it kind of crested over the banks—my friends that work at the C2RMF in Paris actually had to evacuate some of their lab equipment that was in labs that were below the water level. Because they were afraid that if the water came in, it would flood the labs, and it would wipe out their operation. So they actually evacuated. It was physically exhausting to relocate this heavy equipment to higher ground.

03-01:43:52
Eardley-Pryor: That makes me wonder about anticipatory responses in cultural heritage to climate change—knowing that climates are changing, and that conservator spaces will have to adapt, perhaps, their environmental controls because the global climate is changing.

03-01:44:09
Schilling: Absolutely.

03-01:44:10
Eardley-Pryor: Is that something that's on the radar of the analytical community?

03-01:44:15
Schilling: We've talked about it, certainly, in-house. We haven't formulated any kind of research strategy yet to deal with that. But it's certainly being talked about more meaningfully now. I think every year that goes by, the conversations are getting a little more urgent. So we'll see how the conservation community responds. Yeah. But definitely, it's something we're going to have to keep—we're going to have to be aware of that. Yeah.

03-01:44:43
Eardley-Pryor: Historically, was that something that came up amid concerns of acid rain in the eighties, when you were first getting involved in your cultural heritage work? I know acid rain was a topic of discussion for, "How do we control this through a political means?" Was that something that was of concern in your early experience in cultural heritage?

03-01:45:04
Schilling: Yeah, absolutely. It's interesting when you compare sort of the outdoor environment with the indoor environment. We all think that when works of art are outside, they're more vulnerable and susceptible to what's in the air around them, what's in the environment around them, and that once they're in a building, they're safer. It's interesting. It's a little off-topic, but I'll get back to your point—materials in galleries and in display cases and in storage spaces can off-gas pollutants. Some of the pollutants are harmless to objects, others are pretty nasty. So certain types of wood can off-gas acetic acid, vinegar, and acetic acid loves to react with, say, lead.

03-01:45:56
Eardley-Pryor: So if you had a wooden frame that's off-gassing this acetic acid, and you have lead-based paints that's inside the frame—

03-01:46:02
Schilling: Not so much paint as much as metals. So lead that's used in sculpture and objects, certain types of glasses can react with acetic acid. Seashells can react with acetic acid and start damaging them. So, interesting—once they're inside the building, we can't completely breathe a sigh of relief. There are still things to be aware of. And I think Michal Lukomski's kind of tackling those issues in his research, then, on the museum environment. But just wanted to bring that up, that not all is well once the objects get back inside.

03-01:46:44
Really interesting example of an Egyptian sculpture, limestone sculpture. Certain types of Egyptian limestone have clays in them, and clays can pick up water from the air, kind of swell and contract, and expand and contract. So this Egyptian sculpture was perfectly stable outside because it was nice and hot and dry in Egypt. It was brought into a museum where the humidity

fluctuated more and went higher than it would normally see outside, and the statue started to crumble.

03-01:47:18
Eardley-Pryor: Wow.

03-01:47:19
Schilling: Yeah, and it's because of these swelling types of clays. So the environment is interesting. It's an interesting aspect of our work.

03-01:47:29
Eardley-Pryor: And it speaks to—

03-01:47:32
Schilling: Understanding it, controlling it when we need to, monitoring it and trying to mitigate the bad effects. I think I mentioned Shin Maekawa yesterday, working on climate monitoring and building display cases, storage cases, just to have a protective environment into which objects would lie.

03-01:47:53
But to get back to the acid rain question. Certainly acid rain, and then particulate pollution, those are horrible things that happen, you know? The Yungang Grottoes in China, which we did not speak about yesterday, but you mentioned them, along with the Dunhuang Grottoes, where we worked a lot. The Yungang Grottoes were across the street from an open-pit coal mine. And there was coal dust just constantly blowing into these Grottoes, and covering the statues. So then the site managers had to dust the statues with feather dusters to try and get rid of this disfiguring black coal dust. We worked in Prague, at the St. Vitus Cathedral. And it has—it's a beautiful church. And it had these beautiful stained glass mosaics in the front, and it was called the "Golden Gate," that was kind of the nickname of this set of three stained glass mosaics. But none of the residents of Prague knew why this was called the "Golden Gate," because it was just uniformly dark black against soot from factories, diesel and things like that, just covered the entire outside of the church. So there was no difference between the appearance of the stone and the appearance of the mosaic. So Dusan Stulik was the person who, again, is from Prague, he loved that place, and he wanted to see it look like the Golden Gate again. So there's a wonderful summary of his work on our website, talking about what we did to restore the luster of that stained glass mosaic. But again, it's reversing that pollution.

03-01:49:50
And acid rain, I haven't dealt with the effects of acid rain personally, but our Built Heritage group absolutely does care about that. Yeah, it's horrible, because the acid degrades carbonate minerals, like marble, limestone, dolomite. And it just ruins it, absolutely. So we're glad that industry is moving away from sulfur-rich fuels and going to more clean fuels.

03-01:50:25
Eardley-Pryor: Yeah.

03-01:50:27
Schilling: Yeah, the climate is just the latest flavor of that ongoing battle for what we're doing to the planet, and what's happening to our legacy of cultural heritage.

03-01:50:40
Eardley-Pryor: And the battle for maintaining those objects. It speaks to why materials analysis and materials characterization are essential.

03-01:50:49
Schilling: Right.

03-01:50:50
Eardley-Pryor: You cannot protect from the environment, whether it's an indoor environment or outdoor, not really knowing what it is that you're protecting.

03-01:50:58
Schilling: Exactly.

03-01:51:01
Eardley-Pryor: That's great. Well, we mentioned earlier, your promotion to senior scientist, and some of your responsibilities changed. Another moment I wanted to address with you is in 2010, in the wake of the financial crisis of 2007, 2008, the Great Recession has hit. The GCI has to go through its own reactions to that. Some of that had to do with layoffs that happened to the staff.

03-01:51:23
Schilling: Yes.

03-01:51:25
Eardley-Pryor: I understand that you also had, with new responsibilities, had to play a role in that. What was that like for you? What happened?

03-01:51:33
Schilling: It was really a difficult time for all of us. Anyone—you know, any organization that lives off an endowment was just devastated by it. It was just beyond our control, certainly. But the leaders had to face the reality that even though the Getty endowment is large, and was large even after the Great Recession, still there had to be changes to the expenditures. So staff layoffs are really inevitable. Paring back the scope of our programs was just something that we all had to cope with. And that was difficult when people had to be laid off, our friends, basically, and colleagues, with whom we worked for many, many years. Having to let them go was traumatic, it really was. Many of them actually landed on their feet, which was so gratifying and reassuring. It was just, "Oh, hallelujah" that they landed and got good jobs after they left here. Yeah, I don't envy the decision makers that had to actually face those challenges in a very real way. But everything was done in a

sensitive way, with a minimal impact as much as possible on our operation. Yeah, it was just—it was a hard time.

03-01:53:10
Eardley-Pryor: How did that experience of having to have people leave the GCI, how did that change the dynamics of the work that you were able to do, or the personal connections in the work that you were already doing?

03-01:53:17
Schilling: Well, we lost certain expertise, certainly. Cecily Grzywacz was our expert on air pollution monitoring. So when she left, that skillset was gone. We still haven't completely recovered from the loss of her expertise. So air pollution monitoring is not one of the things now that we do regularly. What was the other? She also did HPLC [high performance liquid chromatography] dye analysis—again, that project on looking at organic pigments in Chinese wall paintings. That had to be closed, because that was her area of expertise. So we wrapped that project up, we wrote papers on the results. They were fine results, which was great to see all of that good research get into print so other people could benefit from that. So yeah, and that was true for any of the institutes here that lost staff members, that were just irreplaceable. Irreplaceable knowledge, and if we ever wanted to become experts again, we'd have to hire new people and start from scratch. So again, back to the learning curve.

03-01:54:42
Eardley-Pryor: What was that experience like in terms of your growth as a supervisor? Kind of new challenges, looking to your experience in your new position as supervising research.

03-01:54:55
Schilling: Well, one thing for sure, I appreciate the staff more. I think that's inevitable when you go through something like that. You really appreciate people in a different way. Wanting other people to learn a wider range of techniques so that there's not just one expert at a given method, that there's redundancy in that. That was a traumatic example of why it's great to have one expert, but it's also great to have people that are pretty good at what the expert is best at. So I think that's probably the biggest lesson that we learned from that, is let's not put all of those eggs in one basket. And again, that even addresses a different issue of kind of legacy. Legacy's something we've talked about at the institution for a long, long time, because we've had so many gifted people here over the decades, and they're at the top of their game in the world. How to meaningfully pass along their knowledge to the next generation. And depending on the skillsets, the responses kind of varies. For some, it's adequate to write a book of what they learned. For others, it might be do workshops, train other people. It might be mentoring and working alongside of someone to pass along the skillsets. We'll talk later about this aspect as it relates to lacquer analysis and Py-GC/MS analysis. But that's an interesting thing, that it's really hard to have one standardized way of handling it,

regardless of the person or expertise. You have a set of responses for that. So that is something that, again, came to our attention as we had staff cuts.

03-01:57:11
Eardley-Pryor: That issue of legacy is something that came up when I spoke with Tom Learner in preparation for our discussion today. Tom told me a story of outside visitors coming in and exploring the GCI, and they asked you, you know, what happens whenever you retire? Tom said your very typical humble response was, "We've got great things going on in the lab. We have all these members here that are doing great," and Tom stepped in and had to say, "No, this is a serious concern. What do we do when Michael decides it's time for him to retire?" What have you done in thinking about your role in terms of legacy, to enable the work that you have been able to do, to continue and build even when you do decide to retire?

03-01:57:59
Schilling: I think all of the things that I mentioned, actually, I've done in some way—some more meaningful than others—but training people, certainly working alongside of them, showing them how to use the instrument well to the best of their ability. Publications. Workshops. Joy and I are working with Henk van Keulen, an expert in Py-GC at the Netherlands Cultural Heritage Agency, writing up a book on our exploits using GC/MS and Py-GC/MS. And the workshops are a great way to pass it along at a fairly high level, to a wide range of people all over the world. So I'm doing the best I can. Yeah.

03-01:58:44
Eardley-Pryor: That's great. Well, let's take a break here for this session, and we'll come back and start our discussion on Asian lacquers after lunch.

03-01:58:48
Schilling: Okay, sounds good. Thanks.

03-01:58:49
Eardley-Pryor: Thank you, Michael.

Interview 4: April 19, 2019

04-00:00:00
Eardley-Pryor: Today is April 19, [2019], Friday. I am Roger Eardley-Pryor from the Oral History Center at the Bancroft Library at UC Berkeley. This is session four of an oral history with Michael Schilling at the Getty Center.

Michael, last discussion we had was about kind of a wide-range discussion about environmental monitoring, both indoor and outdoor. That, I think, relates in some ways to the next project you want to talk about, which was work with Disney. What was that work?

04-00:00:27
Schilling: The early animated films were made with artists painting figures onto plastic sheets, and then those transparent plastic sheets laid over a watercolor image of the background. And the animation happened when the sheets were photographed, and then the sheet was replaced with the next pose, and the next pose, and the next pose. So there might be a hundred-thousand or more of those plastic sheets that were photographed individually, so that when the film was played back at twenty-four frames a second, you had the illusion of motion. That was the cutting-edge technology back in the [nineteen-]thirties and forties and fifties and sixties and seventies, of animation. We would call that "hand-drawn animation."

So Disney was a pioneer in making feature-length animated features. Walt Disney himself saw value in retaining some of this artwork that was related to the animated shorts and feature-length films that the studio was producing. He started saving some of these animation plastic sheets, they're called "cels," short for celluloid or cellulose acetate, cellulose nitrate, so C-E-L-S, not C-E-L-L-S, not biological. But anyway, these animation cels, you've probably seen them. They're beautifully colored, like Alice in Wonderland. A pose of Alice in Wonderland getting ready to open the bottle and drink what was inside. You know, those cels could be purchased at different stores. They're worth a lot of money, because—

04-00:02:24
Eardley-Pryor: And each one was hand-drawn and hand-colored?

04-00:02:28
Schilling: Yes. The interesting part of that process, then, is the animators drew the original figures on the paper, right? And those line drawings then were traced onto plastic sheets by a group of people called anchors.

04-00:02:45
Eardley-Pryor: See-through plastic?

04-00:02:49
Schilling: There was a team of inkers that laid a transparent plastic sheet, a cel, over the drawing, traced it, and then that sheet was handed to a painter, who basically

was following almost a paint-by-numbers kind of approach, picking out the paints that fill in each detail of the drawing. So a cel has a line drawing on one side, and then on the opposite side, it's painted. So there's artwork on both sides of this transparent plastic sheet.

Then the sheets, after they were dried, then they were again paired up with their corresponding watercolor background. Sometimes multiple sheets were laid on top of each other, if there was more than one animated figure in a particular scene. They were photographed, and they were played back again at twenty-four frames a second. That was the animation process that was really happening in the heyday of the twentieth century. Again, Disney pioneered the use of that process for full-length features.

04-00:03:53

So the interesting thing about Disney himself is that he saw value in retaining some of this artwork. He retained all of the drawings, and many, many of the cels. He put them in what he colloquially called "the morgue." He used to work in the newspaper business, and in the newspaper business there is a room where all the back editions would be stored, and that was called "the morgue." So there's lovely little short vignettes of him in the Disney morgue talking to people about, oh, here is where we have stuff stored for Cinderella, and Alice in Wonderland, and Snow White. It was great, in that Wonderful World of Disney, the TV show, he would show that. It was really great to see behind the scenes. The interesting thing for us in terms of preserving cultural heritage, that Disney saw the value in keeping that. Many studios did not keep any of that, because they didn't see the need for it. They didn't want to waste the resources in storing it, and they wanted to reuse the plastic sheets because the paints could be washed off and reused, the plastic sheets, making the next film. But Disney had wisdom to do that.

And as a result, that morgue—fast-forward many decades past the passing of Mr. Disney—that morgue then became the Walt Disney Animation Research Library [ARL]. Okay? So it's here in Southern California. And we were approached by the collections manager at the ARL [Walt Disney Animation Research Library], Kristen McCormick. She approached Tom Learner in the intervening years, who became our head of the Science Department, and wanted to know if Tom would consider working with the ARL staff at studying the cels, because again, they're made of plastic. The plastic itself is reactive, as we talked about, some plastics are more reactive than others. Cellulose acetate is relatively stable, but it has certain stability issues, and she wanted to know if the protocols that they had in place in their storage vaults, which are really not a bank vault, but it's a climate-controlled room with compact shelving. On the shelves, then, were put boxes of cels and drawings, all of those things that would have been produced by the artists and animators in making the movie. Wanted to know if we would look at the cels and look at the storage conditions, and just see how they're doing, right? They were

interested in always doing better, if there was anything they could do better, they wanted to know. They wanted to know if we were interested.

So here's the interesting point. We were originally interested in working on this project with them because the cellulose acetate and cellulose nitrate, those are two common plastics that were used by sculptors. Cellulose plastics were some of the earliest commercial plastics that were made by industry; very popular in the twenties, thirties and forties and fifties. The other interesting thing is, we thought this cel collection would be a reference collection, then, to look at sculpture from the same time period. So if an animated feature came out in the 1960s, we could use that plastic cel as reference material for sculpture that was made from the sixties, right? That was the idea, at least, it seemed logical to us. Okay, sculpture from the fifties, we would look at plastic cels from movies made in the fifties, and compare. So in a way, the cels, since they had certain production dates for the movies, the cels would act like a calibration curve for us.

04-00:07:56
Eardley-Pryor: Yeah.

04-00:07:58
Schilling: And we could look at cellulose acetate from the thirties, forties, fifties, sixties, seventies, and eighties.

04-00:08:02
Eardley-Pryor: And the thought was to have that complement some of the plastic research that was happening to the POPART campaign?

04-00:08:08
Schilling: Right. Exactly. So we had all those tools developed in the POPART Project. We thought, okay, this sounds good to us. Cellulose acetate was, again, a popular sculpture medium. It was used in a lot of commercial items; eyeglass frames, hair clips, combs, screwdriver handles—a lot of commercial products. A lot of design art projects. Children's dolls were made from these things, photographic film was made from those same plastics. So we thought, sounds good, let's do it. We had our in-house experts who worked on POPART, like we said earlier. Then to that team, we added a post-doctoral fellow, Emma Richardson from England. We added Miriam Truffa Giachet, who was a talented intern from Italy, she worked with us for a year. And together, we all studied the plastics sheets. We were keenly interested in knowing something about the plastic sheets, what they were made of, so to confirm the type of plastic, what the plasticizers were that made the plastic sheets flexible.

04-00:09:21
Eardley-Pryor: The additives?

04-00:09:24
Schilling: Correct. Those additives that are so important in the properties of the plastic. And how degraded the plastic was. It may be too complicated to talk about

right now, but basically, cellulose acetate is made from cellulose and acetic acid. We mentioned acetic acid being vinegar. So as cellulose acetate degrades—if you think of mixing vinegar and cellulose together to make a product, cellulose acetate—the way cellulose acetate degrades is, the reverse reaction happens. Cellulose acetate reverts back slowly over time to cellulose and acetic acid, right? So it's an interesting plastic in that its degradation is the reverse of the reaction that formed it. I can't think of any other polymers that do that, where they depolymerize to form the starting materials.

So what does that mean for you? If you had one of these cellulose acetate dolls and you gave it to your child back in the fifties, in the sixties, the doll's going to start to smell like an Easter egg, kind of a vinegary smell, right? That's a sign of degradation. Then those plasticizers will start coming out of the pores of the doll and form little weeping patches on it. And they look tragic when it happens to a doll. When it happens to a comb, it might start to warp, and again, smell bad. The smell is the key that this reverse reaction, which we would call hydrolysis, is happening. And hydrolysis happens more rapidly when the storage temperature of the object is a little higher, and the humidity is a little higher. So the plastic makers really thought, when they made cellulose acetate, it would last a long, long time.

