AIME

Founded 1871

AMERICAN INSTITUTE OF MINING, METALLURGICAL, AND PETROLEUM ENGINEERS

ORAL HISTORY PROGRAM

Donald Sadoway: Pursuing Service with a Passion to Change the World

2022

PREFACE

The following oral history is the result of a recorded interview with Donald Sadoway conducted by Antoine Allanore and Hojong Kim on February 27th, 2020. This interview is part of the AIME and Its Member Societies: AIST, SME, SPE, and TMS Oral History Project.

ABSTRACT

Donald Sadoway, a professor of materials chemistry at the Massachusetts Institute of Technology, has had an impressive career stemming from the influence of inspiring professors and his Ukrainian grandmother, who installed in him that to serve is a noble act. Pursuing service with a passion to change the world, Sadoway discovered engineering and has made valued contributions to the field of metallurgy. Sadoway emphasizes the importance of an idea, and it was his idea which led to the genesis of molten oxide electrolysis on his search for an inert anode. This discovery led Sadoway to a TED Talk, Time 100, and Colbert Report. Among research, Sadoway is also a passionate professor and has transformed his chemistry classroom into a link between the science, arts, and ethics. A TMS member since 1979, Sadoway notes the critical value societies offer for young professionals to present themselves and create a personal representation of their idea.

Readers are asked to bear in mind that they are reading a transcript of the spoken word, rather than written prose. The following transcript has been reviewed, edited, and approved by the narrator.

TABLE OF CONTENTS

00:47 En Route to a PhD and Migrating Into Engineering – The Cusp Between Science and Application

Allanore:

Today is February 27th, 2020. This is an interview of Donald Sadoway, who is Professor of Materials Chemistry at the Massachusetts Institute of Technology, in the Department of Material Science and Engineering. The interviewers are Hojong Kim and myself, Antoine Allanore.

Kim:

Donald, would you tell us about where you grew up?

Sadoway:

Yes, I was born in Toronto. At the age of three, my parents moved to Oshawa; it's a town about 35 miles east of Toronto. That's where I grew up all the way through high school, and then returned to Toronto where I attended the University of Toronto.

Kim:

So next question is, who or what influenced you to become an engineer?

Sadoway:

Well, that's an interesting question, because it's quite by accident. Actually, I was really interested in teaching. So when I went to the University of Toronto, I went with the intention of getting a bachelor's degree and maybe returning to Oshawa to teach high school, something in the sciences. But once I got to the University of Toronto, when I saw the professors, I said, "I like that." So, of course, to become a professor, you needed a PhD, and to get a PhD, you had to do research. So I was required to do research.

Then en route to getting the PhD and doing research, that had me migrate over into engineering. Why it was engineering, because I didn't really understand what engineering was— I enjoyed science. The University of Toronto, was very— it really worked for me that they called the school of engineering, which they called the Faculty, they called it the Faculty of Applied Science and Engineering. I don’t think I would’ve chosen engineering. I would have chosen science, which would have been a mistake for me.

Applied science was ideal because it captured the notion of “science applied to what,” and I didn't realize these words yet. I've since coined the phrase "science in service of society." So applied science is at the cusp between science and application, which later I learned is what engineering is. But anyways, that's a long answer to your question.

03:18 Inspired and Mesmerized – Following in the Footsteps of My Extraordinary Professors

Kim:

That's a great answer, actually. Did any of your professors mentor you in any particular way?

Sadoway:

Yeah, absolutely. I wouldn't be here if it weren't for a few key people along the way. The main one was

Professor Spiro Flengas. He was at the University of Toronto. He came from Greece and he did his PhD after the war, in London, King's College. For three years he said that He was in a tunnel underneath the Thames, and he says, "The river was dripping on the back of my neck for three years." Then he came to Canada and he worked at the equivalent of the Bureau of Mines in Ottawa. Then he hired on at the University of Toronto.

I met him in my third year. The interesting thing is that I didn't choose the topic. I chose the person. It's said in some sectors of venture capital, "You don't bet on the technology, you bet on the team." I was doing the same thing; I didn't realize it at the time. Of all of the faculty that were at the University of Toronto, in materials science at the time, he struck me as the most interesting person.

