CERAMIC TECH CHAT

Episode 15

Title – "A teacher's thoughts on glass and money: Steve Feller (E15)"

INTRO

McDonald: "I'm Lisa McDonald, and this is Ceramic Tech Chat.

When pursuing a degree in the sciences, students often do not have the opportunity to conduct serious research until they begin their graduate studies. Fortunately, the National Science Foundation funds a large number of research opportunities for undergraduate students through its Research in Undergraduate Institutions program, or RUIs, and Research Experiences for Undergraduates program, or REUs.

While many of the RUI and REU programs are based at large universities, some small liberal arts colleges have developed highly successful programs with NSF funding as well."

Feller: "There are now about 80 physics majors at Coe College of which, in a given summer now, about 30 to 40 are staying to do research and many more are going to work with collaborators or in internships or in REUs. So, in any given summer, out of the 80 physics majors, maybe 50 or 60 are doing some sort of research. And that is, to me, a very pleasing result."

McDonald: "That's Steve Feller, professor of physics at Coe College in Cedar Rapids, Iowa, a small liberal arts college with enrollment just over 1,400. Steve, known as Doc to his students, has been instrumental in developing an extensive NSF-funded glass research program at Coe over the last 40 years. Recently, he has transitioned from teaching to conducting research with students full time."

How does someone become involved in developing a research program exclusively for undergraduates? And what is it like conducting research on glass? Also, glass is not the only topic that Steve has researched extensively—we'll learn about the discipline of numismatics as well."

(music)

SECTION 1

McDonald: "Though known internationally for his research on glass, research was not Steve's main goal during graduate school. Instead, first and foremost, he wanted to develop his ability to teach science, which led him to make a unique choice while pursuing his Ph.D."

Feller: "I grew up in Brooklyn, New York, which of course is part of New York City. And there were three high schools for science in New York City: the Bronx High School of Science, Stuyvesant High School, and Brooklyn Technical High School. All of these are comparable, and entrance by examination only. In fact, the State of New York has a law that only the test is to be used to determine who gets in. My parents said, 'You're taking the test.' Why? Because it was perceived as a better high school than the neighborhood school. I was in eighth grade, I didn't know better. So I took the test, I passed the test, I went to the high school, and from that day until four years into graduate school, I never thought about what I was going to do.

Now I ended up being a physics major in college and in graduate school. I went into physics because I liked it, but I never worried about it. I never got nervous about it in any way. I just kept going. Finally, near the end of graduate school, I began thinking, 'Now what am I going to do?' And I had liked teaching a bit in the lab, but that was kind of canned, you know? The labs were not very exciting, although I enjoyed working with the students. I was a TA for one year and then I became an RA, which is sort of the usual route in the physics.

So I decided I would like to see if I would like teaching and do well at it. So I got this idea that I would give up my RA and become a TA again. That's highly unusual, Lisa, to give up one thing to sort of quote unquote go backwards, but I wanted teaching experience."

McDonald: "Yeah, everyone I know, they just can't wait for the day to not have to TA, most of my friends in grad school."

Feller: "I was the opposite. I enjoyed research actually, but I didn't see the sense of just having an RA when I can get teaching experience. So I went to the department chair at Brown and I said, 'I'd like to get teaching experience teaching in a course. I'd like to give up my RA and become a TA again.' And his response was, 'No way.' And he explained it like this. In today's dollars, if something like, I don't know, $65,000 a year to go to Brown, and a lot of those students pay the full cost. So he said to me that an undergraduate is not going to go to Brown, pay that much money, and get a graduate student for a teacher. So I said, 'You know, that makes sense.' But I said I had the catalogue with me, not by coincidence, and I said to him, 'Here it says you train teachers.' So I said, 'Where's the training?' So he said, 'Well, you're a lab TA.' I said, 'That's nice, but that's not real experience in teaching. That's minimal.' So I thought I had a pretty good response to him.

So they let me teach a course—they did—that was a self-paced course. In those days, in math and physics and perhaps a few other disciplines, they had courses where students went at their own pace and they'd come in for questions or for help sessions or to take tests, otherwise they're on their own. A little radical, eh? Now, this was, you know, in the 70s, and they let me be the instructor in charge of that class, which I loved. I got to give, not exactly lectures, but discussions of various topics. I had a lot of freedom, and I enjoyed that for one semester very much.