04-00:11:16

And that's true for kind of a moderate climate. But boy, that wasn't true in India. When they started selling cellulose acetate in India, which is a hot, humid country, that vinegar smell started happening much sooner than it happened in a cooler, drier climate. So the climate control would be essential for controlling this rate of hydrolysis, rate of production of the vinegar, right? So I think the term "vinegar syndrome" was used by makers of this plastic to describe this reverse hydrolysis reaction of going back to starting materials.

So by Disney, at the ARL, putting these cels into climate-controlled vaults, they did just the right thing. The vaults are cooler than ambient temperature in the rest of the building, and drier than kind of the ambient conditions. And those two environmental measures, temperature and humidity, were carefully controlled, so they were constant, as constant as possible. They learned that information from the research that was done on movie film at the Image Permanence Institute in Rochester, New York. They worked on studying how to stabilize movie film for a long, long time, they learned a lot, and so the ARL learned from looking at the Image Permanence Institute publications that, yeah, these are the conditions that we want for the storage vaults.

So that's where we come in. We come in thinking, "Okay, let's start looking at these. Let's see how degraded they are." So we looked at the literature on how to measure the amount of degradation of cellulose acetate, and we developed a refined GC/MS protocol to measure that. We developed other protocols later to measure the same thing, but the basic ideas were measuring the amount of acetate that's still attached to the polymer. Cellulose has no acetate, so its

acetyl content would be zero, right? And then cellulose diacetate has quite a bit of acetic acid attached to the cellulose. Cellulose triacetate has even more. So movie film and a lot of later photographic film was cellulose triacetate. What we were looking at in the Disney collection, largely, was cellulose diacetate. So CDA is the polymer, cellulose diacetate.

04-00:14:02
Eardley-Pryor: Why do you think the Disney animators were using that particular product?

04-00:14:04
Schilling: That was what was prevalent at the time. I think for Disney, the most important property of that plastic was being colorless, having no speckles or dust on it, being flexible, and the paint that they applied and the inks that they applied would stick well. So it had to be optically perfect, like looking at nothing. Because that thing is laying over a background and other cels, and they didn't want any imperfections in those plastic sheets to be photographed, because otherwise it would be like looking at something through a dust storm when it's played back as a movie.

So we learned a lot about what plasticizers the cel makers used, because Disney bought the cels from some plastic maker. They were made with a certain size and certain optical properties, physical properties. And they bought a lot of them because they made so many films.

04-00:15:10
Eardley-Pryor: I imagine thousands. Tens of thousands, even.

04-00:15:13
Schilling: Yeah, millions and millions and millions of these they would have purchased over the years. So we learned a lot about that.

04-00:15:17
Eardley-Pryor: So wouldn't you—in your lab, to learn about these things, what were the instrumentation methods that you found most helpful?

04-00:15:25
Schilling: We mentioned GC/MS, FTIR [Fourier-Transform Infrared Spectroscopy] is another good tool for differentiating the types of plastics and the plastic sheets. Ion chromatography is another type of chromatography that measures the concentration of ions. Sorry, if you were to dissolve vinegar in water, the acetate ion can be measured by this ion chromatograph.

04-00:15:52
Eardley-Pryor: What kind of data were you hoping to glean from that?

04-00:15:53
Schilling: The amount. The concentration. So the higher the concentration of acetic acid in that solution that we extract from the cel, the better.

04-00:16:04
Eardley-Pryor: And with that knowledge—?

04-00:16:04
Schilling: And the lower [the concentration of acetic acid in that solution], that meant that some of that acetic acid that was attached to cellulose has now converted to vinegar and evaporated away.

04-00:16:14
Eardley-Pryor: Would that change, then, the plan for how those would be stored by the ARL?

04-00:16:15
Schilling: It could, yes. What happens is, as the degradation process occurs, this vinegar actually occupies quite a bit of volume of the plastic. So as the vinegar evaporates, the plastic starts to distort. The polymer kind of collapses on itself, it warps and it distorts. Smells bad, plasticizers start coming out. Crystals and liquids start forming on the surface, and it discolors. That's kind of the end state of highly-degraded cellulose acetate—that's what the sculptures tend to look like from those time periods. That's really interesting to us as chemists. Why do the sculptures degrade so rapidly, but the cels from the same time period really look good? Really, it's only a small percent of the cels in the Disney collection that show evidence of warping and discoloration.

04-00:17:14
Eardley-Pryor: Which I imagine would then make the flaking of the paints that are applied to it also crack?

04-00:17:17
Schilling: Exactly. Exactly. So that's an interesting aspect of it. So eventually, we decided that for a sculpture, a sculptor would buy cellulose acetate sheets that were quick thick. The cel plastics are the thickness of a sheet of paper, right? So for cellulose acetate to be produced in thick sheets, it has to be heated to a high temperature and rolled out. If you apply high temperature to it, the plastic will degrade, so the plastic makers knew that, so they added different additives to the plastic in order to keep it stable at high temperature, as it's being rolled out. So those temperature stabilizers caused degradation to happen more rapidly.

04-00:18:10
Eardley-Pryor: In the sculptures?

04-00:18:11
Schilling: In the sculpture, yeah. The cel sheets didn't need those, they didn't need to be rolled out at high temperature, so you don't see the same degradation. So there's an example of a polymer, same polymer, but it has two different rates of reaction, rates of degradation, depending on the additives.

04-00:18:30
Eardley-Pryor: That's great.

04-00:18:33
Schilling: Yeah.

04-00:18:32
Eardley-Pryor: With the Disney project, it sounds like to me, they came to you with the questions of, "Are we doing things correctly?"

04-00:18:40
Schilling: Right.

04-00:18:41
Eardley-Pryor: And you, from the Getty's point of view, came in and said, "We can help you with that. We also have our own questions we want to ask with relation to our ongoing plastic work."

04-00:18:49
Schilling: Exactly.

04-00:18:50
Eardley-Pryor: How did the questions—with regard to the Disney project, about what you were doing and what kind of information you wanted—how did those questions in that project change over time?

04-00:19:00
Schilling: So they changed in a big way. We worked, really, on our own for about three years, totally self-sufficient, and all the work was carried out by our staff, and again by our visiting staff. We made several publications with Kristen McCormick and the other people at the Disney ARL. And we were all very happy with our results. But then Kristen got back to us a bit later, and wanted us to do more. They really wanted us to more fully investigate the storage issues; the relationship between storage temperature and the stability of these plastic sheets. And they were also interested in addressing something that you were alluding to just now—so again, you have good foresight; you really need to work in our labs, I think—what happens to the paints that are trying to stay stuck to a plastic sheet that's starting to warp and bend and degrade? Paints start to crack, and they start to peel off. And they can peel off completely, right, which is devastating, because if you want to preserve the cel, the plastic sheet is nice. It's the support for the line drawing and the paint layers, right? So it's stable paint, really, on an unstable support.

04-00:20:21
Eardley-Pryor: And both sides. That's what the—

04-00:20:23
Schilling: On both sides.

04-00:20:23
Eardley-Pryor: That seems like a unique issue in this particular art object.

04-00:20:29
Schilling: Exactly. There are analogs, I think, in the fine arts world where you have glass that's painted on the inside, painted inside, and you're looking through the glass at the paint layer. So it's a nice effect, viewed in that way. But it really does present storage challenges. Like you can imagine the paints might be a bit sticky. And so if you're storing fifty or a hundred or two hundred cels from Bambi, and you have to put paper or some kind of sheet between adjacent cels so that the cels don't stick to each other, because the paint would really stick well to an adjacent cel, because the paint was made to stick to plastic. So at the ARL, they were using different kinds of what we would call "interleafing sheets"—sheets that have a release agent on it so they don't stick. Kind of along the lines of a wax paper, if you think of it that way. It's not wax paper, but it's like that idea.

Anyway, so they were really interested in us to pursue this question of storage conditions versus stability of the plastic, and how could these paints be treated to re-attach them back onto the plastic sheets? So Disney was kind enough to actually give us funding for two staff positions. So I think it's probably one of the few times that the GCI has received funding to do research. Very generous, half a million-dollar grant to the GCI [Getty Conservation Institute]. We hired Katharina Hoeyng, she's a paintings conservator from Germany, and we knew of her work on animation cel treatments in Germany, and we thought, she's the right person for this job. Then we hired a graduate student in the Material Science program at UCLA, Carolyn Carta. And Carolyn is still working with us right now, even as we speak. She's in the lab right now.

So Katharina's job was to find a minimally-invasive way of reattaching the paints. And we talked about invasive, non-invasive. So to do as little as possible to put the paint back in contact with the plastic sheet. Then Carolyn's task was to understand better the relationship between the storage conditions and stability of the plastic, and also to measure the adhesion of the paint, because if paints strongly adhere, Katharina doesn't have to do much. If the paints don't adhere well, Katharina has to do a bit more. So we wanted to find a way of measuring that strength of the bond between the paint and the plastic. That was another one of Carolyn's jobs.

And that project will wrap up next year, with an expert's meeting and some workshops. We'll have invited people come who are recognized experts in the field, and we'll discuss the results of our work together—Katharina, Carolyn, and the rest of us—and do some workshops on the techniques that we developed to do the analysis, and also the treatments. So they're both interesting. Could talk on those for a long time, especially—well, all of it is really interesting.

04-00:23:54
Eardley-Pryor: Where would you like to see that work go, in the wake of this summation of the work that's been done, and the analytical methods? Where would you like to see next phases move toward, with the Disney work?

04-00:24:08
Schilling: It's a very good question. There is a small, but growing community of researchers who are interested in preserving animation art. Carolyn and Tom and Kristen and Katharina and I attended a meeting at the Eye Museum, the E-Y-E Museum, in Amsterdam, in the Netherlands, last year. And the project they had for two years was called Materials in Motion. And it was really to do a survey of cel collections at different institutions around the world. So their team, Aafke Weller and Mette Peters came to the U.S. and visited the Disney ARL, and saw the Disney cels in their native habitat, in their storage vaults, and then also went to the Motion Picture Academy to look at their self-collection. That was an interesting project, the expert's meeting was interesting. We think many of the people who attended the Materials in Motion symposium will be interested in coming here next year when we have the experts' meeting on what we've learned, and studying the Disney cels.

04-00:25:27
Eardley-Pryor: It sounds like there's an international community. You have spoken about the West, but I'm thinking about Japanimation and the Asian cartoon scene that has been producing things since the sixties as well.

04-00:25:37
Schilling: Absolutely. Certainly the Ghibli collection in Japan—hugely interested in what we're doing.

04-00:25:45
Eardley-Pryor: An entirely different environment in terms of humidity than Los Angeles.

04-00:25:47
Schilling: Yes, exactly.

04-00:25:48
Eardley-Pryor: So different kind of storage issues, I would think, over time, too.

04-00:25:52
Schilling: Mm-hmm. Mm-hmm. And again, that gets back to expense and how much it would cost to make refrigerated vaults, and all of that.

04-00:26:01
Eardley-Pryor: Hmm. That's great. The next [topic] I have for us to discuss, an enormous part of your career here, and also sharing internationally and getting a lot of international recognition for, and that's your work on Asian lacquers.

04-00:26:15
Schilling: Yes.

04-00:26:16
Eardley-Pryor: And a lot of that happened in collaboration here with another conservator, Arlen Heginbotham. Can you tell me a little bit about how the Asian lacquers work began? And then how it proceeded?

04-00:26:27
Schilling: Sure, okay, happy to. At the Getty Museum, here at the [Getty] Center location, we have a collection of French decorative arts from the eighteenth century. And some of the furniture is decorated with lacquered panels that were created in China or Japan. So lacquer in Asia is made with very different materials and techniques than lacquer in the West. If you've seen lacquered bowls and lacquered screens from Asia, they're characterized by just incredible beauty, delicate surfaces, gloss black, deep red, sometimes augmented with gold leaf, gold flake, gold dust inlay, tortoise shell, Mother of Pearl—it's really beautiful. It's a unique expression, a unique artistic expression that really came out of Asia. And when the Europeans started seeing lacquered objects in the sixteenth and seventeenth centuries, they wanted them. The collectors wanted them. So there was this trade of lacquered objects from Asia and into Europe. The first ones came into Portugal; the Portuguese were trading them. And lacquer from Japan, especially, was making its way into the wealthy patrons in Lisbon and throughout Portugal. And then as the Dutch took over that trade and it was coming into Northern and Western Europe.

04-00:28:11
Eardley-Pryor: And then the French elite furniture makers began using these Asian lacquers in their own furniture?

04-00:28:21
Schilling: Yeah. So what happened was, again, these bustling trade routes, getting these objects to the collectors in Europe. And the kind of common objects that the French furniture makers were interested in are these large screens that act as room dividers. So the lacquered screens in Asia are decorated on both sides. So French furniture makers were really skilled at making veneer, so taking big logs and cutting thin slides of them, and then bending them, molding them, adhering them onto complex shapes on furniture fronts and legs, and things like that. So what the French furniture makers did is, they would buy these screens, and then they would take off the lacquer layer as a veneer, and then adhere that thin wafer of decorator surface onto their furniture. And oftentimes they didn't need to cover the whole piece of furniture with this lacquer veneer. They would need to replicate the appearance of that Asian lacquer, and they would use materials that they were used to working with.

So they had totally different formulation for making lacquer, using Western spirit varnishes, tree resins dissolved in solvents. They could color those and paint them out. They were highly skilled at replicating the appearance of these Chinese and Japanese lacquered screens, but with materials that they were

used to using. They had no idea what materials the Asian lacquer makers were using, it was an absolute secret.

04-00:30:08

So it turned out that—and I don't know who revealed it, and when it was revealed, that would be an interesting story in and of itself—but it turned out that what the lacquer makers were using in Asia was saps from three species of trees that grow in Asia. And they're in the family of Anacardiaceae, so we call them "Anacards." Okay, so there are three Anacard species that produce sap. So if the bark of one of these Anacard species is cut, the sap will start oozing out. And it has reactive chemicals in the sap that dry to a film—it makes a scab like we would, if we were cut. The sap will cross-link and polymerize, and form a nice hard layer that's impermeable to water, and it's resistant. It will help the tree heal at that point. Now this sap is incredibly toxic to the touch. The tree sap and these three Anacard species—chemically similar to the sap in poison ivy. So the chemicals, the active ingredients in Asian lacquer tree saps—these Anacard tree saps, for which the European lacquer-makers had no clue what they were—they're called "catechols."

A catechol is basically a benzene ring, with six carbons in a ring. It's got two OH groups on it, so they look like little antennas, and then this long sidechain. It's a hydrocarbon sidechain, maybe fifteen carbons long, maybe seventeen carbons long, or maybe twelve carbons long with another benzene ring at the end. So I've just described the active ingredient in all three of those Anacard species. The one that we would call urushi is the one that's common in Japan and Korea, and parts of most of China. It would be the catechol ring with a fifteen-carbon sidechain. The one that grows primarily in Vietnam and the southern part of China has seventeen-carbon sidechain. And the one that grows in Southeast Asian countries, like Burma and Cambodia and Thailand, has those twelve carbons with another benzene ring at the end.

04-00:32:43

Eardley-Pryor: So those three different benzene rings are—

04-00:32:46

Schilling: Sidechains.

04-00:32:47

Eardley-Pryor: The sidechains that those molecules—those collections of atoms and molecules, all come from the same family of trees?

04-00:32:58

Schilling: Yes.

04-00:32:59

Eardley-Pryor: And the way that you can differentiate them is, those carbon chains and the chemical structures are analogous to where they grow, geographically?

04-00:33:06
Schilling: Yes. It's almost entirely correct. So the one thing I want to point out that connects back to what we were talking about earlier is, in those three molecules I described, the one that's peculiar to each of the three species, those are marker compounds, then, for those three species of tree sap. So depending on what marker compounds you can identify in the dried tree sap, that lets you determine which of the three species of tree produced the sap that's in that lacquer. Okay? So at the time, there were kind of limited geographic regions where these trees grew. Now, of course, we have trees at the LA County Arboretum that we actually tap. There was a laccol tree that we would think would only be in Vietnam and South China. We actually tapped one that's growing in Southern California. A lacquer conservator friend of ours, Marianne Webb, she lives in Vancouver. She has urushi trees growing on her property. So these trees can survive in other geographic areas, in other climates. But that's where they were thriving back when the Europeans discovered just how beautiful Asian lacquer is.

04-00:34:29
Eardley-Pryor: I see.

04-00:34:28
Schilling: Right? So each country had their own tradition of which saps to use, and then what additives to put in the lacquer. So many of the lacquer makers, their traditions were passed on from generation to generation, so the son would learn the lacquer making craft from his father, and so on and so forth. So those traditions of materials and techniques—the way the lacquer was made and put on, and polished—those would be carefully guarded secrets. But sometimes publications would be made of recipes. If you want to make a recipe, you want a nice glossy, black lacquer—take the urushi sap and mix it with some kind of drying oil, and maybe tung oil, et cetera. So you see, much like we talked about binding medium. And sometimes artists mixed things together. There was oral tradition and written documentation that that was also happening in Asia, using these tree saps, these Anacard tree saps.

Just as a side note, the lacquer sap has been used in these countries, especially Japan and China, for thousands of years. It was used as an adhesive, as a coating, long before they developed the tradition of lacquer making. And lacquer, again, is this colorful, decorative surface that adorns objects. Small and large. You can make small lacquer boxes, lacquer dishes, lacquer trays, lacquer chests, lacquer screens—it's a beautiful material, it's really durable. I don't know of any other natural product that has more flexibility in the way it can be used, flexible in terms of its application properties and mixtures, and things like that. It's just an incredibly versatile material. It's really lovely, but it's really toxic, it gives you a bad skin rash. So there's a small percentage of the population that don't respond with a skin rash if the lacquer touches them. They're the ones usually that ended up being lacquer makers.

04-00:36:49
Eardley-Pryor: And it makes sense that they would pass that down, genetically, by their sons and their family members, because they also would not have that same reaction.