He came from Greece; he was European. He had a British education and he happened to work in high temperature electrochemistry. If he'd been a ceramist, I would have followed in his footsteps and become a ceramist, but I'm really glad that he was a high temperature electrochemist. It wasn't just what I learned from him in terms of the technical, but the way he carried himself, the way he conducted himself, that had a powerful influence. When I finished my PhD, I won a NATO fellowship, and it allowed me to go anywhere in NATO.

I chose to come to MIT because I had been reading the four books, the paperback Wolf Series. They were written by MIT faculty, and those were fantastic books and I said, "I want to go there." So Flengas said, "Well, so you're going to work for [John F.] Elliot?" And I said, "No, I had met Szekely". [Julian] Szekely had come; He was Hungarian, he'd fled Hungary in 1956 and got his PhD again, in London. He was a chemical engineer formally. Then he came to Canada and he worked with Nick Themelis at a chemical company in Montreal. Then he got a job at State University in New York, Buffalo. He was in Buffalo, and at that time Buffalo had a very strong industrial base, including a plant, Bethlehem Steel.

So he linked up with the steel company and started doing things. At one point while I was a graduate student, he came to Toronto and he gave a lecture. And again, I was just totally, totally stunned. His presence in the room, and he was wild. When I told Flengas that, "No, actually I'm going to work with Szekely." And he says to me, "They say he's mad. You know, he's mad." He called him Julius, instead of Julian. I said, "No, it's Julian." Anyways, he cautioned me. I said, "No, I'm going to ignore this." When I was a postdoc with Julian, for a little bit less than a year, at that time he organized a conference of people from the steel industry.

I was the postdoc so I did all of the legwork, of course. So I met all these people and the stuff that we talked about it was ... Today we don't think about stuff like this, but in 1977/78 to have a professor being interviewed by 33 magazines, business things and technical things, the professors, they were professors, but Julian was already out there doing this. I looked at that and said, "I can do that if I grant myself permission." So, most definitely there were key people.

Kim:

That's [a] really exciting experience and then you had the great opportunity to work with them, right?

Sadoway:

Yeah.

08:43 A Rigorous Engineering Science Program and An Influential Classmate

Kim:

My next question is, did you have any classmates that influenced your studies?

Sadoway:

Yes, I did. When I got to Toronto as a first-year student, I really didn't know how to properly study. Things came easy to me. I was top of my class in high school, and I studied at some level. But when I got to Toronto, I was in engineering science, which is the honors engineering program; it was very demanding. In fact, on the first day, I remember there was a gathering of the engineering science students, because we actually chose the department major as an incoming freshman.

There was no general first year. So I chose engineering science, and there [were] 181 majors. We met in the basement of the Royal Ontario Museum. The director of the program was Professor Donald Ivey, who he and Patterson [Hume] jointly they put out the video series, Physics Secondaries Science Project, which the terms of this were set forth by Jerrold Zacharias out of MIT.

But Ivey and Patterson did these videos and they taught Newtonian mechanics and electricity and magnetism in these videos. So this is now Donald Ivey, who I've seen in video, and he comes out and he welcomes us. He says, "Look to the man on your left and the man on your right." I thought he was going to say, "One of you won't make it to the second year." He says, "One of you will make it to second year."

Two out of three people dropped out of that program, that's how severe it was. Most of them went just to the regular engineering. There were 60 of us on the first day of the second year. In fact, the EngSci [Engineering Science] dropout was an institution of itself. There were more dropouts than there were people in the major.

So there was EngSci dropout hockey team, EngSci dropout baseball team, everything. I was struggling and I met a classmate, Frank [Palmay], I know him to this day. He was also a child of Hungarian immigrants. One thing that I did learn, from my strict Victorian education in Oshawa, was how to write. Frank was brilliant. In fact, he was first in the class as it turns out, but I didn't know it at the time. He was puzzled by the lab notebooks that he was not getting the top grades in the lab notebook in the physics lab.

He asked the TA, then we called them demonstrators, he asked the demonstrator, "What's wrong with this?" And he points to me and he says, "You should go talk to him. He really knows how to write." So I met Frank because he wanted to see how I was writing my lab reports and we became good friends. Then we became part of a study group because I didn't understand the concepts. I did everything by myself through high school, but now we had a study group, and so that was really influential for me.

12:35 To Serve Is a Noble Act – My Ukrainian Family History and Grandmother's Powerful Influence

Kim:

That's great. So this question can be a little bit redundant because you already described some of your experience, but did you have any influences or mentors?

