ORAL HISTORY PROGRAM

John Speer: Born for Metallurgy

2023

PREFACE

The following oral history is the result of a recorded interview with John Speer conducted by Kip Findley on September 29th, 2021. This interview is part of the AIME Oral History Program.

ABSTRACT

Growing up in the steel-centered community of Bethlehem, PA, John Speer was inspired to pursue metallurgical engineering at an early age. Speer attended Lehigh University and earned his PhD at Oxford University, where he gained valuable research skills and went on to make many contributions to the ferrous metallurgy field. After returning to the States, Speer began working at Bethlehem Steel in the Homer Research Labs and held technical and supervisory positions in the company. Speer applied his experience and understanding of the responsibility of leadership throughout his career and transition into academia at the Colorado School of Mines. Now director of the Advanced Steel Processing and Products Research Center at Mines, Speer devotes his role to his students and the success of the institute. Speer remarks on the importance of industry collaboration and student engagement, and he aims to facilitate these metrics of success in the classroom. As a past AIME President and National Academy of Engineering inductee, Speer supports student engagement with professional societies that will propel the evolution of materials engineers across universities and industry.

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00:00:00 Introduction

Findley:

Today is September 29th, 2021. This is an interview with Professor John Speer, who is director of the Advanced Steel Processing and Products Research Center and American Bureau of Shipping Endowed Chair for Metallurgical and Materials Engineering at the Colorado School of Mines. This interview is being conducted as part of the American Institute of Mining, Metallurgical, and Petroleum Engineers Oral History Projects. My name is Kip Findley, and I am sitting with Professor Speer at the Colorado School of Mines in Golden. Today we'll discuss his experience working in industry, in academia, his education, as well as his contributions to the ferrous metallurgy field.

00:00:48 Growing Up in a Steel-Centered Community – Pursuing Metallurgical Engineering

Findley:

John, you grew up in Bethlehem, Pennsylvania. Your father worked in Bethlehem Steel. How did that and the importance of the steel industry in the community affect your decision to pursue metallurgical engineering?

Speer:

Well, I don't know if I could put anything specific to that, although it must have had an influence because Bethlehem is a town that had a lot of people working for Bethlehem Steel. My father and grandfather [both] worked for the steel company, my grandfather actually in Lackawanna, New York, and my father was initially there. [Growing up, many of] my friend's parents also worked for Bethlehem Steel, and so there was a very steel-centric culture to the community. Bethlehem Steel affected a lot of things in town. At school, students would bring projects that were steel science-focused and things like that, so you had that exposure as a child. I think we all did.

Findley:

Did you know you wanted to be a metallurgical engineer when you entered Lehigh University?

Speer:

I didn't; I went through different phases. I think when I was in elementary school, [that] I wanted to be a meteorologist. I don't remember why. I think I went through a phase during junior high school or high school where I wanted to be a lawyer. I think I knew coming out of high school, though, that engineering was a good area for me to be studying. I made that decision early at Lehigh, though, that metallurgy was a good field for me.

00:02:46 Lehigh University and Tennis – An Outlet and Complement to My Studies

Findley:

You went to Lehigh not only for metallurgy but you also went for tennis. Can you talk a little bit about how your involvement in sports complemented what you were doing with your education at the time?

Speer:

Yeah, I guess I got recruited by the tennis coach at Lehigh, who I'd known for a long time, and [whom] I really liked, sort of a mentor of mine. It's not like I was a world-class athlete, but tennis had always been important, and I was pretty competitive. So, that's always been part of my life. Lehigh was in my hometown. Even in graduate school, I played varsity tennis. So, I actually played seven years of college tennis because I went to graduate school overseas, and they didn't have any eligibility restrictions for graduate students. So it's been part of my life. My friends were often people that I played on the tennis team with, and we traveled together.

So, I have some close relationships that I maintain to this day from tennis teams that I've played on, both as an undergraduate and a graduate student. You have to manage your time well, but it's a good outlet, I think, and I enjoyed it a lot.

Findley:

Yeah, it's useful to have those outlets.

Speer:

I think we have students here at Mines, graduate students who have been competitive athletes. Mark Taylor, actually, was one of the better tennis players in Colorado. He came here from Texas as a graduate student. Michelle Kent is kind of a really high-end runner in the program now. So, I think I understand, and I encourage students to still pursue those [activities] because they can still be successful as graduate students. Our administrator in the center, Karen Abt (now Coulson), is a professional soccer referee on the weekends. I think that makes her life busy, but she organizes things and gets things done. So, I encourage people to kind of pursue those other avenues.

Findley:

Yeah, they're important. I guess it's worth noting, too, that Michelle is also an alumni of Lehigh University.

Speer:

That's right; I didn't think about that.

Findley:

So, how did you ultimately choose to do metallurgical engineering?

Speer:

I guess I fell into it. I don't know if I could put my finger on that. When I was at Lehigh as a freshman, all of the freshmen took a class that exposed them every week to a tour of laboratory facilities and discussion about what the field meant. And, the metallurgy department did a really nice job with that, and it was one of the earlier [tours] that I went to, I think.

So, it just sort of felt right, and I made a decision without putting a lot of thought into it, and I didn't

actually ever really second guess that. As I tell students here, I probably could have been happy doing any number of things. But I was happy doing that, and it's worked out well.

00:06:22 My PhD Experience at Oxford – Learning Independence in a Research-focused Program

Findley:

Following that, you must have really liked it because you chose to pursue a PhD at Oxford, which is a pretty unique pathway for an undergraduate student to pursue graduate school. Can you tell us a little bit about what led you to make that decision; how that experience came about?