04-00:36:55
Schilling: Exactly. Exactly, yeah. So that's a little bit of history of lacquer in Asia, kind of what makes Asian lacquer unique. It's really the materials and the processes in laying it down. It's laid down in multiple layers. Some lacquers have twenty, thirty, forty layers. Sometimes there's polishing going on in between applications of lacquer. Sometimes there's carving and then filling in the carved areas with other things, maybe an inlay. Maybe paint is applied in these carved out areas. Sometimes it's a clear area, sometimes it's pigmented with a red or a black or a green, other types of colors. So the distinguishing features of Asian lacquer that we were most interested in was this multi-layer, and most of the layers contained this unique catechol-containing tree sap. And there is an enzyme in the sap also, that promotes this cross-linking reaction. So if you had the catechols together in kind of a mixture, you bought them as pure chemicals and mixed them together, they wouldn't polymerize as fast as they do in the tree sap, because the tree sap has this enzyme called "laccase," which makes sense because it's "lacquer"—laccase. And that promotes cross-linking of these long polymer chains. But these long polymer chains also resemble a little bit the unsaturated fatty acids in drying oils. They have double bonds that pick-up oxygen and photo-oxidize.

04-00:38:36
So there's a two-step drying process when lacquer is made. Lacquer is applied, like a paint, painted out onto the surface of the object. Then that object is put into a humidity-controlled chamber for a couple of days. It's usually, say, eighty percent inside that chamber. Kept there for a couple of days. That moisture in the air activates the enzyme, the enzyme starts the cross-linking process. These small molecules start linking together to form bigger and bigger molecules, making this polymer chain build up slowly. Then the object is taken out of this humidity-controlled box and just left in the air, to autoxidize. Oxygen in the air is picked up by these double bonds and these sidechains, and further cross-links the lacquer. So the end result is an incredibly durable finish. As long as you keep lacquer away from a lot of light, it will last a long, long, long time.

So just as an aside, we've analyzed lacquer that's been buried for two thousand years. And we can still detect these markers. There's permanent markers that form that we can detect with Py-GC/MS. So incredibly durable, incredibly beautiful. Very different than the lacquer that's made in the West, both from the standpoint of materials and application, and very stable, but sensitive to light.

04-00:40:10
Eardley-Pryor: So you laid out this beautiful understanding of where lacquers are from, how they're made, what their composition is. How did you come into research on lacquers? How did it come into your purview?

04-00:40:25
Schilling: We were talking at the very beginning that the Europeans were keenly interested in lacquer, and they wanted it. They wanted to possess it. So there was quite a trade going. And French furniture makers got these lacquered screens, turned the lacquer into a veneer, adhered the veneer onto the carcass of the furniture, augmented undecorated parts of the furniture with European lacquer, which in the jargon is called "Japanned lacquer," because it imitates what they were seeing in Japan. So you have the Asian lacquer and Japanned lacquer on the furniture.

04-00:41:01
Eardley-Pryor: On the French furniture?

04-00:41:05
Schilling: [Yes.] The Getty Museum has pieces of Asian lacquer furniture in our collection. And the curator at the time, Gillian Wilson—this was about, I guess, twelve years ago, thirteen years ago—she wanted to do a catalog of the French decorative arts in our collection, the Baroque collection. So she was working with the Decorative Arts Conservation team that was headed by Brian Considine. One of Brian's associates is Arlen Heginbotham; he's a Decorative Arts and Sculpture conservator. So Arlen approached scientists at the GCI and said, "Gillian wants to study our lacquered furniture collection to see if we can identify where the Asian lacquer parts were coming from." So the fronts and some of the sides, where were they made? Were they made in Japan with Japanese lacquer materials and techniques? Were they made in China, with Chinese lacquer materials and techniques?

04-00:42:07
Eardley-Pryor: So the geography was a question from the start.

04-00:42:08
Schilling: Correct. Correct. And could we differentiate them? Could we differentiate Japanese lacquer from Chinese lacquer? And what about the Japanned lacquer, what did it contain?

04-00:42:21
Eardley-Pryor: Before you got involved in this work, what were the methods that those conservators used to try to identify geographic origin?

04-00:42:32
Schilling: There really wasn't a good method that everyone agreed on. Just again, as another aside, GCI got involved in a lacquer project, really, right around the time that I was hired—

04-00:42:49
Eardley-Pryor: In the early eighties?

04-00:42:50
Schilling: Yeah, the then head of Decorative Arts Conservation at the J. Paul Getty Museum was Barbara Roberts. She was interested in urushi, the Japanese lacquer. I don't know too much about the extent of this project, but just—it's enough to say that we did research on lacquer. Michele Derrick did FTIR analysis of the Asian lacquers, thought that she could differentiate some of them with FTIR, based on their spectra. And that project that Barbara started was a collaboration with the institutions in Asia, and so it culminated in a symposium. So there was the urushi symposium that people still talk about today, and it was really the GCI's first dipping the toe in the whole question of differentiating lacquer. I wasn't involved in that, that wasn't my thing back in the day. I was the pigment and glass and PLM [polarized light microscopy] guy.

So that was kind of the state of the art, really. And a lot of work has gone on in Japan about analyzing lacquer, and better ways of doing it than FTIR. The accepted way of doing lacquer analysis in Japan came out of Meiji University in Tokyo. There are researchers there. Tetsuo Miyakoshi was really at the forefront of lacquer research for most of his career. He recently retired. He found that pyrolysis-gas chromatography-mass spectrometry—Py-GC/MS—was a good tool for differentiating the three species of Anacards. So again, looking for the catechol ring with the fifteen-carbon sidechain that was characteristic of the urushi lacquer; catechol seventeen carbon sidechain, those characteristic of the Vietnamese laccol lacquer—that's what that would be called, laccol. So I have urushiol, laccol. And then thitsi lacquer was the catechol with twelve carbons and another benzene ring.

04-00:44:59
Eardley-Pryor: From Southeast Asia?

04-00:45:02
Schilling: That's the one from Southeast Asia. So Miyakoshi's method used fairly large samples, larger than what we would be taking if we were looking at, say, our de Kooning painting, perhaps. But he would use Py-GC/MS. He got these complex pyrograms that had marker compounds for the three different species of lacquer. That was more or less what came out of his Py-GC/MS work.

So the first scientist who was looking at this was going over the literature, her name is Julie Arslanoglu. She now works at the Met [the Metropolitan Museum of Art of New York City]. She was the one that actually gave the talk that I heard about the Frontier pyrolyzer, that convinced me that that was the pyrolyzer to get. That was a little bit after our lacquer project started, after Julie left to go the Met. So I got involved when Julie went to the Met. So it was my job, then, to work with Herant to do FTIR. Arlen is the conservator on the project working for Brian Considine in Decorative Arts and Sculpture

conservation. So it's Arlen's job to remove samples from the lacquered objects, bring them over to our lab. And then Herant and I studied them, Herant with FTIR, and then I was going to do some kind of Py-GC/MS.

So then the next complicating question is this: Miyakoshi's method worked well enough to differentiate the three types of tree saps. No problem, it worked well. Samples were a little large, but okay, if that's what you need, that's what you need, right? But his method wouldn't work well for a European lacquer.

04-00:46:42
Eardley-Pryor: Why?

04-00:46:44
Schilling: So European lacquer, again, I mentioned is made from tree resins, and they're highly oxidized chemicals. So when they're oxidized, it means they have a lot of carboxyl groups on them, CO_2H, OH, they have lot of hydroxyl groups. And anything that has an OH on it is not a good candidate for GC/MS, especially if the molecules tend to be large, because molecules with OH groups on them hydrogen bond inside of the GC column. And when that hydrogen bonding happens, it means that they stay in the column too long and they don't come out in one little peak. They come out in this broad lump. So a compound that may be the same weight, may be the same size that doesn't have an OH group on it—that might come out at just the same time, would come out as a nice, sharp peak. You add an OH group, either a hydroxyl or a carboxyl, and boy, that shape changes. What we would call "degrades the performance" of the GC analysis. It makes detecting the compound harder because, now, all of that amount of material is being spread out over, like, a one-minute span on the chromatogram, instead of the two or three second span. Since the size of the peak relates to the area of the peak—area of the triangle is one half base times height—if the base is very narrow, the height is very tall. But if the base gets wider, the same area means it's getting shorter. The shorter the peaks are, the harder it is to detect above the baseline.

So the performance of the GC/MS analysis, or the Py-GC/MS analysis, is degraded for compounds that do this hydrogen bonding. So as chromatographers, we need to figure out a way to circumvent that problem, and we go back to this issue of derivatization.

04-00:48:59
Eardley-Pryor: Let me pause you and just make sure I'm following where you're going. The European lacquers would not work as well in this methodology that was developed in Japan that uses the Py-GC/MS.

04-00:49:07
Schilling: Yes.

04-00:49:08
Eardley-Pryor: The reason why the European lacquers would not do as well in that analysis is because they have these OH attachments to their molecules, and that those adsorb within the GC column.

04-00:49:25
Schilling: Yes.

04-00:49:26
Eardley-Pryor: So that means they move more slowly through the column, so that your result—

04-00:49:28
Schilling: Right. They get spread out. They start out as a narrow little band, and that narrow little band is supposed to stay narrow as it goes through the column. But because they're interacting so much with the stationary phase, what's happening is, they're broadening too much. So it's not like they're just slowed down, they're actually broadened. So it's a little more complicated.

04-00:49:55
Eardley-Pryor: I see.

04-00:49:54
Schilling: Yeah. So when it broadens, that makes the peak shorter.

04-00:49:59
Eardley-Pryor: Then you can't identify it as easily.

04-00:50:00
Schilling: Right. So here's the point, then. So those types of European materials are used in picture varnishes, and they're used in paint media, like an oleoresinous paint, oil and resin mixed together. So the people that analyze easel paintings knew this from a long time ago, right? I told you about John Mills. He knew that fatty acids and oils have OH groups on them. He added this reactive chemical to convert those OH groups to O-methyl groups—chemical derivatization—using our agent that would put methyl groups in place of the H.

So methylation is the answer to the European lacquer question.

04-00:50:47
Eardley-Pryor: And you wouldn't need to pyrolyze it, then.

04-00:50:49
Schilling: And so there are lots of publications that talk about the use of methylating agents with oleoresinous paints or varnishes from Europe. And their chromatograms look perfect. All the peaks are narrow and sharp, and those chemical derivatives are just cousins of the original molecules. And we know, then, from their mass spectra what those marker compounds are, and the materials that produce them. So we know the set of markers that comes from

shellac. We know the set of markers that come from pine resin, mastic, dammar, elemi—those types of things, those tree resins. Sandarac, copal, amber, and—

04-00:51:34
Eardley-Pryor: And those show up well because they're in this derivatized methodology?

04-00:51:39
Schilling: Because they're in the derivatized form. That's correct. And so the NIST library [National Institute for Standards and Technology mass spectral library], the mass spectral libraries that you can buy that help chemists like me identify compounds based on their mass spectra, they're loaded with mass spectra of these derivatives of these resinous materials. Because they're not only used in works of art, they're used for lots of other commercial applications.

There's lots of literature that Julie found on using methylation to identify European lacquer, right? European materials. Then we have this other set of related information using also Py-GC/MS, but with no derivatization or agent, that's great for lacquer from Asia. So Arlen said we really need one Py-GC/MS method that will allow us to identify both types of lacquer.

04-00:52:30
Eardley-Pryor: Through one test.

04-00:52:33
Schilling: One test. Okay, then we just have one test, we apply it to all of the lacquer, because when Arlen takes a sample, we're still not sure if what he's sampling is European lacquer or lacquer from Asia.

04-00:52:46
Eardley-Pryor: So part of Arlen's interest in this is ensuring that he doesn't have to do invasive treatment onto an object and run to different tests?

04-00:52:53
Schilling: Right, invasive sampling, exactly.

04-00:52:55
Eardley-Pryor: Invasive sampling. He doesn't have to do a sample that runs through the European methodology versus a second sample to run through the Py-GC/MS.

04-00:52:54
Schilling: Yeah. Yeah. Mm-hmm. Correct.

04-00:53:05
Eardley-Pryor: So what was the innovation you found to solve that question?

04-00:53:08
Schilling: So what we ended up doing is, flip a coin, right? So do we want to start developing a whole database of European resins that are analyzed with no

derivatization, or do we want to develop a database of marker compounds from Asian lacquers using chemical derivatization? So the answer was pretty clear. We thought, "Okay, there is such a diverse range of compounds in European lacquer, let's not bother trying to recreate a bad result"—it's like a bad chromatogram— "in hope that we can differentiate them." So we decided, "Okay, let's treat all of the samples with a methylating re-agent."

The one we picked was commonly used in Py-GC/MS of European lacquer, it's called tetramethylammonium hydroxide, TMAH for short. So the TMAH does two things in the pyrolyzer: it reacts chemically with the sample vapor, and it's, again, converting OH groups to O-methyl groups, and NH groups to N-methyl groups, okay? So there's that chemical derivatization. But also, the high temperature in the pyrolyzer is doing this thermolysis that we talked about, the pyrolysis. So you have two things happening: thermally assisted hydrolysis and methylation. So you would abbreviate that as THM. So TMAH does THM in Py-GC/MS. So the full acronym, if you really want a long acronym—THM hyphen Py hyphen GC slash MS [THM-Py-GC/MS].

04-00:54:56
Eardley-Pryor: This makes sense to me as to how you are renowned for creating these wonderful acronyms to describe your research projects. It makes sense in the sense that all of the work that you're doing has these wonderful acronyms.

04-00:55:08
Schilling: Yeah, that's true. They really help us.

04-00:55:11
Eardley-Pryor: You're helping speak the scientific language to people that are doing the art conservation work.

04-00:55:15
Schilling: Right. Yeah. So that's what we would look for, then, in the literature, THM-Py-GC/MS. Miyakoshi was doing Py-GC/MS, right?

04-00:55:18
Eardley-Pryor: And you were able to complement that with a form that you would methylate the sample, and run the Py-GC/MS.

04-00:55:30
Schilling: Right. Right. So now we had quite a bit of literature that Julie and Arlen and Arlen's intern—Shelley Smith. He had Shelley also going through the literature and Decorative Arts and Sculpture conservation, trolling the literature for lacquer recipes: what materials should we now be aware of that were used in European lacquer and in Asian lacquer?

04-00:55:59
Eardley-Pryor: That kind of research would be pretty extensive, language-wise.

04-00:56:04
Schilling: You bet. And the great thing is, right now, sitting in one of the largest art libraries, the Getty Research Institute—and the Getty Research Institute, I haven't mentioned the Getty Research Institute yet—I have to. They have an incredible staff, so helpful to have researchers at the GCI and the Museum and the Foundation get access to the most diverse range of materials possible. So having them in your back pocket is, wow, it's so incredibly—it's such an incredible resource. And they're great colleagues. We have a staff in the Information Center at the GCI. It's headed by Cameron Trowbridge. Valerie Greathouse works there. They worked with us daily, and our interns and fellows and scholars, to help us get literature through the GRI, the Getty Research Institute. And it makes our work possible. So can't forget about the GRI.

Anyway, we had our people in the Museum, and also at the GCI assembling that literature so that we're aware of what materials to start looking for. If we know what materials to look for, then we can look for literature to find people who have talked about marker compounds for each type of material. So okay. He and other people in the MOLART project, which we talked about, headed by Jaap Boon. Klaas Jan van den Berg did a lot of work on pine resin, oxidation products from pine resin. They published extensively. So that literature is there. What we had to do was look at Miyakoshi's publications, and then people who worked with Miyakoshi, like Professor Honda, Professor Kamiya, and others, Rong Lu—all these people who worked at Meiji University, and say, "Okay now, we're starting with this kind of molecule. What's it going to look like chemically when we replace H's, on the OH's, with methyls?"

So a catechol, remember, is a benzene with two OH groups. These H's get replaced with methyls.

04-00:59:18
Eardley-Pryor: Because you're methylating them from the start, before you put them through the Py-GC/MS.

04-00:59:20
Schilling: Right. Now I've got a sidechain, and maybe if there are OH's along the sidechain, they'll get methylated. Now we have to start from Miyakoshi's publications, and then figure out how big these new molecules would be, what their molecular weight is.

04-00:59:39
Eardley-Pryor: And you needed to do that in order to be able to identify them at the end result, after they have gone through the mass spec?

04-00:59:47
Schilling: After they have gone through the whole THM-Py-GC/MS process, what do they now look like? What do those derivatives look like?

04-00:59:55
Eardley-Pryor: Because otherwise you wouldn't know what you're identifying.

04-00:59:55
Schilling: Are the things that Miyakoshi published all there?

04-00:59:59
Eardley-Pryor: That makes sense.

04-00:59:56
Schilling: So that's what we had to do. And we thought, this is much easier to do. It's a limited universe of marker compounds. That's what we thought at the beginning. Okay. So we flipped our coin mentally, we thought, "Let's use THM, we'll analyze them all the same way, European and Asian materials—same analysis protocol." And let's start, we know kind of from publications what the marker compounds are for European materials. Now we start inferring what the derivatives would be like from those Asian lacquers, those Anacard saps. We figured we were in business, right? Okay.

So now, Arlen has a really bright idea. Arlen is a really smart guy. He's one of the smartest guys I've worked with. He's a great guy to get along with, he's friendly, easy-going, and he thinks about things in a different way. And more than just thinking about it as a conservator, he really does think about it as a different way.

04-01:01:02
Eardley-Pryor: Now what do you mean by that?

04-01:01:03
Schilling: He came to me one day, and we were, again, starting to use THM, do our Py method on reference materials. And he said, "You know, Mike, it would really be great if we could have kind of one database for all of the marker compounds, for all the types of lacquer that we're studying, and look for the same set of marker compounds in each and every sample." That's often not the way we would do things, looking at a GC/MS chromatogram. Usually we would go back and start getting mass spectra for individual peaks in the chromatogram, and then doing some kind of mass spectral search on individual peaks. And we write down, "Oh, there's methyl palmitate. Oh, there's dimethyl azelate. There's methyl stearate." Well, those are all from drying oils. So we'd write that down, we'd write a report— "Drying oil," right? "Oh, there are some pine resin markers. Well, there's pine resin," right? But maybe there are some small peaks in the pyrogram that are really significant, right? Maybe it's the same chemical that would be present in high concentration in one lacquer; but may be present in a really small amount in another lacquer, and the peak would be so small we might miss it. Right?