Sadoway:

Did I have influences from mentors?

Kim:

Or mentors. Influences or mentors?

Sadoway:

Yeah. Well, I mean, this goes beyond. I'll be a little bit personal here. I think what drives me, it was my family. In particular, my grandmother, my mother's mother. The background on them, both sides of my family are Ukrainian. My father's side, they came to Canada before World War I. Western Ukraine was part of the Austro-Hungarian Empire. So they came to Canada as Austrians, Austrian nationals. ~~There was no ...~~ Ukraine was not recognized as a national entity, because it was partitioned between the Russian Empire and the Austro-Hungarian Empire. So World War I breaks out and they are on Austrian passports. So they were designated enemy aliens. There was internment camps, and my father's father, whenever he left the house, he had to wear a big letter A for alien and so on.

On my mother's side, they came right after World War I. Western Ukraine had been— They dismembered the Austro-Hungarian Empire and Western Ukraine was glommed onto the newly created Polish Republic. Well, the xenophobia was strong so if you weren't Polish, you didn't want to stay. So they came to Canada. My mother's mother was born in 1892. She was completely illiterate. At the age of nine, she was already working as a servant girl in the manor of a Polish landlord, but that woman had such a sense of community duty.

She was active in social organizations and active in the church in sort of a ladies' auxiliary, which was always involved in service. She was a very powerful influence on me, so I sort of appropriated that. The notion that you are part of a larger community and that to serve is a noble act. So then if you think about service as a noble act, and you think about passion for applied science, then it becomes science in service to society. I think that's the genesis of it. It's not because I want to fight for climate change mitigation or something like that. It's very simple.

Kim:

I'm very glad [to learn] where that quote comes from. From your personal experience in your childhood.

Sadoway:

Yeah, absolutely.

15:58 Genesis of Molten Oxide Electrolysis – Contributions to Metallurgy

Allanore:

So we're going to switch ahead in time. We were curious about what the most important contributions that you have brought to the field of metallurgy? Maybe as a background, you worked in the steel industry for a little bit. Your advisor at MIT was someone from the iron and steel industry; you said it before. Then your advisor in Toronto was in chemical metallurgy, molten salt, and some electrochemistry. So, you really cover two of the most important metals along your career. Can you share with us some of the contributions you've made to either of these metals and this field?

Sadoway:

In the area of the aluminum, there was work on melt speciation. We did some Raman work and Raman work in-situ. We had electrolysis cells with transparent windows so that we could do Raman [spectroscopy] while we were doing electro-deposition. There was some nice observations there.

Then of course in the eighties, there was a big push for inert anodes, and the inert anode was really formative. I think I have something that's a very nice inert anode, but it was never deployed because things moved on, but it served as the basis for our work later when you came on board and then pushed it over the finish line with the molten oxide electrolysis. But that was an important stepping stone. The whole enterprise with aluminum was really good because it started to focus me on applied electrochemistry, high-temperature electrochemistry. There was also a lot of work on the magnesium as well. Similarly, the magnesium didn't need the inert anode because they were able to use carbon. But still, there is very interesting work in fluid dynamics and so on because in magnesium, the metal and the gas go up. In aluminum, the metal goes down and the gas goes up.

Then, it was during the course of the search for the inert anode for aluminum that I stumbled upon the MOE. Because the molten oxide electrolysis, it came about because I was thinking about changing electrolyte composition. I remembered there was a meeting once at MIT, because we had some grant money from the Department of Energy, and they had asked Warren [Hoppin], who was a high-ranking researcher at Alcoa, to act as an adjudicator. He visited me at MIT and I was working with John Haggerty and a few other people. I was thinking about, at one point, for an inert anode to use something like a very conductive oxide, something like lanthanum chromite, but lanthanum chromite would be sparingly soluble in the electrolytes. So I said, "Well, maybe we could seed the bath with a lanthanum compound and thereby prevent further dissolution."

I threw this idea out and [Hoppin], practically lunges out of his chair and he says, "You mean you're proposing to change the composition of the bath?" And I thought, "Yeah." He looked at me as though I just committed some vulgar act in public and I realized that their problem was so constrained. They wanted to just pull out the one carbon element, the anode and replace it with some magical material and touch nothing else. I was already thinking about, well if you want to optimize the anode, you make other adjustments as well. Then I freed my mind and I started thinking, "Well, the whole thing is stupid. You have an oxide feedstock, and it's only sparingly soluble in cryolite. Homage to haul any rule, but maybe there's something even better."