And then I thought that rather than get research credit for a thesis or thesis credit, I said, 'I'd like to take a few courses in the education department.' Had to go to the department chair, and his response was, 'No way. You're not taking money from physics and giving it to the education department. Why do you have to take those courses? They're not worth anything.' I said, 'Well, maybe I'll learn something from it, maybe I won't. But what good is thesis credit? It's just a placeholder. It's not anything else, really. You do research, yes, but you do research whether you get thesis credit or not.' And I said, 'I'd like to learn something about teaching.' So finally they agreed to that.

And I took three courses in education at the undergraduate level. Two out of the three were methods classes in science and math. It was okay. I mean, I got to write a few lesson plans, but not very exciting. But the one class that was extremely useful was educational psychology, which I went into schools and I observed and I learned about educational psychology. You know, that is a field of scholarship. And I learned that, for example, most teachers do not use their time equally among students. And you can see, you can time who gets attention, who doesn't. And most teachers don't really know how to teach that well. They don't wait long enough for students to respond, and there are certain favorites in the class that they go to if they want to move the class along and get answers. So I learned that a good thing to do in a class is to walk around the class to see everybody and to call on everybody. And I've maintained that throughout my teaching career. So that class was extremely useful.

And after that, an ad in The Providence Journal appeared, which basically was an ad from Providence College seeking instructors for their required science course. So I applied for that after discussing it with my advisor. We agreed that this would probably add six months to my stay at Brown, but now I got to teach my own course, two sections of it, every semester.

So you can see that this business of becoming a teacher was actually, I went beyond the usual. And so when I left Brown and left Providence College, I had several years of experience already teaching my own classes. And then taking the educational courses including the psychology, and had observed in schools. All that was for the good. And I used it actually."

McDonald: "And I definitely saw it in all the classes that you taught."

Feller: "Well, thank you, Lisa. So you can see there was some aspects of it being deliberate."

McDonald: "Did your experience with the education courses shape the type of school that you wanted to work at when you started applying for jobs?"

Feller: "I would say, not necessarily because of the education courses, though I'm sure that had a role, I'm positive it did. I definitely wanted to go to a place where teaching came first. So when I applied at the schools in my year, I applied to 30 undergraduate schools. Now I did not know at that time, Lisa, that I was going to be active in research. I hadn't really thought about it. But now I've come to embrace it in a way I never would have imagined.

I would say research is part of teaching, actually. Fully part of it. And I've made that argument ever since. That I believe with my heart, that there's no such thing as research and teaching. Research is a subset of teaching. An important one, actually. It's the doing of science."

(music)

SECTION 2

McDonald: "A lot of the research at Coe does focus on glasses, glass materials. How did you go down the pathway to becoming interested in glass?"

Feller: "Oh, I have been interested in glass for a long time now. My first exposure to glass was, in terms of research, was 1973. Before that I had dabbled, I used that word before, in college. I studied phototropism on plants, which is the bending of plants toward light, which turned into an interesting little project, but kind of dabbling. And the way physics works is, you're admitted to a graduate school and everybody took classes the first year, typically three a semester. As physics graduates, we took a lot of courses for three or four years, I think, was four years I took courses. At the end of the first year, though, a memo comes out from the department chair, the one I interacted with, basically saying, 'As a graduate student, it's your responsibility to find placement in a group.' You don't go to physics graduate school, at least in those days, and join a group. You have to get yourself matched. So what you do is you find out who has money basically, and several people had positions, you get a list, and I made appointments, and I went around. Eventually I found my way to Phil Bray, a world expert in NMR. But what also impressed me there was the group. So he had a group at that time of about six to seven graduate students. I felt comfortable with it, I talked to the graduate students, I talked to Phil. He insisted that we call him Phil, which I liked also, by the way. And I joined the group. So that's how I got interested in glass, by the way, joining an NMR group on glass. I never made a glass, at that point I'd never seen a glass made in the laboratory."

McDonald: "Among all the glasses, do you have a favorite type of glass system that you like to study?"

Feller: "The borates are my favorite, just because I've done the most work on them. And I mentioned that my advisor was the first to do NMR on glass. Well, he did it first on borates, and in particular, B_2O_3 glass, he was the first to see the response and so on. I got involved with boron-10 NMR. So my first big project was to derive some theory for the isotope boron-10. The NMR response was not known at that time. And so we applied quantum mechanical calculations to determine the shape of the response of boron-10's NMR. And that became my first paper, which was submitted I think in '76, came out I think '77."