04-01:02:26
Eardley-Pryor: Why do you think it would matter from Arlen's point of view? Why would he want all that?

04-01:02:28
Schilling: Arlen just thought, "Let's just see if we can look for the same set of compounds in every sample." So it was a concept that I hadn't thought of. I really hadn't thought about, "Hmm—it kind of makes sense." So Arlen kind of flies in, he offloads info from this magnificent brain of his, and then he leaves, right? And he lets me think about this. So I always like to think of Arlen as the Steve Jobs of the Getty, and I'm the Wozniak of the Getty. So Jobs has this brilliant idea, and then Wozniak has to sit there and go, "Well, how do we realize this vision of Steve Jobs?" So there's a really interesting idea. I wasn't sure off the top of my head, and I thought, "We're used to doing quantitative analysis, so I'm going to set up a quantitative analysis program on our GC/MS. And I'm going to start looking for these compounds"—not quantitatively, but just to log them into this list, and always look for all of the compounds in that list. And it's really cumbersome with this software that comes with the GC/MS for quantitative analysis. It doesn't do a great job. It's better than doing it manually myself, but it's not great.

04-01:03:50
Eardley-Pryor: And this is not F-Search, the software?

04-01:03:52
Schilling: It's not. It's just the software that comes with the instrument, and every instrument manufacturer has their own version of this quantitative analysis software. But that's what I was used to doing with quantitative analysis. And I thought, "Okay." So slowly over time, I built up a database of about maybe 250 compounds that we had been identifying.

04-01:04:13
Eardley-Pryor: And they just happened to be anything that had been sampled? Not just the peaks that you'd be usually concerned about, but anything?

04-01:04:19
Schilling: Yeah. They're the ones that were just the markers, the ones that we knew what they were. Maybe we knew exactly what the chemical was, that that chemical is a known chemical that comes from, say, pine resin. But there might be some markers that we know come from Anacards, but we don't know exactly what the chemical is. We'd call it "Anacard unverified one," "thitsi unverified five," you know, something like that, where we knew that a peak always comes out at that time, and it always has this mass spectrum—and we know it always comes out in thitsi, but we don't know what the actual molecule looks like, what the collection of atoms looks like in that molecule. So it's unverified, but we know it's thitsi, right?

So anyway, that's what our, say, 250-compound database looked like that was in this quantitative analysis software. So I could run this quantitative analysis program on a pyrogram, and I'd get a list of compounds. And they were in order, numerical order, and the order was the order that I put them into the table, this table of compounds. So the first one is butanoic acid methyl ester,

that's a four-carbon fatty acid that's in drawing oils. And on and on and on and on. So it worked okay. It worked okay.

04-01:05:42
Eardley-Pryor: What didn't you like about it?

04-01:05:44
Schilling: I didn't like it because I had to do a lot of interaction to kind of verify that it was drawing the baselines properly, that it was subtracting the background properly. The background is the signal that would be coming out along with the compound. Maybe it's stuff that's leaked in from the air, maybe it's stuff that's coming off the GC column. It's contributing to the overall mass spectral signal, and that background spectrum has to be subtracted from the mass spectrum of the peak. So I have to interact with a software and find a best place to subtract the background. So I—

04-01:06:20
Eardley-Pryor: So it wasn't automated then?

04-01:06:23
Schilling: No, it wasn't automated by any means. And it was very monotonous, and you were never quite sure that you were really doing it well. But it worked okay.

So what happened was then to think about it in a kind of chronological basis. Then I thought, "Okay, let's tabulate the compound somewhere and sort them." I was used to using Excel. I've used spreadsheet programs my whole career. They're really helpful for scientists to keep track of big data sets. So I developed a simple Excel worksheet that would accept this quantitative report from the analysis of the sample, using THM-Py-GC/MS. And I had some markers that were from oils; and some markers that were from European materials; and some markers that were from Anacards, just a small number. And I used Excel to sort them into columns. So the report was pasted into one worksheet. And then I had equations that looked for all of the fatty acid methyl esters that would be from drying oils. I then used another part of the worksheet to sort all of those compounds into—and I called it "Fatty Acids." And I had another set of columns that sorted all the pine resin markers into that. I had another set of columns that sorted all of the urushi compounds into one set. So then I could look at that worksheet, and I could just scan across those columns and say, "Oh yeah, well, there's no marker compounds that were identified for cedar oil in this sample. But there are marker compounds for camphor, because I saw some compounds there that had peak areas associated with them." So when that compound is detected, the software measures the size of the peak, the peak area. Now there's a number listed under peak area for that marker compound. So it's easy for me to see what materials were present and what materials weren't.

04-01:08:30
Eardley-Pryor: And their amount.

04-01:08:34
Schilling: And the approximate amount based on total peak area detected, from this rudimentary system that we developed at the beginning of our project. So that was interesting.

04-01:08:44
Eardley-Pryor: So you're using this Excel spreadsheet to capture this massive, long list of data, but to organize it and collate it in a way that separates it by different types of species of resin.

04-01:08:55
Schilling: That's correct. And that knowledge came from what we learned of the literature, and also from our own in-house research. Again, these unverified compounds came from us. So that was kind of the prototype for what we started doing with lacquer, and the big concepts. The two big decisions were to treat all of the samples the same way, and we're going to methylate them all. And we get much better results for oxidized compounds. Then the second was to look for all of the marker compounds that we're aware of in every sample. Boy, did that pay off in spades.

04-01:09:38
Eardley-Pryor: In what way?

04-01:09:40
Schilling: We started seeing these other materials that the artists, the lacquer artists added to these tree saps, and we found them routinely in the lacquer from our furniture. So it was the first time that the literature was really verified. The lacquer artists really did add pig's blood to foundation layers of Chinese lacquer. Japanese lacquer makers added starch to their foundations. The foundation layers are kind of the priming layer onto which the lacquer was built up on. So we knew from the literature that Japanese lacquer makers used different materials in their foundations than Chinese lacquer. And here, now, we started to see marker compounds that could allow us to differentiate pig's blood and starch.

04-01:10:35
Eardley-Pryor: Based on the sample you'd run through, you could see this difference?

04-01:10:37
Schilling: Yeah. Exactly. And if we weren't looking for these compounds in an automated way that took us out of the equation, right, then we would over-simplify the result. But the software could detect peaks, even when they were really small.

04-01:10:56
Eardley-Pryor: And that's when Arlen came and said, "Let's start looking at these smaller peaks."

04-01:10:58
Schilling: "Let's start looking at every marker compound. Once we know that we've got a marker compound for a material, let's always look for it. Let's not just look at the big peaks, let's look at every marker compound, every time," right?

04-01:11:13
Eardley-Pryor: And all this new information came out of that, as a result.

04-01:11:17
Schilling: Yeah. Now we started to see evidence for these other materials besides the big three Anacard tree saps, those three catechol type things I talked about. And we started to see drying oils present in lacquer, in abundance. So the types of drying oils they'd use in Asia were a bit different than the drying oils we'd been talking about in relation to, say, de Kooning and Jacob Lawrence. They used perilla oil. They used tallow tree oil. They used tung oil, right? So they have different fatty acid profiles, they have different drying rates. They have different kinds of physical properties. And when they're mixed into lacquer, they actually change the working properties of the lacquer.

So what Arlen would do when he found out that tung oil was added to Chinese lacquer, he got some of the urushi lacquer, and he stirred in some tung oil, and he painted it out on the glass, and he let it cure. He put it in the humidity chamber, and then he left it out in the air, and then he put it on his windowsill for a couple of years. Then he said, "Here's some samples that had been aging." Then we started testing them. Now we could start to see oxidation products. Why could we see oxidation products? Good question.

04-01:12:38
Eardley-Pryor: Because they had sat in his window?

04-01:12:43
Schilling: We could see them because we used TMAH, because the oxidation products pick up oxygen. They have more OH groups on them. So now, our vision of the range of marker compounds that Anacard tree saps form has expanded greatly. Because now, by using TMAH to treat the samples, we can detect oxidation products from the Anacard lacquers, that Miyakoshi could never have seen, because they would have hydrogen bonded, never left his column.

04-01:13:20
Eardley-Pryor: That's great.

04-01:13:22
Schilling: So now we're starting to see—

04-01:13:21
Eardley-Pryor: So your methodology made that possible?

04-01:13:24
Schilling: Correct. Correct. So now, because we made that fateful decision to use TMAH, and because we had made the fateful decision to look for all of the

marker compounds in every single test, now we're starting to see these markers in a big concentration, low concentration, reliably, right? And because we're using Excel, we're summing up those peak areas, and we're able to say, "Hmm, let's bundle all of the drying oil markers together, all of the tung oil markers. And how much total peak area would there be in the sample? And let's express that in a pie chart." And we're seeing in Chinese lacquer, let's say carved red lacquer—maybe 80 percent of the total peak area that the GC/MS detector sees is from tung oil. And maybe only 20 percent is from urushi. And we found that to be the norm, not the exception. We started then testing samples from other collections; the Victoria and Albert Museum was a big sponsor of our early work. We started to see the same kinds of formulations in what they would call "domestic lacquer," lacquer that was made for use and for sale in Asia, right, by the local residents. Not for export into Europe. So export lacquer may have different formulations than domestic lacquer. Sometimes they did, sometimes they didn't.

04-01:14:52
Eardley-Pryor: So this information, these new realizations about what the chemical content of these lacquers were—how they were made, what they were made of—how did that, then, change the story of the understanding of the relationship between those traders that were in Asia, the purchasers that were in Europe, the people that did the veneer work in Europe? How did the story of the art change as a result of your analyses?

04-01:15:20
Schilling: The story started to change when Arlen started going into the GRI, the Getty Research Institute, and do some in-depth, scholarly study of the literature. And he found trade literature that was produced by the Dutch VOC [the Dutch East India Company], the big trading organization in Holland. And they kept meticulous records of the cargo of their trading ships, as they went from Asia back to Europe, and kept trading things in and out of these ports, all along the way. And they had these wonderful records of thitsi being sold and then bought by the lacquer makers. And thitsi lacquer is the Southeast Asian lacquer, right?

04-01:16:09
Eardley-Pryor: And the Dutch had their—

04-01:16:10
Schilling: And we were seeing it being purchased in Japan and used by Japanese lacquer makers in their export lacquer that was being sold and made into screens, sold to European furniture makers and converted into the Japanese lacquer that we have in our collection.

04-01:16:27
Eardley-Pryor: Wait, wait, wait, so—

04-01:16:28
Schilling: So we're seeing a mixture of these Anacard saps. Not just pure Anacard sap mixed with an oil or a resin. We're seeing two different Anacard saps mixed together—

04-01:16:43
Eardley-Pryor: In your collection.

04-01:16:43
Schilling: —in Asia when they were making these panels, that were sold to the Dutch traders, that were brought into France, that were turned into furniture that was eventually bought by Mr. Getty and put on display at the Getty Museum.

04-01:16:59
Eardley-Pryor: Let me see if I follow you. So, from where the Dutch have their empire headquarters in Jakarta in Southeast Asia, they're bringing tree saps from Southeast Asia, where they are, up to Japan—

04-01:17:09
Schilling: Yes.

04-01:17:11
Eardley-Pryor: —then selling them to the Japanese lacquer makers. The Japanese are then using this Southeast Asian lacquer tree saps, combining their own Japanese urushi lacquers for export to sell back to the Europeans, that are then brought back around to Europe and sold and made into furniture by the French there, which are eventually purchased by J. Paul Getty to be on display here.

04-01:17:39
Schilling: It's a pretty cool story, isn't it?

04-01:17:42
Eardley-Pryor: It's really cool.

04-01:17:43
Schilling: Yeah.

04-01:17:44
Eardley-Pryor: So seeing the fact that you can designate the geographic origin of these different tree resins based on their molecular structure, and you developed a method to do that, you could understand differently how those trade routes happened that you wouldn't otherwise.

04-01:17:58
Schilling: Right. Exactly.

04-01:18:01
Eardley-Pryor: Because you wouldn't know where those tree resins had come from until you could identify that they were combined into one product sold in Europe.

04-01:18:10
Schilling: Exactly. Right.

04-01:18:10
Eardley-Pryor: That's wonderful.

04-01:18:13
Schilling: And the urushi trees, they don't produce very many milliliters of sap when they're tapped. So the sap's harvested from the tree by actually cutting grooves and notches into the tree bark, and then there are little receptacles that collect the sap. So they do that certain times of the year. And they only collect maybe a couple of ounces, I think, of urushi sap per tapping. Then they can only tap the tree for so many years, and then the tree is cut down, and they plant a new tree. Thitsi lacquer comes out very freely, so thitsi is relatively cheap.

04-01:18:48
Eardley-Pryor: By supply and demand.

04-01:18:48
Schilling: Right. So what we were seeing—and here's another aspect of our work that really sets it apart from other researchers. Again, back to Arlen. Arlen knew, again, from looking at cross-sections of lacquer, that the lacquer is complex. It has lots of layers, different colors, different thicknesses, and different appearance under fluorescent light. So he's able to look at a cross-section of lacquer from our furniture collection under white light—and you can see what it looks like, this reflected light normally—and then how it fluoresces under ultraviolet light. So then Arlen had the idea, "Hey, let's take a flake of lacquer that came from the same area where the cross-section came from. Let's lay the flake onto, say, a glass slide, and then attach it with crazy glue.

04-01:19:43
Eardley-Pryor: Why?

04-01:19:42
Schilling: Cyanoacrylate. Then look at that flake again under white light or ultraviolet light, and start scraping away the layers one at a time, right? So he scraped away the top layer. Maybe the top layer fluoresces a little brightly. It gets down to a layer that doesn't fluoresce as much. He stops scraping. He puts all the powder that he collected aside into one sample holder. He gives me the first sample: "Here's layer one from sample A, from this location." Scrape, scrape, scrape; observe, white light, UV light. "Okay, it's starting to look different now, I'll stop scraping." And that's layer two.

04-01:20:26
Eardley-Pryor: That's part two of, still, sample A.

04-01:20:29
Schilling: That's the second test, right? So I got two samples to test from the one sample, all right? Three layers, four layers, he gets through. So the top layer, he goes through the upper lacquer; then lower lacquer; now into the foundation.

Maybe there are two layers of foundation. Then he's gone through all of the decorative layers that would be on the panel, and he stops. And he gives me that set of samples that would be tested by THM-Py-GC/MS. And then I would run the analysis on them: I'd add the chemical, do the analysis. I'd run the quantitative software on them. I'd get a list of marker compounds that are in our database. I'd put that into Excel. I'd make that little bar graph, I'd see the columns that had numbers for marker compounds identified for camphor, and cedar oil, and tung oil, and urushi, and thitsi.

And now we were starting to see, in one of our Japanese objects, in the lower lacquer layers: they were enriched in thitsi, but mixed with some urushi. So the less expensive one was mixed with some of the more expensive one in the lower layers. Because when you're looking at a piece of furniture, you're only seeing the upper layer. So, "Okay, great. No one's going to see it. Let's just put it down there," right? Maybe it had good drying properties, you know? These lacquer makers had to crank these things out, because the Europeans gobbled them up. As soon as they got their hands on them, they wanted more lacquer objects. So, supply and demand. Lacquer makers had to get going. It might take longer to cure urushi than it does the mixture. So there may be more than just the economic advantage here.

Anyway, in the upper lacquer layer, it was enriched in urushi with a little bit of thitsi. So there is—

04-01:22:26
Eardley-Pryor: Keep the good stuff on top, hmm?

04-01:22:30
Schilling: Exactly. The good stuff's on top, the stuff that really gives the fine luster, that final surface appearance.

04-01:22:36
Eardley-Pryor: So not just doing a sample and using your methodology for the entire sample, but breaking that sample up by layer.

04-01:22:43
Schilling: Right. Arlen calls it unpacking, or micro-excavation. And he's skilled enough, and conservators are skilled enough because they have incredible hand-eye coordination, they can sample a twenty micron-thick layer.

04-01:22:58
Eardley-Pryor: That is tiny.

04-01:23:01
Schilling: And exclude what's above it, and what's below it. So it's quite thin. So it's pretty amazing that you can do this comprehensive analysis on individual lacquer layers, and tell something about the unique chemical composition at the surface, and then the next layer down, the next layer down. Then you start to detect—in Chinese lacquer you start to detect blood, in Japanese lacquer

you start to detect starch, right? It's pretty extraordinary how unpacking the lacquer, layer by layer and analyzing each layer, reveals much more of the story about the artist's technique.

04-01:23:40
Eardley-Pryor: The craftsmanship.

04-01:23:44
Schilling: But also, how damaged or not damaged the surface is. I mentioned that lacquer is extremely sensitive to light. We had an exhibition here, I think it was about ten years ago now, a really beautiful Japanese export lacquer chest was on display from the Victoria and Albert Museum. It's called the Mazarin Chest, and it's a beautiful masterpiece of Japanese export lacquer, from about the same time period, sixteenth century. That's the interesting thing I didn't mention. The screens are from the sixteenth century, and they were being put into eighteenth century furniture, right? Okay, sorry I forgot that.

But the Mazarin Chest was conserved—I think the project went on for the better part of ten years to study it and conserve it. And I had the wonderful good fortune to be here with the curator who came with the Mazarin Chest. And she opened the chest for me, before it went on display. It was in the gallery. Her name is Julia Hutt, and I can't thank her enough for that privilege, because the inside of a chest is always dark. And I said light is the damaging thing for lacquer. So the outside needed conservation after four hundred years or more of aging. The inside was pristine. It looked like it must have looked like when it was just made. It was radiant. It was glorious. It was beautifully gloss black and gold, and it was stunning.

04-01:25:35
Eardley-Pryor: And you could really tell a difference from the outside, from its four hundred years of aging?

04-01:25:36
Schilling: Yes. As gorgeous as the outside looked after conservation, it really did pale compared to what it looks like inside, where it's always been dark.