I started thinking, like dissolves like. I was already teaching the freshman chemistry and I said, "Well if you have an oxide feed, why don't you have an oxide solvent?" Then I started spinning in my brain, the idea of an oxide solvent for an oxide feed, where a conducting oxide could be the anode, but it could also be the feedstock. Then I conceived an iron oxide magnetite, which at those temperatures would be an electronic conductor and it would be dissolving desirably. It's not an inert anode. It is a consumable anode, but a carbon-free anode and the solvent is an oxide solvent and that was the genesis of the molten oxide electrolysis. I subsequently realized that it sounds like a great idea but the anode member is at sixteen hundred degrees at the splash line of the melt but in the upper parts, it's much lower temperature to the point where it's not conductive. But it got me thinking in the right direction. I guess I've wandered a lot on the answer to the question, but anyways, these are little places where there may be some contributions.

22:11 Posing the Right Question Leads to New Answers – The Most Important Thing Is The Idea

Allanore:

Along the lines of this creative work, innovative work, and difficult work in the field, can you share any of the situations or any of the technical challenges that really slowed you down in the path toward some of the great ideas and deployments that happened afterwards?

Sadoway:

It's time on task. You have to have the idea first and then you just surround yourself with bright young students, and if you have the resources, the financial resources, then financial resources buy you the physical resources. The most important thing is the idea and then it's the execution.

Allanore:

I like this version of your optimism if I may say. It's really interesting that you have this way of tackling important problems. Clearly, like you described for the inert anode, you're facing challenges and you flip it around to invent a new way of thinking about the problem. Defining the problem so that we can move on and continue to think about different ways of doing things.

Sadoway:

I've always said you have to pose the right question. So for example, the quest for the liquid metal battery, I never used the word battery. I want a giant, effective electricity storage device. If I'd said battery, then immediately I would be closing the horizon to something that's a right circular cylinder that fits inside the barrel of a flashlight and thinking how to make that thing big. Instead, I said, "I need a storage device."

I looked for inspiration to electrometallurgy. I looked at the aluminum smelter and said, here's something that's big. It traffics in huge amounts of electricity, and it turns dirt into metal for less than 50 cents a pound. If I can teach this thing how to not consume electricity, but to store it and give it back on demand, I know at the end I'm going to have something that's big and cheap. Everybody else starts with a battery that is in the telephone and tries to figure out how to make it the size of a football stadium. It's by posing the question correctly that you come to new answers, a brilliant answer to a bad question is not “science in service to society.”

25:11 Transition Within MIT to Becoming A Professor– First A Recitation Instructor

Allanore:

This brings me to another very important of your contributions to the field, which is in education and teaching. Something you have been recognized for, including an extraction and processing division and other type of awards. It sounds like you'll be able to come back to your origin or motivation, that is you wanting to be a teacher. And clearly you are excelling into that. How did this come back into your life? How did teaching come back into your contribution to the field? Can you describe to us your transition within MIT to become a professor and how your classes and the field has been transformed by your time teaching?

Sadoway:

When I was hired on, I was a post-doc with Julian and then he urged me to apply for the faculty position. I wouldn't have applied, but he said he knew Kent Bowen, who was the chairman chairing the search committee. They were actually looking for a physical metallurgist. Julian came to me one day and he says," You should put your name in." I said, " Oh no." He says, " No, don't edit yourself out, let them judge." So I put my name in, I interviewed and to my pleasant surprise, I was offered the position. As a faculty member at MIT, everybody must teach in addition to research and in addition to some service to the department, you're going to serve on committees and so on.

All right, so I've got to teach. I was assigned to my first class, was the big first-year chemistry class. I was a recitation instructor. So three times a week, Professor [August F.] Witt did the big lectures, and then twice a week, I had one hour with about 25 students, basically Q&A format, answering their questions, going over material and so on. That was straightforward and just Q&A, but I watched Professor Witt. He had a big class; we had filled an auditorium of over 450 students. I envied that. I liked the big stage because it's about impact. Why teach 30, if you could be teaching 530? So, that was the Fall. Then in the Spring, there was a core class in the graduate curriculum, Kinetic Processes and Materials.