McDonald: "So you've mentioned NMR, but what is NMR? What does it stand for? What was it originally developed for, if not glasses?"

Feller: “NMR stands for nuclear magnetic resonance. It was not developed for glasses. So it was discovered from the period 1920 to 1950 or so, that nuclei, that many of them are magnets. And when you place a magnet in an external magnetic field, there’s an energy of interaction. We know this because the magnet tries to align itself, so it tries to minimize its energy. And if you try to take it out of alignment it, it takes energy. You have to put energy into the system to twist it away, okay? Now in classical physics, you can basically twist it to any angle you wish, it takes a certain amount of energy. In quantum mechanics, it depends on the spin of the nucleus, so you only get certain orientations that are possible. Which immediately gives rise to the possibility that you could change orientations, which are quantized, from one sort of [orientation to another], move the nucleus [spin] to the next allowed orientation.

Now if that was the whole story, that would be nuclear magnetic resonance, but it’d be useless because every nucleus would resonate at the same frequency and you’d get one frequency, called the delta function, and that’s it. You’d learn nothing. But there are interactions involving the nucleus that tell you about its bonding. So for example, a nucleus can see another nucleus because it will change the magnetic fields at both sites, at both nuclei. The field of the other nucleus will impact upon it. And that depends on what nucleus, and how far away it is. So that begins to tell you about the geometry.

Then there’s a thing called the chemical shift, which is the interaction of the electrons orbiting around the nucleus and the external field. Electrons try to reduce the external field to oppose it. That’s the law of induction, one of the basic laws of electrodynamics. And that tells you information about the bonding. The more effective the electrons are in shielding, the more changes in the magnetic field, and that can be detected. And then, if the nucleus is not a sphere, but an ellipsoid or a football, then that tells you about the bonding because that football-shaped nucleus can interact with the electrons as well. So all these other interactions can tell you what surrounds the nucleus and where these things are and the symmetry of what’s around it, where the other atoms, any of the atoms.

So that’s nuclear magnetic resonance, which was discovered simultaneously at Stanford and Harvard, and the Nobel Prize in Physics was given for it. Now, of course, NMR is used, it’s one of the major techniques in chemistry and biology and physics. In chemistry, it’s the gold standard technique. And in biology, there’s a technique called MRI, which is NMR on biological entities. People, animals, vegetables, fruits. You can do NMR on anything that has magnetic nuclei, which is a lot.”

McDonald: “Compared to other techniques, like other spectroscopy techniques, diffraction techniques, why is NMR so useful for studying glasses in particular?”

Feller: “So it uses the very nucleus of the atom as the probe, so that’s already a plus. The other spectroscopies are good, but let me compare it, for example, to Raman and FTIR, Fourier transform infrared spectroscopy. Those vibrational spectroscopies are inherently qualitative because, in order to understand the responses from different environments, we have to know how light interacts with a given environment. Like if you’re sending in infrared light. And that is not known in principle. So you can get qualitative comparison.

You can say this unit's there, this unit's there. But it's hard to say this is 60% of the glass, this is 40% of the glass. NMR is completely quantitative, so you don't have that problem. If you see a certain response that's twice the area under the curve as another, then it's twice as abundant. That's super useful.

Now neutron scattering and X-ray scattering is quantitative as well. But what you need in general is a big source. You either have to make neutrons, which is very expensive, or you want to use something like the Advanced Photon Source at Argonne. Now we're talking big, big bucks, and you've got to bid for time and the analysis is much more involved. But I would say that they complement each other, X-ray, neutron scattering and NMR. They look at different aspects. So for example, in neutron scattering, you shoot neutrons from a source at a sample, and you count how many bounce off at different angles. That is quantitative as well, and you can get information about bond lengths easily, coordination numbers pretty readily. X-rays can also be studied, but X-rays interact with the electrons, not the nucleus. So X-ray and neutron scattering are complementary to each other.

And we do both. We do it at Argonne, and we go to the Rutherford lab in England, where we do neutron scattering."

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BREAK

McDonald: "The Glass & Optical Materials Division of The American Ceramic Society focuses on the scientific research and development, application, and manufacture of all types of glass, including fiber optics, the encapsulation of nuclear and hazardous wastes in glasses, and the interaction of glass and ceramics in biosystems. Learn more about and join the Division at ceramics.org/gomd."