04-01:25:47
Eardley-Pryor: Hmm.

04-01:25:49
Schilling: So that's an interesting cautionary tale—keep Asian lacquer away from light. And all the conservators knew that. But now for the first time—through Arlen's careful unpacking technique of layer-by-layer sampling; and our analysis method, using, again, TMAH to detect oxidized compounds along with the normal compounds; and with our data treatment method of getting peak areas and making pie charts from these columns of sorted data—we were now able for the first time to detect oxidized products, products of photo-oxidation, in those thin, upper surfaces. And it's those upper surfaces that you see when you're looking at a lacquered object that pick up dust from the

environment, and that conservators have to clean and try and restore the surface luster. Because the Mazarin Chest after treatment looked beautiful. It was nice and glossy again. The conservators found ways of treating that surface that had lacked luster because of the formation of these oxidation products. So that's an interesting thing to remember later on in our conversation when we start talking about lacquer conservation.

04-01:27:15
Eardley-Pryor: Okay.

04-01:27:16
Schilling: We started giving presentations at conferences about our work, and one of them was at the Victoria and Albert Museum. They had a wonderful symposium there at the culmination of their Mazarin Chest conservation project. A wonderful book came out of it, a collection of articles from all the lectures, it's called *Crossing Borders* [*Crossing Borders: The Conservation, Science and Material Culture of East Asian Lacquer*]. The talk that Arlen and I gave about what we found in our Japanese lacquer collection was incredibly well-received by conservators and scientists alike. And we were approached by them afterwards, saying they'd really love to learn how you do this analysis.

So we came back thinking maybe we should think about doing a workshop, right?

04-01:28:09
Eardley-Pryor: And you had done workshops previously.

04-01:28:12
Schilling: We know how to do workshops here at the GCI in science, absolutely. So there was one drawback, one drawback to our method. The drawback is actually in the software used to detect the peaks. We were using the quantitative analysis software that came with the instrument. The instrument is made by Agilent Technologies. Good equipment, but not every conservation scientist uses an Agilent GC/MS. So the calibration table that we had would be unsuitable for someone using another manufacturer's GC/MS. So my friend in Amsterdam was using another instrument; he couldn't use this data treatment method that we had to detect our list of marker compounds.

04-01:29:08
Eardley-Pryor: The same Excel sheet that you had made to—?

04-01:29:09
Schilling: The Excel is the last step, that's no problem. But getting things into Excel was the software that was kind of proprietary.

04-01:29:22
Eardley-Pryor: That spat out your list?

04-01:29:23
Schilling: Yeah, the thing that spits out the list of marker compounds identified in the sample, that could only be used by people who also had an Agilent GC/MS. So what about the people who have Shimadzu or Thermo instruments? Can't do the first step in our data treatment. And I was always interested in finding some kind of vendor, like a third-party vendor, that wrote software that could accept data from any instrument manufacturer's GC/MS.

So I'm going to move forward in time a little bit, before we get into what the workshop was like. So I was keen to find something, and I heard about a program called "AMDIS"—it's Automated Mass spectral Deconvolution and Integration System—A-M-D-I-S. It's made by the National Institute of Standards and Technology, NIST. They're based in Gaithersburg, Maryland, and they're a federally-funded organization that works on problems of measurement standards and technology. Okay. So they made this program called "AMDIS" to automate the process of detecting and identifying compound in GC/MS chromatograms.

04-01:30:43
Eardley-Pryor: What was their interest in it?

04-01:30:47
Schilling: So I heard about it through someone who was working at Winterthur. His name is Mike Szelewski. And Mike actually worked for Agilent, and he taught people how to use AMDIS to do this, to do this very thing. So he called me up after we did one of our lacquer workshops—again, I'm fast-forwarding a little bit, just so it's a better story—and he said, "Do you have a spectral library program that you use?" I said, "Well not really, it doesn't work great with the Agilent software." He said, "Have you heard of AMDIS?" I said, "You know, I have, but the owner's manual is an inch thick when you print it out, and it's written by computer programmers, and I really don't get it." He said, "I teach people how to use AMDIS." I perked up. I sat up in my seat. I said, "Do you think your boss would let you train me?" He said, "Let me check." He said, "Yep." I said, "When do you want me to come out?" So I spent a week learning AMDIS from Mike Szelewski at the Winterthur Museum in Delaware. And the great thing about AMDIS was, it does something that I really wanted it to do. It opened any instrument manufacturer's GC/MS files. So anything that I do with it could be done by anyone else who had the same program, regardless of who made their GC/MS. They made it to identify chemical weapons signatures.

04-01:32:26
Eardley-Pryor: The AMDIS was created for that reason?

04-01:32:25
Schilling: Yes. That's why they made AMDIS. NIST worked with the Organization for Prevention of Chemical Weapons, I think. It is a UN organization, and their mandate was to find reliable ways of detecting traces of chemical weapons at

crime scenes. So to make a long story short, AMDIS does a really great job in using a library that the user creates of the marker compounds that they're interested in, and looking for those marker compounds in every sample. And isn't that exactly what Arlen wanted to do? Arlen wanted us to have a library of marker compounds that we looked for in every sample. And here is this program, it's free of charge. You can download it for free from the NIST website, bless their hearts, they're wonderful people. It connects to the NIST library that we already use. So whoever bought the NIST library already has AMDIS on their computer, and it nicely connects back and forth. And you can toggle between looking at your result in AMDIS and looking at it with the NIST library.

04-01:33:53
Eardley-Pryor: And the NIST library is essentially a collection of all possible chemical markers that they're interested in?

04-01:34:00
Schilling: Yes.

04-01:34:01
Eardley-Pryor: A huge database.

04-01:34:03
Schilling: Almost three-hundred thousand compounds in that library.

04-01:34:06
Eardley-Pryor: And AMDIS is the software that they created in the wake of the United Nations coming to them and saying, "We want to have a better way of identifying chemical weapons chemicals"?

04-01:34:16
Schilling: Yes.

04-01:34:18
Eardley-Pryor: So AMDIS was the software that pulls from that [NIST] database to identify specific markers for chemical weapons?

04-01:34:24
Schilling: Almost. You almost got it. AMDIS can use those spectra, but they can also use spectra that the users generate. Maybe there's a chemical that VX makes when it degrades. They don't know what the structure is, but they know that it's coming out from VX. So the users of AMDIS can add that spectrum to that AMDIS library of chemical weapons.

04-01:34:45
Eardley-Pryor: So you can build the AMDIS library?

04-01:34:49
Schilling: You build the AMDIS library yourself. You can take spectra from the NIST library, this massive three-hundred thousand-plus compound library. Or you

can add your own spectra from your own tests. That's an important distinction. AMDIS does not work with the NIST library being the search library. AMDIS works from your own user library in AMDIS.

04-01:35:12
Eardley-Pryor: And that user library was initially populated with chemical weapons markers?

04-01:35:12
Schilling: Yes, for the original use of AMDIS.

04-01:35:19
Eardley-Pryor: But because you can add your own chemical—you can build your own library within AMDIS, you saw a tool you could use.

04-01:35:24
Schilling: Right. Correct. Exactly. It did exactly what Arlen and I wanted it to do, right? We could build a library of marker compounds, their mass spectra. We put it into an AMDIS library. We can then associate them with the materials that form them in Excel, and we have our reporting structure in Excel.

04-01:35:50
Eardley-Pryor: So the AMDIS library that you've created is essentially all of these resins, they're from the Asian lacquers, the European lacquers, all these different resins are in your AMDIS library?

04-01:36:00
Schilling: The tree saps, [yes], the resins, the oils, the proteins, the carbohydrates, colorants—everything. Everything that we could identify in Asian lacquer went into that first AMDIS database.

04-01:36:16
Eardley-Pryor: And then from that massive AMDIS database that you've created off of your research—your many years of research of these different types of lacquers and resins—you can then use this Excel platform that you've created, to pull from AMDIS all of these markers, and then collate them in a way that makes it more readable for your needs?

04-01:36:35
Schilling: Right. Yeah, they sort them by type of material. And so you need some expertise. You need the expert knowledge to know the markers that are formed by each lacquer material, whether the lacquer is made in the East or the West. You have to have someone tell you, "Okay, pine resin forms these markers. Oxidized pine resin also has these markers in them." And I mentioned we were identifying, for the first time, oxidized markers from the Anacard tree saps, right? That, again, you can't detect without that chemical that we add—if you don't add the TMAH, you can't see them. So we're adding those to this database. And I was delighted that Mike Szelewski called, because he was the savior. He trained me in the software that has changed my life and all of the people that use it. There's just no going back once you use AMDIS, because it does everything that you wanted to do as a scientist,

automatically. You load the file, you press Run, and within ten seconds you have a full report on every marker compound that is present in that sample.

04-01:37:53
Eardley-Pryor: That's that automated thing that you wanted.

04-01:37:52
Schilling: That's represented by your library. Yeah. It's astonishing.

04-01:37:55
Eardley-Pryor: Yeah. Automates the process.

04-01:37:57
Schilling: It produces a report, and it tells the compound and its chemical abstract service number—that's the unique name for it—the size of the peak in terms of peak area, where it comes out. It's wonderful. And it does it in seconds. And it does it in a way that a user never could, because it's looking at every single peak in the chromatogram. In a pyrogram, like what we get from lacquer, there may be hundreds of peaks. And AMDIS doesn't care if they're big or small, it can detect them. They're all the same to AMDIS, right?

04-01:38:38
Eardley-Pryor: And it'll tell you the relative amount based on when it came out [of the GC/MS], and—

04-01:38:43
Schilling: Yes. Exactly. Exactly. Based on the size. It's all there. So now we had everything that we needed for anybody who was interested in testing lacquer, regardless of where they work, regardless of what instrument they use. Because just about everybody has Excel, and the kind of Excel report template that we produce that sorts the marker compounds in the AMDIS report by type of material. Everybody has Excel. Everybody can get AMDIS because it's free. And then what we can do is provide the AMDIS library that we built and the Excel report template to people who are interested in it. So now we actually had the goods that we could deliver in a workshop. Like I said, we learned about AMDIS after we already did a couple of workshops.

So the first couple of workshops that we did used the [Agilent] ChemStation software. Everything that we've done afterwards, we've done with AMDIS. And I felt so bad for the people who learned the workshop with just the ChemStation that I found them all and I trained them all myself.

04-01:39:55
Eardley-Pryor: Wow.

04-01:39:56
Schilling: Either over the phone, I did like webinar type of thing, I visited them, I had them come here. I connected with all of them from the first two workshops. So now all the people who were analyzing Asian lacquer with our techniques,

unpacking the THM-Py-GC/MS, and our software tools, AMDIS and Excel—everybody's using that platform now.

04-01:40:25
Eardley-Pryor: What do you call that platform?

04-01:40:29
Schilling: So the platform, we call "ESCAPE." It's an "Expert System for Characterization using AMDIS Plus Excel."

04-01:40:38
Eardley-Pryor: How did you come up with that acronym?

04-01:40:39
Schilling: It just came to me. We were talking and just trying to think of something, and I thought, "Hmm, it's an Expert System." It really is. And I'll get into that in a moment, why that's so important. But it helps a user by providing expert knowledge to "Characterize" materials. It uses "AMDIS Plus Excel." I wish I could get rid of the word "using" or "user," but that's okay. But anyway, that's ESCAPE. And the first application of ESCAPE was to characterize Asian and European lacquer, right?

04-01:41:15
Eardley-Pryor: Those are part of the workshops that you were doing?

04-01:41:19
Eardley-Pryor: Right, and that then became the core of the Py-GC/MS part of the workshop. But there are other aspects to lacquer that were interesting, lacquer analysis. Certainly the unpacking technique that Arlen perfected is worth learning, because it really—like you said, that knowledge allows you to really get inside of the head of a lacquer maker and find out how they made the lacquer, what materials were used.

04-01:41:49
Eardley-Pryor: That unpacks the story behind how they got the materials themselves to begin with.

04-01:41:55
Schilling: Exactly. That fascinating back-story about how those materials got moved around, and what was used, and how they were used, and how they're changing at the very surface.

There was another technique that I heard about when I was visiting the Victoria and Albert Museum. I met a PhD student, her name is Nanke Schellmann. And Nanke was studying lacquer foundations. She knew that those foundation layers—onto which decorative lacquer was applied—they sometimes fail. They start breaking. So if an underlying layer of something decorated starts breaking, then some kind of consolidant has to be injected into that space, and then the decorative surfaces are pressed down. That also happened in Mogao. The wall paintings, when they started to lift, consolidant

and adhesive could be injected behind, the flake pressed back into place. So Nanke wanted to study lacquer foundations and find ways of assessing the efficacy of consolidation methods, to consolidate the foundations. The only analytical tool that she had at her disposal was a light microscope. And she knew that there were histochemical stains that had been used for decades in the biology field—

04-01:43:19
Eardley-Pryor: What's a histochemical stain?

04-01:43:21
Schilling: —that would, applied to a cross-section, could actually stain a layer of the cross-section for a specific type of material present. So there's one stain for oil, there's one stain for starch. There's a stain that does protein and oil together. So these simple stains are inexpensive. Nanke mastered the way they're used and applied to lacquer cross-sections. The whole treatment protocol, the application, the reaction time, the drying, the photography under white light, UV light and blue light. She developed this whole protocol. I met her when Arlen and I were with Julia Hutt, and we were going through the storage rooms and Arlen was collecting samples from the objects.

04-01:44:12
Eardley-Pryor: At the Victoria and Albert?

04-01:44:12
Schilling: At the Victoria and Albert. Nanke was there. I struck up a conversation with her. She's really bright, really engaging. She's an excellent researcher. She's a conservator, but she's an excellent researcher.

So she told me about these stains. And I said, "Well, how do you know that they really are staining just the thing that you think?" And she said, "Well, I don't have another way of verifying it." I said, "Hmm, would you like me to test a few of your samples with our Py-GC/MS method to see how well your results compared to the results that we would get?" It would be a nice confirmation for me, too, right? So she agreed. And she sent me a couple of dozen layer-samples of the foundations, and all of her results were correct. They all got confirmed by the Py-GC/MS results.

04-01:45:01
Eardley-Pryor: So this microscopy method that she and other conservators were able to do without a Py-GC/MS was confirmed by the fact that you had done your research.

04-01:45:13
Schilling: Right.

04-01:45:11
Eardley-Pryor: And the analysis said, "Yeah, the microscopy method does work."

04-01:45:14
Schilling: Mm-hmm.

04-01:45:14
Eardley-Pryor: That's great.

04-01:45:17
Schilling: Yeah. So our results confirmed each other. So she was encouraged that what she's writing about in chapter one of her thesis actually works, and so she integrated those results from my report into her thesis. And I was so impressed by the way that it worked, and the visual aspect of it, that I thought, "Hmm, if we're going to do a workshop, not only should Arlen be teaching them how to unpack layers, and not only should I be teaching them THM-Py-GC/MS, we need to get Nanke there to teach conservators especially how to use those inexpensive histochemical stains—

04-01:45:54
Eardley-Pryor: Staining methods.

04-01:45:56
Schilling: —to get some spatially resolved information about the use of lacquer materials in the different layers of lacquer.

04-01:46:03
Eardley-Pryor: So those three pieces, is that what became the body of the first workshops?

04-01:46:06
Schilling: Right. So then we were thinking about that in earnest. Again, people who work at the Getty are blessed with an abundance of resources: financial, equipment, and also people. And at the GCI in particular, we had, at the time, a separate group doing educational initiatives. Now, the educational initiatives are part of the group that's been renamed "Collections." But let's talk about them as the Education group, just for the purposes of our talk here.

04-01:46:45
Eardley-Pryor: Mmm.

04-01:46:44
Schilling: So the Education group, the head of that is Kathy Dardes. Kathy has been a colleague of mine for decades, even when we were back at the Marina del Rey lab. And I had spoken to Kathy one day, when we were at a reception. There was a reception for a contemporary artist who worked in plastic. And Emma Richardson had worked with this artist, Tom [Learner] had worked with the artist. It was a beautiful display here at the Getty, and it was a great reception. We were out front. Kathy and I were having a drink, chatting about what a lacquer workshop might look like. And as a chemist, I have a lot of experience in teaching scientists our test methods. And that was my original vision for what a lacquer analysis workshop would be like. But Kathy said, "Well, you know, you and Arlen worked together on this project for years, and it seems like your skills really complemented each other. Why don't we try and

recreate that in the lacquer workshop by inviting conservators to come with the scientists together?"

04-01:47:57
Eardley-Pryor: Bring them both together.

04-01:47:59
Schilling: Right? And I didn't even need to have any drinks to think that was a wonderful idea. That was a wonderful idea. And I never would have thought of that on my own. So Kathy, Arlen and I started getting together and talking about what this workshop might be like. So we decided scientists and conservators will apply together. At the first workshop, it was easy. It was the first one, so the gene pool was untapped. So institutional conservators worked with their scientist colleagues, they came together. The conservator would bring a flake from a lacquered object, a cross-section that was already prepared and photographed, so we could see how many layers there were. We sent them a PowerPoint template that they could put basic information about the object into: a picture, the accession number, the country it's from, the date, and what the issues were, what were the questions they were interested in studying through analysis?

04-01:49:07
Eardley-Pryor: You gave that to them from the start?

04-01:49:09
Schilling: Correct. So we sent that out to the teams of the scientists and conservators who were applying together. And we sent another PowerPoint to just the scientists, saying, "Tell us how you analyze lacquer. Do you to Py-GC/MS? If so, how much experience do you have? How do you do data interpretation? Do you use software tools? How do you do reports?" So that's what we send out to the applicants, and then we decided to teach all three techniques. We insisted then that Nanke and Arlen and I be the three instructors teaching those three aspects. The high-tech analysis of the amazingly micro-excavated and unpacked cross-section, and the lower-tech but perfectly valid visual staining method. So three techniques. And we figured that by working in teams, we could accommodate nine teams nicely. So there would be six people at each station working. That meant that we had to have three microscopes for unpacking the samples, three analytical microscopes that could do the staining, and three GC/MSs, three Py-GC/MSs, right?