The department head, Walter Owen, had plans. The person who was teaching it at the time was struggling and there was sort of rumors that this person was probably not going to make tenure. So Walter was already grooming me to take that over. He asked me to take the recitation sections in that class for one year, and then the next year I was made the lecturer in charge. I don't like to make a fool of myself. So if you're going to do a job, do it well. I worked on that and the students found it very difficult because they take thermodynamics in their first semester. Then they take kinetics in their second semester. It seemed to me that everybody had some comfort level with thermodynamics.
Now, granted, they were taken beyond that, but at least they had a point of departure. But my sense was that almost everybody felt unmoored when it came to kinetics. That was a prime territory for me because I could take people that felt unmoored and help them get some grounding and that was fun, but it was technical. It was a graduate subject and so on.

29:40 Taking Over the Major Lectures in First-Year Chemistry – A Series of Epiphanies

Sadoway:

But then when I was able to take over the major lecturing in the first-year chemistry class, with the four, five-hundred first year students, that's where I was really able to grow because there were little things that happened. There was a series of epiphanies, each one of them may be small, but the integral of them all is big.

For example, the little things. So I had been watching Professor Witt, his name was Gus Witt, August Witt, also a European immigrant. He was Austrian and then ended up at MIT. He'd come to work with Godan in hydrometallurgy and worked with Godan for several years. Then the funding evaporated, and he ended up with Harry Gatos and migrated over to silicon and made his career in semiconductors and so on. But, if I told you, he is Austrian, you figured he is going to be stiff and formal and so on. The man was very warm, and I would go to all of the lectures because I was preparing for the recitation sections. And I would sit almost at the very back of the auditorium because I wanted to get a sense of what it was like to be a student in that auditorium and feel what the students are feeling at the back.

So I'm at the back and I'm watching this man teach and he had this conversational way of rolling out the subject matter and there was no fancy audio visual, nothing. There was a one man with a piece of chalk. That's all it was. I'm sitting there and I feel as though this man is having a one-to-one conversation with 450 people. ~~it was~~ That was for me an epiphany, how to present the material, respect your people. I didn't feel like he was the professor and I'm just this little kid. I felt as though we were peers, he was talking to me as a peer. He expects that I bring something to the class, like some native intelligence and some background.

He's going to just take me to the next step, next level. That was big and he lectured—the lecture periods are 50 minutes. They started five minutes after the hour. They go until five minutes before the hour and then in the intervening 10 minutes, you get to empty the auditorium and bring the next carload in. So, he would lecture for 45 minutes on topic and then the last five minutes was some kind of an application, you could call it chemistry in the world around us. He would try to find something related to the subject matter. That was very interesting. Then I made sure that I would find interesting things. I remember I was at home in the summer before I was going to take the major lectures and I was going through a lecture on hydrogen bonding. I said to my wife, "I think on the day that I give this lecture, I'm going to play some music. I'm going to play Handel's Water Music, a passage from Handel's Water Music. And she says to me, "Why only on that day." Well, I said, " I don't know. "

I guess I can do anything I want as long as it's in good taste. So at that moment, I resolved that I was going to every lecture, the five minutes on the hour to five minutes after the hour, while the students are entering the lecture hall, I'm playing music but the music must be thematically linked to the content of the lecture. Now I have to devise the linkages and it could be classical music, could be world music, it could be rock and roll, popular, whatever. Then the students would start to guess, what is the connection? There was a lecture on polymers and I had Aretha Franklin's "Chain of Fools." The students loved it because it's linking science to the arts and so on. And then I realized I could bring in literature.

34:58 Linking Science to the Arts – Creating A Chemistry Centered Class

Sadoway:

I was teaching the Bohr model of the atom. So I showed them in the five minutes, I referred to the play by Michael Frayn Copenhagen. In which Werner Heisenberg goes to see Niels Bohr during World War II and Denmark is occupied by Germany. Bohr is essentially captive in Denmark and Heisenberg is the director of the Nazi equivalent of the Manhattan Project. It's his duty to develop nuclear weapons for Hitler. And he goes to see his old mentor, that's a fact. They have dinner, that's a fact. They go for a walk, that's a fact, and they never speak to each other after that night. So Frayn writes the novel, the play about what did they talk about? Did Heisenberg come to ask Bohr, "What are the allies doing?"