SECTION 3

McDonald: "With all of the research you do with the undergraduates, the international traveling, it would seem that the glass studies take up a lot of your time. And yet I know you have another hobby that you're able to fit in among all those things: numismatics. So how did you become interested in numismatics, and what is numismatics?"

Feller: "I'm very impressed, Lisa, that you pronounced it correctly."

McDonald: "I've learned from the best."

Steve Feller: "You're one in 100 who knows how to pronounce that word. Numismatics is the study of money, and since eight years old, I was a coin collector. Basically until high school, when most people, including myself, became interested in other parts of life. I put the collection aside. But after college, when I went into graduate school, I happened to stumble upon, literally, it was in a hotel in Boston, I was visiting Boston, and there was a large coin show, a couple hundred dealers. So I decided to go in just to take a look. And what struck me, a few things happened to renew my interest. One thing that happened was there was a dealer who had some money from one of the concentration camps in Nazi Germany. I never heard of money out of the concentration camps, and he had a set, and it was pristine, which had Moses pointing to the Ten Commandments on it. I said, 'How could this come from a concentration camp?' Turns out to be it had a propaganda purpose, it was from the show camp that they let the Red Cross into, at Theresienstadt, at that time Czechoslovakia, more precisely Bohemia. And I bought it for ten bucks, seven pieces. It happens to be the most common of the concentration camp money. Now, that piqued my interest. A week later I'm driving home from Brown, and I'm going down Hope Street into Pawtucket. There was a coin shop. I'd just been to the show and so on, so I go into the coin shop just see what he has. And he has a little book, the first book ever written on camp money and World War Two, end of the 20th century. The book was a dollar. I said, 'I'm buying that book.' And there was a description of the known camp money in, this is about 1975.

Part of my family had gone to one of the ghettos on my mother's side. My direct family was not impacted, but my mother had no first cousins as a result of this. They all got swept into the Holocaust. My grandmother came over in 1907 with my great aunt and they were the only two to get out.

I found that that ghetto at Łódź, in the second largest city in Poland, had an extensive issue of money, and I began to study it. I was the first to really study it. And I began to write about it. And I discovered that there's probably 500 different kinds of money from the one ghetto. And I'm still learning about other forms, and I write extensively about it.

And I have two daughters, Heidi and Rachel. Heidi did glass research with me. And on the other side is my daughter Rachel, who studied the numismatic side of things. And we wrote a book on camp money, it's now the standard book in that area. And I have involved Coe College students in this, several of them. One of them went with me, for example, to the Isle of Man, which is in the Irish Sea, because they had ten British civilian internment camps that had money.

But glass is the, to go full circle, glass is the main professional interest. And it's been a very good ride, it's been very good for undergraduate students at Coe College and for me. And now we have Mario Affatigato, Ugur Akgun, Firdevs Duru, who does a little bit of dabbling in glass, and Caio Bragatto, who is my replacement."

McDonald: "So, of course, I've got to ask, with all your interest in glass, how did you come to be involved with The American Ceramic Society?"

Feller: "I remember that, actually. My first meeting of The American Ceramic Society was I think '86, although you might have to do a little homework to find that out. It was the meeting in New Orleans, at the Hotel Monteleone, the same hotel ironically that was going to be the Glass & Optical Materials Division site this past summer. I had been back in '95 I think it was, as well. Sorry, there was a meeting in '86 and '95, and then this would have been the next one. So I went down there to present our early results on modeling density in glass in terms of atomic structure. And I was there with a student, maybe two at that time, and we gave a few presentations. I met Norbert Kreidl, sort of the grandfather of glass, and I learned a lot at that meeting, actually, and it was fun to be in New Orleans and I was bound and determined to continue. I joined The American Ceramic Society, maybe '85 or '86, because now I'm over 35 years. In '95, I brought about 15 students with me, and we helped run the meeting. The Ceramic Society hired our students to be pages or sit in meetings to make sure everything went well. And you know, since that time, we have brought over 1,000 students to meetings."

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CONCLUSION

McDonald: "While focusing on a topic is important when pursuing a Ph.D., giving yourself the freedom to explore other interests as well can lead to a well-rounded and fulfilling career."

I'm Lisa McDonald, and this is Ceramic Tech Chat."

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"Visit our website at ceramics.org for this episode's show notes and to learn more about the glass research program at Coe College. Ceramic Tech Chat is produced by Lisa McDonald and copyrighted by The American Ceramic Society.

Until next time, I'm Lisa McDonald, and thank you for joining us."