So from a standpoint of equipment, it was a pretty tall order. But again—

04-01:50:44
Eardley-Pryor: It's a workshop that requires a lot of preparation.

04-01:50:49
Schilling: Right. And a lot of equipment.

04-01:50:50
Eardley-Pryor: And you took the idea of "work"-shops seriously, that they would come with their own samples to do work that week.

04-01:50:59
Schilling: Yes. Mm-hmm. One of the things we've learned in the workshops over the years is, people are really motivated when they're looking at samples from their own collection. They have a whole new level of interest, because they're learning something about their own collection. And hey, they can go back and report back to their boss and say, "This is what I know about the object now," right? So they're interested at a different level, instead of just looking at reference materials.

04-01:51:28
Eardley-Pryor: And these groups that were coming to attend these initial workshops, was it typical for conservators and scientists to be working together?

04-01:51:35
Schilling: No, not that often. Even here at the Getty, even though there's not much of a geographical barrier between the Museum conservation labs and the Museum building, and the GCI, we don't work together as often as we could. We're all busy doing our own thing. So that experience that Arlen and I had was kind of unique, in a way, working together side-by-side for so long on this knotty problem of how you differentiate the three types of lacquer, and how you can analyze them effectively. So we wanted to recreate that as much as possible in that—

04-01:52:13
Eardley-Pryor: To create that unique opportunity for them, the workshop attendees.

04-01:52:16
Schilling: Right. So we decided five days would be enough to teach all three things. At the GCI, again, we're blessed with a material abundance, instrumental abundance. We had Dave Carson, who actually started here working for me, doing GC/MS work many years ago, when we moved here, actually. And after about a year or so, he started doing SEM work in our built heritage building materials group.

04-01:52:45
Eardley-Pryor: Scanning Electron Microscopy [SEM]?

04-01:52:46
Schilling: Mm-hmm. SEM, yep. And then he was promoted to lab manager, so he now oversees the operation and maintenance of all of our lab equipment. So Dave Carson was really instrumental in helping to get all of the equipment together. Now we had three GC/MSs at the GCI, two Py-GC/MSs and one regular GC/MS. So, "Uh-oh, we're missing a pyrolyzer. What are we going to do about that?" Well, the Frontier pyrolyzer that I talked about—I think I talked about it earlier, right?

04-01:53:22
Eardley-Pryor: You did.

04-01:53:24
Schilling: Yeah, worked very well for us. So we got in touch with Frontier. And they were more than happy, the president of the company, Chu Watanabe, was more than happy to support our workshop by providing a pyrolyzer and a technician to install it, make sure it worked properly, stay here during the workshop, and then remove it and take it back to Japan. So Frontier has been supporting our workshops for a long, long time. They've been great partners. Even though they're a commercial company, the amount of support that they give us is really incredible.

04-01:54:05
Eardley-Pryor: That seemed above and beyond a typical support. Why do you think Frontier has been so supportive?

04-01:54:10
Schilling: I think they're really looking for opportunities where their pyrolyzers can answer questions. And they reach out to certain types of analysts.

04-01:54:24
Eardley-Pryor: Users?

04-01:54:25
Schilling: Yeah, just to see if there's an application where their pyrolyzer would help the analyst. So forensics, certainly, and pharmaceuticals, things like that, there were different target audiences that they were hoping to reach. This allowed them to reach the cultural heritage community.

04-01:54:44
Eardley-Pryor: That's a neat opportunity for expansion and service.

04-01:54:49
Schilling: Absolutely. Absolutely. So for us, at that moment in time, that partnership with them was crucial because we certainly couldn't afford to buy another pyrolyzer. We were fortunate to have three GC/MSs—hey, most labs have one. And we had three microscopes. Dave Carson and Arlen made sure that we got microscopes from the Museum. We had two microscopes of our own at the GCI, put them together. We had the low power stereo microscopes that Arlen needed for unpacking. And we had someone else that I haven't mentioned yet, Julie Chang. Julie Chang was a person who contacted us, was keenly interested in lacquer and offered to volunteer as an intern for a year in our lab. And we thought, "Okay." It was okay administratively, there wouldn't be any problem. So she was a volunteer in the lab. And she is incredible. She's Taiwanese, so she speaks Mandarin and English fluently. And she was an absolute dynamo in really starting to dig into the Chinese-language literature in the original Mandarin, and start finding these recipes for us, reading literature that would be inaccessible to us, because it would be written in a language we didn't understand. So she started contributing to our lacquer

project in a deep and meaningful way, by building up our understanding of what was being reported on in the Chinese literature about the materials that were used in lacquer throughout the ages.

04-01:56:32
Eardley-Pryor: And so her research would then help build the AMDIS library that you're pulling from?

04-01:56:35
Schilling: Her research allowed Arlen, especially, to make reference materials that replicated the recipes that Julie found in these literature sources, right? So then once those lacquers sat on Arlen's window for a while, then we analyzed them, and now we knew what Arlen put into them, because he told us, and then we were able to look for marker compounds for those materials that we added.

04-01:57:05
Eardley-Pryor: Oh, I see.

04-01:57:08
Schilling: So it was Julie's thorough understanding of the literature that, again, she obtained through the GRI, and the Getty's, the GCI's Information Center, that allowed us to have a better bibliography of recipes of lacquer formulations from China.

04-01:57:26
Eardley-Pryor: Which you could then run your own research on.

04-01:57:28
Schilling: Which we could then make—we would call them "drawdowns." We would draw them down under glass, age them, test them, find new marker compounds, add them to the database, account for them in the Excel worksheet in the appropriate category of material. Fantastic.

04-01:57:49
Eardley-Pryor: Enriches ESCAPE.

04-01:57:48
Schilling: So she was an incredible researcher. She was in our lab at the time, and she was very enthusiastic about helping Nanke teach the staining part of the workshop, because that's more labor-intensive, a little more fiddly, even though it's low-tech. There were certain protocols that had to be followed very rigorously in order to get the best staining results, using the histochemical stains. So Julie was a great partner and assistant to Nanke in that first lacquer analysis workshop.

04-01:58:22
Eardley-Pryor: And these workshops, what did you call them?

04-01:58:25
Schilling: Glad you asked. We were presenting research that we were conducting on Asian lacquer. It was new research. The acronym we came up with was "RAdICAL"—Recent Advances in Characterizing Asian Lacquer. It's a great acronym. It definitely was radical. And people love the radical word, just saying, "I'm going to RAdICAL." You know? "I'm doing RAdICAL. You know, the RAdICAL workshop" Just love it. I like words like that.

04-01:59:00
Eardley-Pryor: Did you come up with RAdICAL?

04-01:59:02
Schilling: Yeah. And the logo was kind of a joint effort between Arlen and Nanke and myself. It's a great logo. We'll make sure that it goes into the transcript of our conversation.

04-01:59:15
Eardley-Pryor: Will you explain it briefly?

04-01:59:14
Schilling: Sure. It's basically a little spinoff of one of those catechol marker compounds. So the benzene ring, a couple of OHs, the sidechain that has those fifteen carbons, and then we put a Yin Yang symbol in the middle where the aromatic ring would be. I like to use the word "groovy." It's kind of a groovy symbol—

04-01:59:41
Eardley-Pryor: It sounds pretty "rad."

04-01:59:39
Schilling: —that kind of encapsulates what RAdICAL is all about.

04-01:59:45
Eardley-Pryor: In the first RAdICAL workshop, I have a note here it was in 2012.

04-01:59:48
Schilling: Yes.

04-01:59:50
Eardley-Pryor: That's the one where, you mentioned here, where you had to assemble all of these instruments, all of these people came together?

04-01:59:54
Schilling: Correct.

04-01:59:56
Eardley-Pryor: And that was the first time that you did all that here on site, at the Getty Center?

04-01:59:57
Schilling: Yes. And that was before we used AMDIS, so Agilent was a partner in that first workshop. And they worked with our IT [information technology]

experts—now they're called "Getty Digital," they were ITS [information technology systems] back in the day—so the Getty Digital staff was assisted by an Agilent Technologies Service engineer to install our software on a bank of computer terminals that were down in our training lab, where the ITS people would train Getty users on Getty software. So we had also support from Agilent in that workshop.

04-02:00:37
Eardley-Pryor: The expanse of collaboration to make these workshops possible is really extensive.

04-02:00:44
Schilling: Absolutely, yeah, both from different institutions and commercial companies, things like that. So it all came together nicely, though.

04-02:00:56
Eardley-Pryor: So the next year, the following year, you held another RAdICAL workshop, and this time at Yale.

04-02:01:01
Schilling: Yes.

04-02:01:02
Eardley-Pryor: What was different about doing this in a totally different site a year later?

04-02:01:08
Schilling: It's not our lab, so we don't know where all the supplies are. We're not controlling any of the equipment. We were relying on our partners there at the Yale Institute for Preservation of Cultural Heritage, the Yale IPCH. We mentioned Kate, my daughter, works there now. She didn't work there back then, but Aniko Bezur was a scientist, a conservation scientist, who works at IPCH. She attended the first RAdICAL. She saw what needed to happen in order for a RAdICAL workshop to take place. She went back home, and again, in communication with our education group, Kathy Dardes, and at the time, Sean Charette was the education specialist who worked for Kathy, who was our liaison then with our partners. And Sean and Aniko and Nanke and Arlen and I kind of helped facilitate Aniko's hosting of that workshop. So it was a little different. They had to then work with the vendors to get the equipment.

04-02:02:11
But again, Agilent and Frontier stepped up to the plate, and they delivered three working Py-GC/MSs for them. And they got microscopes from Nikon. The microscope setups were wonderful, they were all identical, so the imaging software is all the same. Nanke said for her, that was the easiest workshop, because the microscopes all functioned the same way. So training someone on one instrument is like training them on any of them. Not always the case, even here. And again, Julie Chang was the assistant to Nanke. And that again was a success.

I should mention one thing from the workshops. The [Getty] Education Department always insists on having a survey afterwards, and they send the survey out to the participants. It was an international group, so from the U.S. and Europe and Asia. And we wanted feedback. So they really came up with a thoughtful survey form. It gives meaningful data to us, as the teachers and organizers, so we can put on a better workshop the next time. And Jenny Poulin is a scientist from the Canadian Conservation Institute. She does Py-GC/MS at the CCI, so she attended with Marianne Webb—Marianne Webb's our lacquer conservator friend from Vancouver—and Jenny said, "This changed my life."

04-02:03:47
Eardley-Pryor: That's pretty neat feedback to receive.

04-02:03:50
Schilling: That was really nice feedback. And it really was the feeling that was kind of implied by other users, that this was such a different way of analyzing data from Py-GC/MS, and being able to take samples in a precise way, and having access to this low-tech, but highly effective staining method, but especially the data treatment.

So the one extra bit I want to add, what puts the "E" in "ESCAPE" is Experts. So we had the luxury of lots of scientific literature on identifying European materials. We had all of Professor Miyakoshi's publications on Asian lacquer. We did our own research and contributed knowledge to the field about what oxidation products form in Asian lacquer, how they're mixed together. So there was a lot of expert knowledge that was there, to not only assemble a list of what the relevant marker compounds are, but again, how those lists of markers should be sorted by type of material.

04-02:04:59
Eardley-Pryor: [You've] got to analyze them.

04-02:04:59
Schilling: And there was one person in particular who went above and beyond to share his expert knowledge with us. That person's Henk van Keulen. Henk is a research scientist at the Netherlands Institute for Cultural Heritage, so the RCE. And I had been in touch with Henk. I'd known him for years. I had done workshops, GC/MS workshops, with him before. We actually did the first MaSC workshop together at his own institution, I think in 2000, 2001. But anyway, Henk was a longtime friend. And I asked him, "Where can I find information on marker compounds on European resins?" And he sent me back something that just blew me away at the time because of his generosity. He sent me back a [Microsoft] Word document, I think five or six pages long, of all the marker compounds that he found in European resin materials, and a range of materials. No one had ever done that before, just really send their own personal list. Normally people send a publication, and it's useful, but it doesn't have all the back-story and the extra information. So here it is, a list of

compounds, their names, what significant ions are in the mass spectra, kind of when they come out of the GC/MS analysis, and what material forms them.

04-02:06:31
Eardley-Pryor: So he shared his raw data with you, of his career's worth of research?

04-02:06:36
Schilling: Correct. He pre-dated me in Py-GC/MS by twenty years, so he had a twenty-year head start on me. And it blew me away that he was so generous. So I was able to find those compounds in my chromatograms, and then, again, eventually make AMDIS spectra for them, put them in the library, add them to the Excel database. And his work really formed the foundation of our ability to identify European resins in lacquers. So even that first workshop had data from him in it. Even before we called it "ESCAPE," it was an expert system, and he was one of the people that put the "E" in "Experts." And so that generosity of spirit, really, we carry over in our workshops by sharing all of our knowledge that we put into ESCAPE with our users during this training process. And they get all of our files, and then we update the library and the Excel report template periodically as we get new information from experts.

04-02:07:39
Eardley-Pryor: What I'm hearing you say is, this is a really open-source platform, that you are taking from the generosity of others, and using that generosity to build the platform larger, and then sharing it with more and more people, especially as they attend these workshops.

04-02:07:57
Schilling: Exactly. We feel that kind of in the spirit of the way AMDIS was produced—AMDIS was produced in order to kind of take variables that might be introduced by the user in interpreting the data, and taking them out. And the way we integrate expert knowledge into the database and into the Excel report template might be graphical, it might be some text notes and things like that, that allow people to make decisions, if all of the necessary marker compounds are present or not. So the yes-no verification of whether or not those markers are there; so, whether or not that material is in a sample. So that expert knowledge, then, is part of what's passed along. So right now, we have nearly two hundred person-years of expert knowledge in ESCAPE, the way it is right now.

04-02:08:50
Eardley-Pryor: That's a lot of resources of careers that have gone into that.

04-02:08:56
Schilling: It is. So then, because we made it an expert system for characterizing any kind of organic material with Py-GC/MS, what we've been doing intentionally now, over the past few years especially, is analyzing more types of materials working with experts in the analysis of those types of materials, and produce—adding to the ESCAPE database and then making customized Excel report templates for those materials. So the next big frontier for us would be

synthetic paint media. My boss, Tom Learner, is an expert in doing Py-GC/MS synthetic paint media, like acrylics and vinyls. I read his book that came from his thesis, and I put that into those sorting equations in the synthetic ESCAPE Excel report template.

04-02:09:47
Eardley-Pryor: So ESCAPE isn't just only for lacquer research, it's for any kind of research that you can keep on adding to your library for marker compounds?

04-02:09:55
Schilling: Any organic materials that you can identify with Py-GC/MS, there is an ESCAPE solution for you, absolutely.

04-02:10:00
Eardley-Pryor: And it's just given for any users who want to use it in the cultural heritage world?

04-02:10:04
Schilling: Correct. And we made it as turnkey as we could, again, kind of in keeping with the AMDIS spirit. But we still feel like a training workshop is helpful, because then we can really show them how to use it properly. And we get feedback from them, which is very helpful. Herant Khanjian had mentioned—he does FTIR—when I trained him on ESCAPE, he said, "Boy, it would be really great if it did this." So I went back and I made Excel do what he wanted it to do. And now you can navigate the forms much more easily with hyperlinks, because of his feedback.

04-02:10:39
Eardley-Pryor: So they speak to each other within the Excel spreadsheet, the different tabs?

04-02:10:45
Schilling: Exactly. So it allows the user, when they're doing the confirmation process, "Is a particular lacquer present, yes or no?" Hyperlinks take you back and forth between different relevant worksheets that have expert knowledge, or it has explanatory graphs and figures.

04-02:10:53
Eardley-Pryor: All within this one Excel spreadsheet.

04-02:11:00
Schilling: Correct. And so we get feedback, then, from the users during these workshops that make the next version of ESCAPE better.

04-02:11:10
Eardley-Pryor: So the RAdICAL workshops, have they essentially transitioned? Because there was another one that you held at the Louvre.

04-02:11:14
Schilling: Yes.

04-02:11:16
Eardley-Pryor: Have the RAdICAL workshops now transitioned to ESCAPE workshops?

04-02:11:18
Schilling: No. Actually, we were still doing RAdICAL workshops. We did a RAdICAL workshop, like you said, after Yale IPCH, we did one at the Louvre at the C2RMF. I want to mention Nathalie Balcar has been my expert in synthetic paint media analysis. That's been a passion of hers for a long, long time. So she's been one of the experts that's worked alongside with me in adding marker compounds to AMDIS, and expanding what the Excel report template can do for synthetic materials. So her institute hosted a workshop, and then Henk's institute hosted a workshop.

04-02:12:01
Eardley-Pryor: A RAdICAL workshop?

04-02:12:00
Schilling: A RAdICAL workshop. And then we had a small RAdICAL workshop here for Chinese researchers last year. And our next workshop will be in Beijing at the Palace Museum in the fall of 2020.

04-02:12:17
Eardley-Pryor: So you get to return to China.

04-02:12:18
Schilling: So we're excited about that. And it'll be fun to do it in Asia for researchers from that region, because that's really one of the places where lacquer was created.

04-02:12:32
Eardley-Pryor: It's coming back—RAdICAL is going home, in some ways.

04-02:12:34
Schilling: It is. It is. And I can't thank all the experts enough, who've really been kind and really gone out of their way to give—download their knowledge that was hard won over decades of dedication and work and frustration, and successes and failures, and sharing that with me in a meaningful way so that I can put it into the system. And together, then, we can do more. Every expert that adds his or her knowledge to the system makes the system better, and all the users benefit from what's shared back by the experts.

04-02:13:10
Eardley-Pryor: It's like a materials characterization crowd-sourcing for cultural heritage.

04-02:13:17
Schilling: It's a good way to think of it. Absolutely. Absolutely. And Henk came up with our motto, he heard it from Leonard Nimoy, who once said, "The more we share, the more we have." And it really is true. The more people who are generous of spirit like Henk and Nathalie and Tom and Jenny, and Ken Sutherland at the Art Institute of Chicago—and the list goes on and on and on.