Or did he come to say, "Should I not do this?" Or "Look, I'm faking it because if I don't do anything, they will replace me with somebody who will. So I'm going to try to fumble the ball, so to speak." So this is all this speculation, but Heisenberg is all about the uncertainty principle, which is a mistranslation. The German is really the indeterminacy principle. The reason it's uncertain, it's not because we don't know, it's that we can't measure with greater certainty. There's always the observer, so there's three people in this play. There's Bohr, there's Heisenberg, and Bohr's wife and they're always in a circle; one circling the other like the Bohr model of the atom. Then the wife, Margaret, is always the observer. So, I bring all this into the class and then the kids go and read it and the connection to literature.

When we talk about polymers, I showed them the film clip from the iconic movie, The Graduate. The scene by the pool where one of the older friends of the family says to Benjamin, Dustin Hoffman's character, "I have just one word, plastics." All of this stuff, bringing it all in. When we talk about oxygen and so on, I showed the scene from Moulin Rouge: "love is like oxygen," showing all of this stuff. So you can bring all of this in, there are no boundaries, the boundaries are porous, so it's no longer a chemistry class. It's a chemistry centered class.

37:59 Bringing Ethics into the Classroom – The Story of Rosalind Franklin

Sadoway:

By the way, the ethics are there too. When I teach them DNA, I migrate over to the story of Rosalind Franklin, of how she did the first x-ray of DNA because they've already seen Lowie backscatter patterns earlier in the subject curriculum. Now, we're going to look at DNA. I showed them the image from the paper where on the basis of the spot pattern, this is an indication that it's a double helix and she has this data. And her supervisor, Morris Wilkins hosts [Francis] Crick, who shows up and Wilkins goes with Crick to Franklin's lab, and she isn't present, and he shows [James] Watson the x-ray pattern. Immediately he recognizes it's a double helix because Linus Pauling had already published that it was a triple helix. Not only on the basis of that pattern, do you know it's a double helix, you know that the heavy phosphates are out, not in. They're not lying inside the double helix. They're on the outside and so on. So he gets on the train, goes back to Cambridge and then they publish.

I show them the paper, 1953, with the image and so on. And the lies in the paper where they say, "this is based on just our own work and we thank the others for helpful discussions" and so on. Then Rosalind Franklin's papers next and I say, "If this happened today, that paper would have been refuted and what happens is that Rosalind Franklin is not mentioned in the paper. Her name is in the acknowledgements, but nothing about the X-ray pattern." Then I fast forward to the Nobel Prize in 1962 and there's Watson, Crick, and Wilkins, and there's no Rosalind Franklin. I say "this is unethical" and I point to the whole class. And I say, "I don't ever want to learn that anybody in this room perpetrates what was perpetrated on her." By the way, she left the university that she was working at, was required to sign on a document saying that she would stop all work in DNA and went to another college and did some more fantastic work on tobacco virus and all kinds of other stuff. She got cancer, died at age 38. It's just a terrible story of abuse and exploitation and it's right at the heart of life science.

You don't put that in an ethics class, you put it right there in the chemistry class, so that everybody knows. You should see the looks on the students as they're leaving the class after that lecture. They're really angry. They're shocked and angry. I say, "What is this?" And as I said, "This was London, not during the time of Charles Dickens. This was London after World War II in 1952, 1953. By the way, because she was a woman, she was not allowed to go to the common room. So at four o'clock, everybody gathers in the common room over a cup of tea, and they discuss things. As a woman, she wasn't allowed to go there. Then you just see the women in the class, getting angrier and angrier.

42:11 My First TMS Meeting in New Orleans, 1979

Kim:

When did you first hear about TMS (The Minerals, Metals & Materials Society) and AIST (the Association for Iron & Steel Technology) and/or the membership society?

Sadoway:

So TMS was there right from the beginning. If I go back to, certainly when I got to MIT, my mentor, Julian Szekely, was very active in TMS. I remember the very first TMS meeting was in the winter of 1979, because I had hired on as a faculty member July 1st, 1978. So this was probably February, March of 1979. It was in New Orleans and it was at the week of Mardi Gras and it was a historical event. The police went on strike. The police went on strike the weekend before Mardi Gras.