Mike Szelewski, who taught me AMDIS—all of those people are making significant improvements in the lives and work of researchers in our field.

04-02:13:53
Eardley-Pryor: That's wonderful.

04-02:13:55
Schilling: Yeah.

04-02:13:56
Eardley-Pryor: Let's take a quick break here, before we finish things up.

[Break in Audio]
04-02:14:00
Eardley-Pryor: So Michael, this work that you've been talking about, was built initially from research on lacquers, and the questions you had about their origins, and how they were used. How has this work on lacquer continued to evolve in your research and work?

04-02:14:16
Schilling: It's interesting. The next phase for us, then, is to build on what we've learned about lacquer, especially the lacquer compositions at the very surface of the objects. And I said before that it's the surfaces that the conservators are most interested in, because its chemical changes take place generally at the surface.

04-02:14:33
Eardley-Pryor: They're oxidizing there.

04-02:14:33
Schilling: That's where the dirt is, that's where the oxidation products build up. They want to know the chemistry of those surfaces. So Marianne Webb—I've mentioned her in a couple of contexts now—we hired her as a consultant to work with us to develop safe methods for cleaning the surfaces of degraded Asian lacquer. So it's an interesting step for me, especially. I seldom get involved in conservation-related work, where the conservation is actually under my supervision. So that's been an interesting new challenge.

04-02:15:08
Eardley-Pryor: That's a new chapter for you.

04-02:15:09
Schilling: Yeah, exactly. Since we learned so much about those surfaces and what the chemistry is, Marianne's fascinated by them, and she's going to be trying out new approaches to cleaning them, reflecting the actual chemistry of what's there in real aged lacquer objects. We were also fortunate to get funding from Tim [Whalen] to hire Jing Han, who received her PhD in Scotland. And she did it on HPLC-MS [High-Performance Liquid Chromatography-Mass Spectrometry] of dyes, textile dyes. And we have an HPLC here in the lab, and so she's going to work for three years for us as a professional fellow, supporting the work that we're doing with Marianne Webb, to study in great

detail the materials that get removed from lacquer when treatments are applied. Then also, we'll be having a graduate intern work with us. He'll be starting in September, Xinying Hao. He'll be working with us on Py-GC/MS to look for the residues that the cleaning treatments leave behind on the lacquer. So Jing is going to tell us what's removed from the lacquer when it's cleaned, and Xinying is going to tell us what might be added to the lacquer when it's cleaned.

04-02:16:29
Eardley-Pryor: So it's not just the whole arc of this, it's not just the origins of the lacquer—what they're made of, where they came from, how they moved around the world. Now it's looking at the end piece of, once they've been conserved, what happens to these lacquers chemically?

04-02:16:44
Schilling: Absolutely.

04-02:16:45
Eardley-Pryor: And that's what the cleaning research is about?

04-02:16:46
Schilling: Right.

04-02:16:48
Eardley-Pryor: That's wonderful.

04-02:16:48
Schilling: Best practices for conservators to use when they're cleaning lacquer. So it really does come full circle now. And it's back to, really, what the Getty Conservation Institution is about, is to do cutting-edge research on materials, learn more about them deeply, maybe more deeply than other people have ever gone, collaborate with experts to help us navigate these scientific challenges, work with conservators to help us learn more about the objects and the way they're made. Then hopefully that information gets fed back into cleaning treatments that are better, they're longer lasting, and less invasive for the objects.

04-02:17:28
Eardley-Pryor: The research that you're doing, it sounds also, as you're doing it, you're building the community of users and the groups that are part of that. You're building them more and more, not only expanding them, but then also integrating them. It's almost like you're [applying] some of these binding resins themselves.

04-02:17:43
Schilling: Yeah. It does seem that way, doesn't it? It's a good way to put it. I like that.

04-02:17:47
Eardley-Pryor: From what I understand, too, you've created online networks for people to continue their research and the collaborations, so that each year you're

updating the software and sharing that. And that goes out through these Google groups that you've created?

04-02:17:59
Schilling: That's right. We each started a Google group, ESCAPE Experts, and we have a lacquer—another RAdICAL Lacquer Google group. Again, that's an online community. All the people who have been trained in our RAdICAL workshops, our ESCAPE workshops, it's a place where they can share what they've been seeing with the method. They ask questions, maybe they ask questions about the objects. It's a great place on an online venue to share information. We can post our updated files on shared folders that would be accessible to the people who have gone through the training.

One of the members of ESCAPE experts is Gary Mallard. He's a retired member of NIST who was instrumental in making AMDIS. I wanted to add that Gary's group shared the Nobel Prize with the OPCW [Organization for the Prohibition of Chemical Weapons], the Nobel Peace Prize, some years ago for making AMDIS.

04-02:18:58
Eardley-Pryor: So the creation of AMDIS is what earned them the peace prize?

04-02:19:00
Schilling: Correct. Correct. It's very cool, working with a Nobel Peace Prize winner.

04-02:19:05
Eardley-Pryor: That's really neat that he's a part of your research community.

04-02:19:07
Schilling: Right. And he was absolutely blown away by what we did with ESCAPE. He said he'd never seen anybody use AMDIS in that way. So he's been really great, feeding back information, and really helping us go farther. So he's a real expert in ESCAPE experts.

04-02:19:25
Eardley-Pryor: That's great. And building off your expertise, where do you see the next phase of your career? And what aspects are you interested in exploring?

04-02:19:36
Schilling: So the one big thing that I'm very excited about right now is, again, another collaboration with my friend, Arlen. Arlen's just a great guy, and again, he was interested in identifying wood species. And the traditional way of identifying wood species is, you take a relatively large sample, maybe a centimeter or so, and you make a thin section of it, and you mount it in resin and you polish it, and you look for features, anatomical features at the microscopic level. And there are online catalogs of these visual features that an experienced user could look for. And by going through these images and these descriptions of the features in the anatomical structure of the wood—

04-02:20:26
Eardley-Pryor: That sounds like a very invasive technique. That's a big sample.

04-02:20:30
Schilling: Very invasive, and you really need to be an expert at doing this. The wood anatomy has been around for about a hundred years, and it works well for many types of woods. Arlen is our resident expert in wood anatomy. He's able to identify many different species of wood in our furniture collection. But he came by one day saying, "You know, wood anatomy doesn't work for tropical hardwoods because they grow in tropical regions, and so the resulting trees that grow there don't have well-defined growth rings and recognizable patterns of anatomical features that can be recognized, even by the top experts in wood anatomy." So dark, tropical hardwoods, like rosewood, like ebony, really can't be identified using this traditional method.

04-02:21:18
So he came by one day a few years ago, and we had a conversation. We thought, "Well, let's try Py-GC/MS. We've done a lot of Py-GC/MS now, together with lacquer. Let's try it." Did some pyrograms of some reference samples in a reference collection, and he worked with a graduate intern, Madeline Corona, a few years ago. They went through the data, they tried statistical evaluation. They really didn't get anywhere, it just was kind of a dead end. So a traditional kind of pyrolysis, and then some statistical treatment of the data didn't work. So it was a bit discouraging.

Then one day, I was in the lab, maybe a year and a half, two years ago, and I was sitting in front of the Py-GC/MS that we used to analyze animation cels, and that we also used to analyze lacquer. And I thought, "Wow, F-Search—it would be a great technique to make a representative mass spectrum of all of the data that comes out from a pyrogram of wood. But if we lower the temperature of the pyrolyzer, we're not degrading the compounds as much, we're just letting them evaporate." So chemicals that biologists would call "extractives" would be chemicals that can be extracted easily from woods by solvents, and then analyzed by GC/MS or LCMS. Those extractives, many of them evaporate at low temperatures—three hundred, three twenty, right?

So instead of pyrolyzing the wood at a high temperature to break it down into many, many, many small compounds, let's use a lower pyrolyzer temperature, and we'll just thermally desorb extractive compounds and lignin compounds, and hemicellulose compounds that are all better marker compounds—that are all better marker compounds, potentially, then—for species of wood than you would get from all of the many markers that had come out of a pyrolyzed wood sample.

04-02:23:31
Eardley-Pryor: So instead of vaporizing, pyrolyzing the entire wood sample, your lower temperature treatment allows for off-gassing of chemicals that you can then identify.

04-02:23:43
Schilling: They're more chemically-specific for species of wood.

04-02:23:47
Eardley-Pryor: For a variety of wood species.

04-02:23:46
Schilling: Correct. So that was the idea I had one day. And we started trying it out. And we tried out different pyrolyzer temperatures, we tried out different residence time in the pyrolyzer furnace, to kind of optimize the analytical parameters in the pyrolyzer furnace. Again, the Frontier pyrolyzer is useful for that, because we can carefully control exactly what temperature the sample is exposed to, how long it's exposed to that. And it's a very inert system, so we get the best results.

04-02:24:21
Eardley-Pryor: And you toy around with those potential uses to build a protocol that you think would work best.

04-02:24:27
Schilling: Correct. And then the second real breakthrough, again, was connecting F-Search to it, thinking that, "Okay, F-Search is a great way to simplify a complex three-dimensional dataset. So time, intensity and mass spectrum in the Z-direction reduce a complex pyrogram to a single mass spectrum—that can be stored in a wood F-Search database." So we built one of those. We tested, I think, sixty or seventy different wood species, and sure enough, the F-Search results are very good at classifying most of the significant woods that are used in furniture, including ebony and *Dalbergia*. And especially ebony and *Dalbergia*, because those woods tend to be rather high in the extractives, and they're very unique extractives. So the combination of thermal desorption GC/MS—so basically pyrolyzing at a low temperature—combined with F-Search data interpretation is a great combined technique that we're trying out to identify wood species.

04-02:25:36
Eardley-Pryor: Where do you think this work will go?

04-02:25:40
Schilling: I think it has the potential to replace, or at least augment, wood anatomy as, again, a turnkey system that people like me, that have a Py-GC/MS, can actually do.

04-02:25:54
Eardley-Pryor: So you can automate that protocol in the data analysis, rather than have to have these expert years of training for just simple visual [recognition]?

04-02:26:02
Schilling: Yeah, recognizing visual features.

04-02:26:03
Eardley-Pryor: That didn't even work for the tropical woods, anyways.

04-02:26:07
Schilling: Exactly. It works really well for *Dalbergia*, it works really well for ebony. And those were the two species that Arlen really wanted to identify. Well, we've also found that it works for other species as well, for which he still can do wood anatomy. So we, again, used "blind robins"—Arlen gave me samples of a furniture collection, samples of wood for which he already had the identification done by wood anatomy, and I got them all right using this system.

04-02:26:39
Eardley-Pryor: So you confirmed the system.

04-02:26:43
Schilling: Exactly. So again, I kind of waver between being a Scully and being a Mulder in terms of the X-Files characters.

04-02:26:52
Eardley-Pryor: What do you mean by that?

04-02:26:50
Schilling: In the X-Files, Mulder was the believer and Scully was a skeptic. So sometimes I look at the data thinking, "Boy, it's too good to be true; it's got to be more challenging than this." Then other times, I think, "This works really well." But again, the wood anatomists have had a hundred-year head start on us. We had been working for not even a full year, not even, kind of on and off over the last couple of years. So I've given talks on the method, to try and generate interest, to see if we can get partners from other labs. So Winterthur, again, is interested. Any museum that has a significant furniture collection has expressed an interest, so the British Museum; Winterthur; Yale, the Yale Museum; and again Yale IPCH; the Philadelphia Museum; the Met—all of these people have Py-GC/MS equipment with Frontier pyrolyzers. They might have to buy an attachment that goes with the system and the F-Search software, but those are relatively low-cost things, and it would augment what they can do with their existing systems.

04-02:28:00
Eardley-Pryor: What needs to happen in order for you to feel comfortable that the wood identification process is fit for a workshop, a RAdICAL-level-type workshop?

04-02:28:08
Schilling: I think one thing, for sure, is—and need to keep this in my head—that we really wanted it to do something that wood anatomy couldn't do. Those were the tropical hardwoods. And that it does really well. So definitely we could do a RAdICAL-type workshop if we just limited the focus to that particular question. These dark-colored tropical hardwoods? We have enough reference samples now, especially for ebony—Arlen's been collecting reference samples from colleagues at Kew Gardens, the Forest Products lab in Madison,

Wisconsin, Tervuren in Belgium, other places around the world have given him vouchered—what we'd call "botanically vouchered specimens," that were verified by a botanist who harvested the sample from the growing tree. So it got a number of these vouchered samples. We have a number of these vouchered samples now from these xylaria and herbaria that are in our collection. So really testing more of them to see how much variability there is for a particular species of, say, ebony tree growing in one country versus another, versus another. So are there differences in the chemical signatures of the extractives? Or are they more or less the same?

So I think starting with a narrow focus on the workshop, seeing how it goes, and then again, augmenting the limited database that we have on oaks and pines and spruce and junipers, with more botanically vouchered specimens, would give us some confidence that we could continue to expand the purview of what can and can't be identified with this new method, Arlen came up with the acronym for this one; he called it "MoXI." So, Molecular Xylem Identification—so MoXI, I like that one.

04-02:30:15
Eardley-Pryor: Yeah.

04-02:30:16
Schilling: It goes hand in hand with RAdICAL, I think. We like our acronyms here.

04-02:30:21
Eardley-Pryor: That's great.

04-02:30:23
Schilling: So MoXI's kind of the next frontier. And Xinying, how I mentioned him in the context of lacquer—he'll be working with me also on building up this MoXI database in F-Search. And we're also using AMDIS. It's another good tool for compound-specific identification.

04-02:30:37
Eardley-Pryor: So would ESCAPE—

04-02:30:37
Schilling: So it's kind of a combination.

04-02:30:37
Eardley-Pryor: —would ESCAPE be used in—?

04-02:30:41
Schilling: It might be, yeah. Certainly AMDIS will be useful, and I'll probably find some Excel form that will sort the compound. So it might be a two-step approach.

04-02:30:51
Eardley-Pryor: I look forward to seeing what other acronyms come out of this.

04-02:30:53
Schilling: Oh, me too.

04-02:30:55
Eardley-Pryor: What other things are you interested in and hoping to work on in the future?

04-02:31:00
Schilling: I think I mentioned one priority for me right now is writing up a book on our GC/MS experiences. So Joy Mazurek and Henk van Keulen and I are working on that. And that's one thing I wanted to mention in terms of ESCAPE, is the issue of legacy. And as the experts I worked with are getting older, like me—more gray hair, less hair, all of those things that happen with time—we all want to find a meaningful way to pass along our knowledge to the next generation. And I think that's one of the key benefits of ESCAPE is making our knowledge accessible to the next generation in a meaningful, easy to use way. So everyone I've worked with who's kind of in the same age bracket as me, is glad that we have this way of distilling our knowledge into something that could be used and expanded upon by the next generation. And then the books that we write, and whatever comes out of wood identification, yeah. And working with Marianne on this lacquer cleaning project. Herant has been absolutely essential in working out the aging parameters that we're going to use for the lacquer replica reports that Marianne makes. So getting those panels aged and dirtied up and cleaned and evaluated by Jing and Xinying and Arlen and Marianne is just going to be great. That's coming up soon.

04-02:32:35
Eardley-Pryor: That's great.

04-02:32:38
Schilling: So watch this space.

04-02:32:37
Eardley-Pryor: Are there any other thoughts you'd like to share about your work here, your career over time, your thoughts about the future?

04-02:32:44
Schilling: I have to admit, I still can't believe I'm here. It just is a dream. Really, it's a dream to be here. We lack nothing. We really lack nothing. And with inspired and inspiring leadership and the resources that we have, and the opportunities that we have to have experts coming here on a regular basis, and going there, meeting with them, the resources that I have here are just unmatched. And I feel really blessed to be here.

04-02:33:21
Eardley-Pryor: Thank you so much for your time, Michael.

04-00:00:00
Schilling: You're welcome. Thank you.

[End of Interview]

Appendix: Photographs and images courtesy of Michael R. Schilling

Family photo at wedding of Cherrie and Michael Schilling at St. Luke's Lutheran Church in Claremont. Michael's brother David to Michael's right, Michael's mother Doris to Michael's left, and Michael's father Roy to Doris's left. (1982)

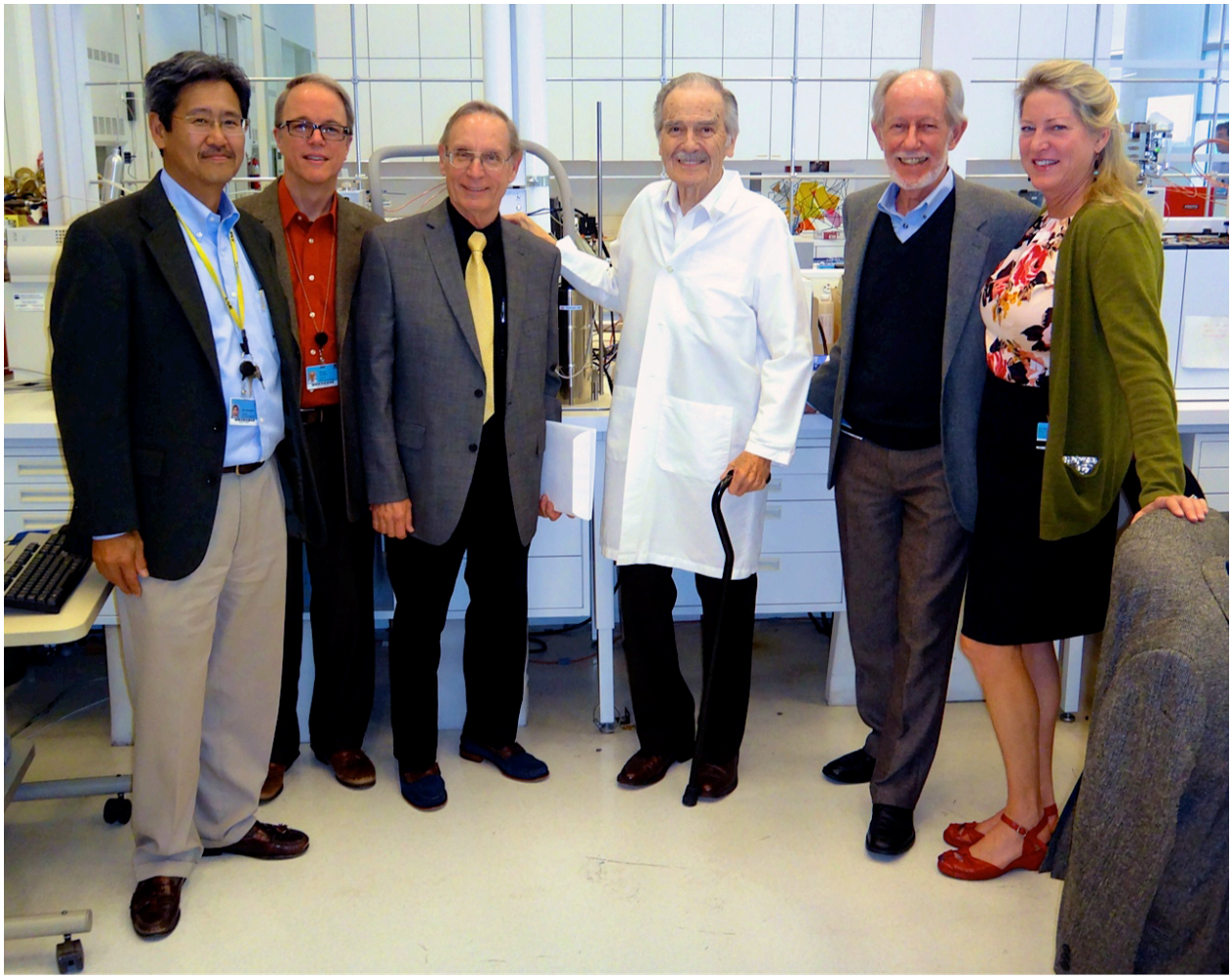
Michael Schilling, daughter Katherine, son Nicholas, and Cherrie
in family photo from First Presbyterian Church, Covina. (1997)

Cherrie, Michael Schilling, daughter Katherine, son Nicholas, daughter-in-law Rhiannon, and grandbaby Abigail (left to right) celebrate Thanksgiving at the home of Nicholas and Rhiannon. (2019)

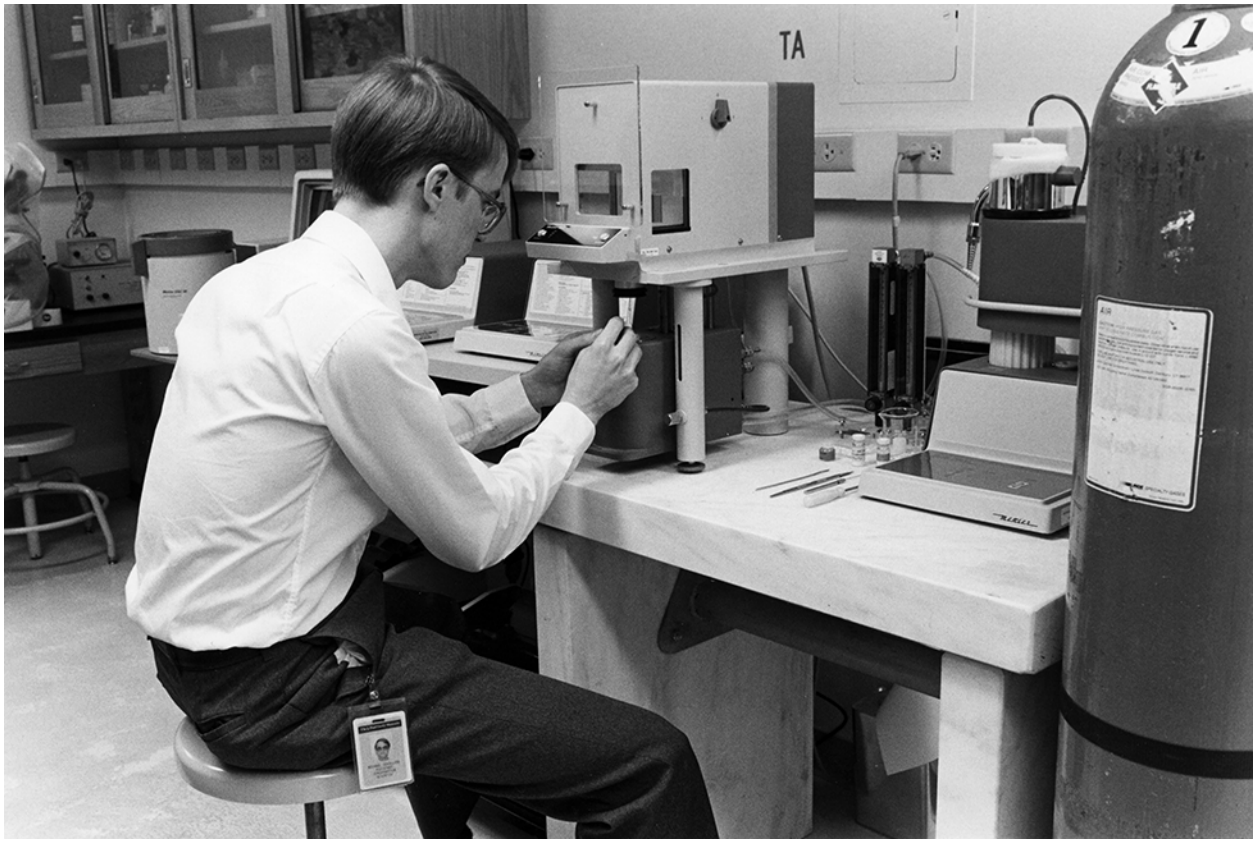
Cherrie and Michael Schilling throughout the years
(counter-clockwise from top left): at wedding in 1983; at First Presbyterian Church Covina in 1997; at home in West Covina in 2006; at the Getty Center in 2019.

Dr. J. Ernest Simpson, emeritus professor of organic chemistry and first coordinator of the Cooperative Education program at California State Polytechnic University, Pomona. (April 2013)

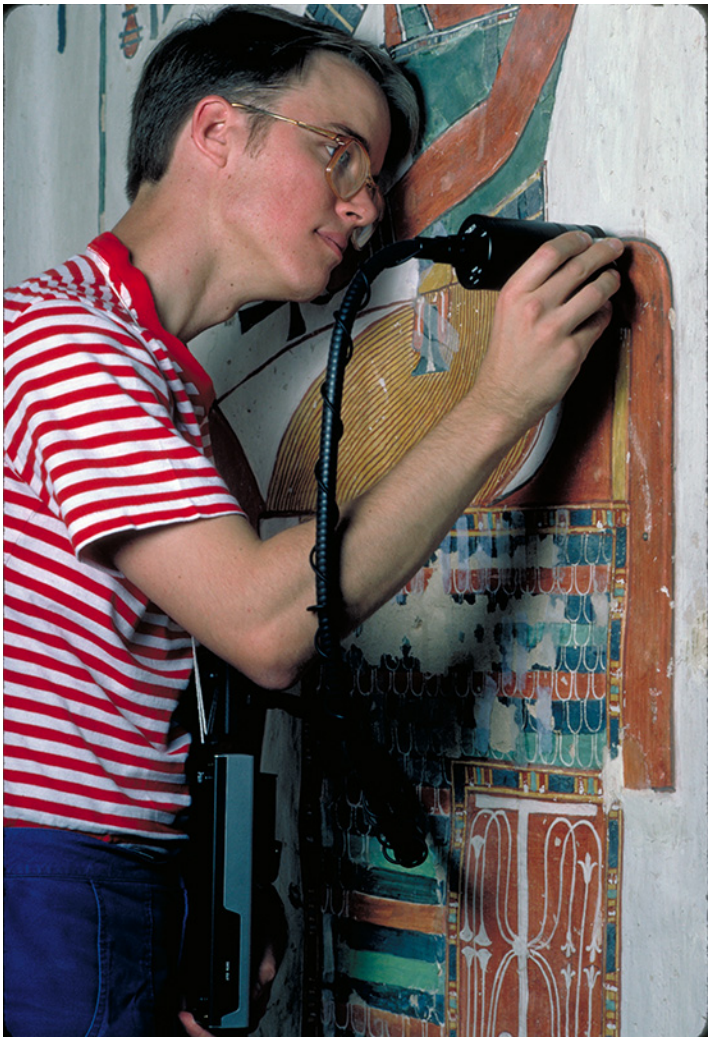
Dr. Frank D. Preusser, the first head of the Getty Conservation Institute Science department, in his office at the Los Angeles County Museum. (January 2015)



Long-time Getty Conservation Institute (GCI) employees celebrate the 90th birthday of Dr. Frank Lambert, retired professor of organic chemistry at Occidental College, in the Materials Characterization Laboratory of GCI Science department. Left to right: Dr. Shin Maekawa, Michael Schilling, Jim Druzik, Dr. Lambert, Dr. Neville Agnew, Tina Segler. (2008)



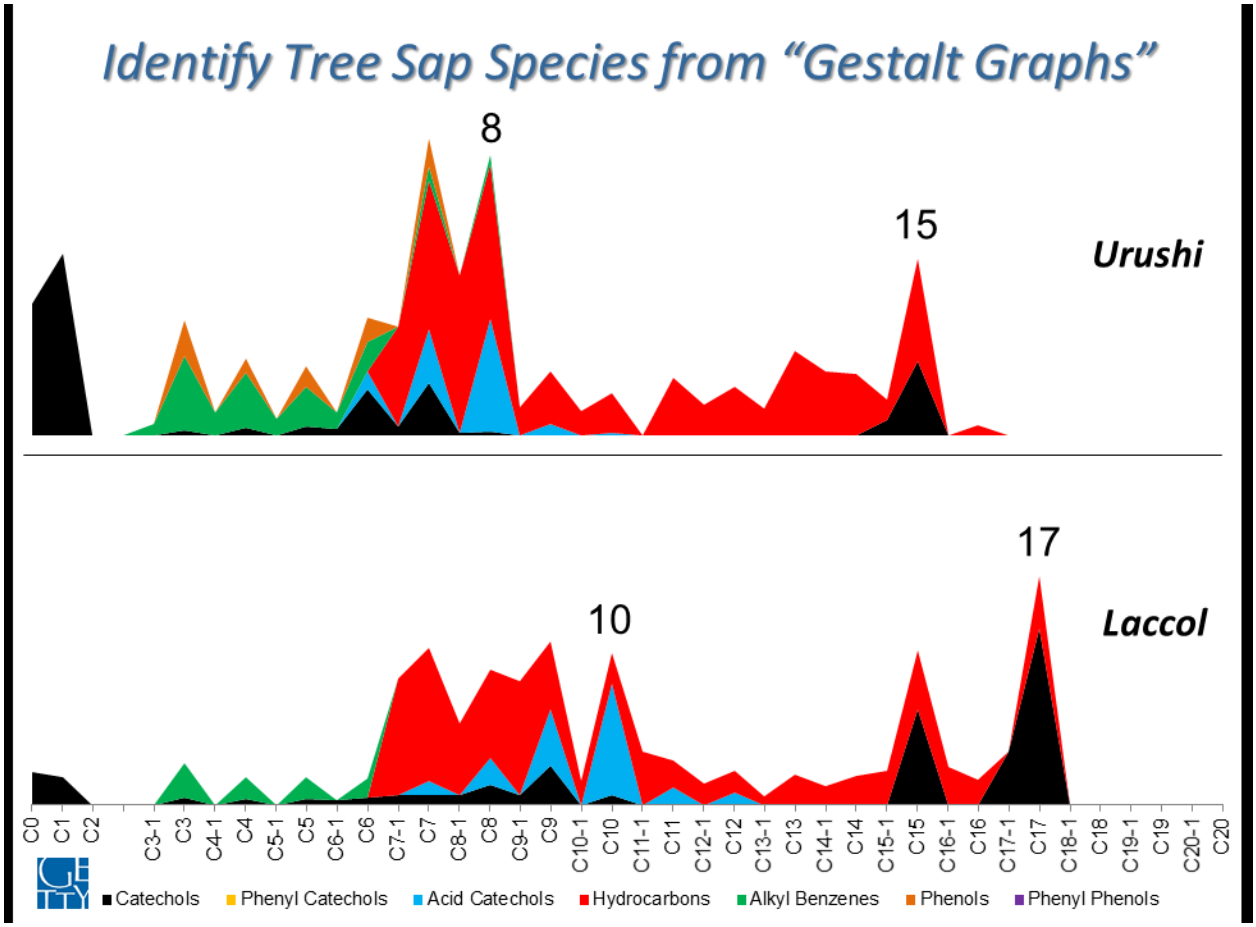
Michael Schilling operating a thermobalance in the Getty Conservation Institute laboratory, which was then located at the J. Paul Getty (Villa) Museum. (circa 1984)



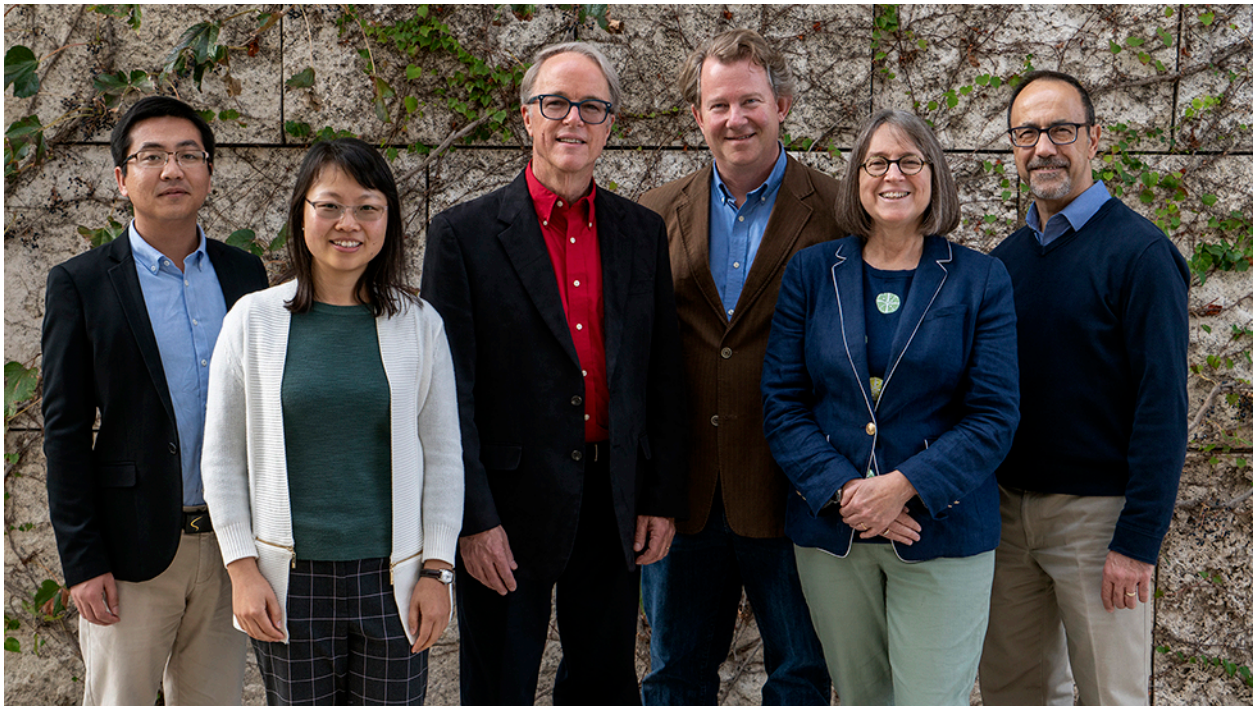
Michael Schilling measuring the color of the wall paintings in the tomb of Nefertari, located in the Valley of the Queens, Luxor, Egypt. (1986)

Michael Schilling (far right) instructing participants in the Centre de Recherche et de Restauration des Musées de France (C2RMF) laboratories at the Louvre during a five-day workshop on RAdICAL (Recent Advances in Characterizing Asian Lacquer). RAdICAL workshops disseminated new procedures developed by scientists at the Getty Conservation Institute, conservators at the J. Paul Getty Museum, and Nanke Schellmann (as part of her Ph.D. thesis) for acquiring detailed compositional information about lacquered objects, with the aim of improving the characterization, understanding, and preservation of this material. The inset logo for RAdICAL workshops was designed by Michael Schilling, Arlen Heginbotham, and Nanke Schellmann in 2012. The logo was based on the molecular structure of catechols, the saps from Anacard tree species used in Asian lacquers. (July 2014)

Henk van Keulen, Jenny Poulin, Nathalie Balcar, and Michael Schilling (left to right) celebrating after the first ESCAPE workshop. The workshop was part of the Eighth MaSC Workshop and Meeting, hosted by the HERCULES Lab at the University of Évora, Portugal. The inset logo was designed for ESCAPE (Expert System for Characterization using AMDIS Plus Excel), a Py-GC/MS data-analysis system developed by Michael Schilling, Arlen Heginbotham, Henk van Keulen, Mike Szelewski, Nathalie Balcar and Jenny Poulin, which was used initially for molecular characterization of Asian and European lacquers. (2017)



An example of color-coded "gestalt graphs" produced from ESCAPE data featuring the different chemical-marker compounds of urushi- and laccol-based lacquers. For further details see Michael R. Schilling, Arlen Heginbotham, Henk van Keulen, Mike Szelewski, "Beyond the Basics: A Systematic Approach for Comprehensive Analysis of Organic Materials in Asian Lacquers," *Studies in Conservation* 61:sup3 (2016): 3-27.



Characterization of Asian and European lacquers project team (left to right):
Dr. Xinying Hao (GCI Graduate Intern), Dr. Jing Han (GCI Fellow), Michael Schilling, Dr. Arlen Heginbotham (Conservator of Decorative Arts and Sculpture, the J. Paul Getty Museum), Marianne Webb (conservator in private practice, Ottawa, Canada), and Herant Khanjian (GCI Assistant Scientist). (2019)