So I get to New Orleans. This is 1979, it was rough. And Julian was a little bit miserly. So he didn't stay in the hotel, which is right on the main street. It was a Sheraton or a Hilton, something like that. He stayed in this little, second tier hotel beyond the canal, and it's about a half a mile away. You walk past a bunch of warehouses and stuff like this.

So I said, "Well if he's staying there, I'll stay there too." So it was daunting. But anyways, I survived. I'm still alive, but that was my first TMS meeting as a junior faculty member. I've been a member of TMS all the time. Back in those days, the AIME (American Institute of Mining, Metallurgical, and Petroleum Engineers)— Someone can correct me if I'm wrong, but my recollection is, because I remember a lot of steel people being at the meeting, so I don't think that the TMS had cleaved from the big steel contingent.

So anyways, I knew people from back in Canada because I spent one summer working at Dofasco. There were people from Dofasco attending the meeting, and I was running into them in the dining areas and so on. So it was a big meeting, but then, I've been a member ever since. Certainly, by the time you came in 2010, but I think a little bit before that, as I got more and more involved in the molten oxide electrolysis, then I hooked onto AIST. At this point I've got membership in both.

45:32 Professional Society – A Stage for Personal Representation of the Idea

Kim:

That's great. So how has the membership benefited you in your career?

Sadoway:

Well, membership is critical in the ability to have a conference venue where you can present your freshest results. Certainly, you can argue today, well you have internet and so on, but I'm still not convinced that internet is a substitution for personal presence. Certainly, when you're young, and you're in the pre-tenure years, the ability to stand up in front of an audience of your peers who are already curated, because they have also chosen to join TMS and they've also chosen to go to this session, which is in your area. You get on the stage and in 20 minutes, you're able to present yourself, your ideas, and that has a profound impact on people's assessment of you. Because as I said earlier in the interview, I chose my mentor. I chose the person, not the idea. I think that the personal representation of the idea is as important as the idea.

So you can have a brilliant idea, but if the person on the stage is not persuasive—And I don't mean that in a slick, deceptive way, I mean that the person has the ability to convey, with clarity and with some enthusiasm, what he or she is doing—then I think it weakens their chances for success, promotion, recognition and so on. So I think the society is a fantastic venue. I can't imagine how you could build a career without it. You'd have to go one by one to visit the key people at their home university, and hope that they're in town the day that you give your seminar and that they hear you and so on and so forth. Whereas you're here, and plus the chance interactions afterwards. So the professional society is absolutely critical in career-building for young people. And for senior people, it's the super-highway for conveying information.

Plus, the other thing is, at some point the roles are reversed. So, I'm coming to a meeting like this. For example, one of the people speaking yesterday was Uday Pal, and he mentioned that he attributed his coming to MIT to me. I remember I was at a professional society meeting, and we were looking for a young hire. You can read the resumes and all the resumes, just sparkle. Everybody's fantastic on paper, but you have to see the person. What better way to see the person is to say, circle, circle, circle, go to these sessions and watch the person present. You leave the room and you say, "That's a potential hire, let's invite that person to campus." Or you take a look and say, I mean, the person has an amazing resume. The letters of recommendation are very, very strong, but I saw the person and I don't know what the excitement is all about, but that person is going to wither. So again, the society is fantastic.

49:39 The Value Proposition of Science and Engineering – Solving the Tough Problems

Kim:

That's great. So to change the question in a little bit different directions, in your opinion, what do you think we can do to attract young people to the sciences or engineering?

Sadoway:

I think to attract young people to science and engineering, the value proposition is the one to take the passion and idealism of young people and say, "This is a problem that we need to solve. It's in your interest and it's in the interest to make the world a better place." Those kinds of things. That has appeal. So it's not about, "You really should study harder and be more proficient in mathematics, it's good for you." That's not a value proposition. But, you say, "If we had grid level storage at the price point of the electricity market, we could have carbon free electricity everywhere. Do you want to join that struggle? Hmm? Do you want a zero-emission vehicle that's cheaper than internal combustion? Well come on. What are you doing?" I mean, I have always said, "what are the tough problems and what are you doing about them?"

Kim:

That's great. That's great.

50:59 The Richest Period of My Career – The Search for the Inert Anode

Allanore:

Trying to wrap up all the conversations we had, ultimately you reflect back on your career, what would be the favorite part?

Sadoway:

Favorite part of my career? I think the period with the liquid metal battery. Because at that point, we had a big amount of funding, big group, and a lot of exciting— Everybody in the group was there because they had a higher sense of purpose. They wanted to change the world. They wanted to make molten oxide electrolysis work [and] scale. You joined the battle, the search for the inert anode, a practical inert anode. We had the big group, that Hojong was in, with the liquid metal battery.

Those were exciting times. I was teaching 3091, the big freshman chemistry class. I didn't say, "Well, now I have more money than the entire center for materials science and engineering. I don't need to teach". I taught in the Fall, the big first year chemistry class. Then the Spring, I taught the graduate class in electro-chemistry. I never stopped teaching. That was the richest mix.

52:45 "Paper In Nature Doesn't Change the World" – Starting a Company

Sadoway:

Then contemporaneously, along with Louis Ortiz and David Bradwell, we started the company. Which by the way, I did not want to do. I'm from Canada. I was prim, proper, nice professor, dutiful, teaching, research, committee work, some stuff in the professional societies. I didn't want this company. This company, I thought it was dirty. All this money, it was corrupting and so on.

I think it was Louis. Louis said to me, "Do you want to change the world? Do you want this technology to succeed? Then you have to push it. You can't just file patents. A paper in *Nature* doesn't change the world". I said, "Okay. Okay." So we started the company. Why? Because my students. My students taught me. If you listen to me, you can learn a lot by listening to other people. Anyway, so that was that period from about 2009 to 2013.

That was really exciting, because during that time there was a number of events that led to the breakthrough year 2012. Which was the invitation for the TED Talk, which came because somebody was reading my work on the liquid metal battery.

54:32 The Breakthrough Year, 2012 – The TED Talk

Sadoway:

There was a member of the board of directors of TED, who was writing a book. This was Peter Diamandis. He was writing the book called *Abundance*. Which actually would be relevant to TMS membership. They would enjoy the book. One of Peter's staff at Singularity University, which Peter had founded. Gregg Maryniak, read the draft chapter on energy. He told Peter, "Your stuff on batteries is incomplete. You need to call this guy at MIT". So Peter called me, we had several conversations. He's on the board of TED, so he says to Chris Anderson, "You should invite this guy to give a talk".

I get a call from Chris Anderson. He says, "I'd really like you to give a talk about your battery". I said, "Yeah, okay. Well, when do you want that?". This was in October of 2011. He says, "Well, the next one, in February, March of 2012". I said, "You know, why don't we push it a year. Because we'll have way more data, and stuff like that".

He says, "Oh no, I don't want to push it. I want to get it early". I said, "Well, I'm from Canada. I do what I'm asked". I said, "Well, okay". He says, "So tell me, what do you do at MIT? Do you teach as well?" I said, "Oh yeah". [He replied] "What do you teach?". I said, "I've got this big freshman chemistry class. 500 students". There was up to 550 at the time.

He said, "What kind of media do you use?". I said, "Media?". "Yeah. What AV, and stuff like that?". I said, "It's just me with chalk at a blackboard". He says, "Would you use a blackboard in your TED Talk?". I said, "I guess, why?". He says, "I've got all these hipsters. They're all over media, and computers, and so on. If you could show that you could still lecture with a chalk", and so that's how the TED.

Then from TED, there was the Time 100. Because I think there was a woman from Time in the audience. That led to the Time 100. Then that led to the invitation for the "Colbert Report." You can count on less than the fingers of one hand, I guess that should be fewer than the number of fingers on one hand, how many people of high temperature electrochemistry that would have gone on the "Colbert Report." Those were exciting times.

57:23 Don't Live Life Beige – Find Your Passion, Pursue It, and Aim High

Allanore:

Indeed. What an impressive career. If you had one piece of advice for the younger generation, people graduating with a Bachelor's?

Sadoway:

One piece of advice? I mean, it's the usual stuff. Find your passion. Follow your passion. Pursue it. Aim high. Don't edit yourself. Grant yourself permission. Ask bold questions. Don't live life beige.

Allanore:

Excellent. Well, thank-you very much for spending the time with us. It was a great pleasure. Thanks for your willingness to share all this history with the society.

Sadoway:

Thank you for your probing questions. It was fun. Thank you.

Allanore:

Thank you very much.