Speer:

When I was at Lehigh, I had the opportunity to support some research programs as an undergraduate—working with Professor Goldstein who was an expert in iron meteorites. I worked on polishing meteorites and assisting graduate students who were doing more in-depth analyses, one of whom was Al Romig, in fact, who I still interact with occasionally, and Dave Williams, who was recently Dean at Ohio State, of engineering. He and Professor Goldstein worked together in the transformations and microscopy areas, so I was exposed to that as an undergrad. It seemed interesting. And the people I was working with were graduate students, and I was doing well in school, and they were encouraging me to think about graduate school. So, I applied to Lehigh, and I also got into the Rhodes Scholar applicant pool, and that's how my interaction with Oxford started. And so, I was going to do one of those two things.

Ultimately, I decided to go to Oxford because, I guess, a lot of reasons. I mean, it was an interesting university to think about. I hadn't traveled much outside of the region of the country that I was brought up in. So, it was kind of interesting to think about that. I lived at home as an undergraduate student, and so that was a big change going overseas. Oxford obviously has a good reputation, so that was part of the decision as well.

Findley:

Sure, I appreciate that response. I guess I had a similar experience in deciding to go to graduate school. But for me, it was because I did undergraduate research with you and the steel center at the time, and I had the same kind of rationale for making a decision for attending graduate school.

You went to Oxford, you worked for Professor David Edmonds, and you've since maintained a pretty close relationship and some close collaboration with him, also. Can you tell us a little bit about that?

Speer:

The educational system is a little bit different there, very research-focused for graduate school, as are we, although our students also take a lot of classes. I think the Oxford [students] spend more time doing metallurgy and materials as undergraduates before they go into graduate school and so probably have a little bit more of an advanced background than I did or the US students do. So, I [did a very] research-focused degree there; it was probably a little bit different [than in the US].

I don't have all the coursework that our students, I would say, benefit from a lot...really learning important information from people that really know it well. So, when I needed to learn something that I didn't know as a graduate student, I kind of had to figure it out and learn it myself. So I didn't have as good a teacher in

that respect. But, you do learn the skill of trying to teach yourself. You're not [as] afraid of learning either. So, I think I was really well prepared for research having the undergraduate background and then a very research-focused [graduate] program. Working with David Edmonds, the advising relationship is maybe a little bit different in the UK because the student has a lot of independence.

And, again, I think that [Oxford's research environment] gives you that sense of independence, the ability to take on problems that you don't feel too comfortable with. I think that's a good skill to have in research because we're never quite sure where we're going or how we're going to get there. You're always kind of walking into the fog as a researcher. And so, I was comfortable with that feeling [of discomfort and ambiguity] pretty early on in my career. David had been working with the Ministry of Defence for a long time in the UK on steels. Then, he got a grant to work on uranium alloys for kinetic energy penetrators with some interactions in the US with the Picatinny [personnel].

I was the first student to work in that area in his program, but still working on phase transformations. And, with his background in steels, he talked about uranium steels, if you will. The ferrous phase transformations area was very relevant to what we were doing in uranium alloys. Then, later on, we started to work together because some of the projects that we were doing here [in Colorado] sort of evolved into areas that I knew David had worked on, bainite and silicon effects in steels with retained austenite. We developed some collaborations later on that way.

Findley:

That's fun. Did you have the opportunity to collaborate with other students there?

Speer:

I had friends who were other students. We probably didn't have the kind of student-student collaboration that we do within our research center, the Advanced Steel Processing Products Research Center at Mines. But, yes, students helped one another learn. One of my office mates, John Posthill, who was also in David Edmonds group, had been there a little longer than me, so showed me how to do [many] different things. And I stay in touch with John today a little bit. But each student was kind of independently responsible for their projects. I guess I would say the projects were not necessarily closely aligned in the case where what one student was doing was highly relevant to the work that another student was doing.

00:13:55 Returning to the States and to Bethlehem Homer Research Labs

Findley:

When you completed your PhD, you came back to the United States. What opportunities did you have coming back to the United States?

Speer:

Well, that's a good question. Being outside of the country, it wasn't like I was being actively recruited by all sorts of people in the US. I had some university people ask me if I was interested in academic positions. I came to a conference in Philadelphia; I think it was 1983. I met some people there. I did have a couple of job interviews. I did an internship at Bethlehem Steel between my senior year graduating and when I started graduate school, so I was familiar with the research program and was pretty comfortable there. And so, that was something that I always had a strong affinity for. And I ended up doing that. They

(Bethlehem Steel) were pretty enthusiastic about hiring me. Going back home was a good thing for me. That's sort of a natural step, I think. Bethlehem's Homer Research Labs was pretty well regarded.

I think our students working in the US with an industry-university collaboration have a lot more sorts of different experiences than many graduate students do. Where I was just working on my project, trying to get my degree, not really working extensively with people that might someday want to hire me.

Findley:

What position were you hired into at Bethlehem Steel?

Speer:

I think I was called a Research Engineer, and there were multiple levels of those in the company.

Findley:

So, working in Homer Research Labs, what was the research and development environment like at that time?

Speer:

It was good. Well, everything was new for me. So, I wouldn't have had anything to compare it with. But, they had just gone through a corporate downsizing, and I think for the folks who were there, [downsizing] probably affected morale a little bit, But I thought morale was pretty good. There were really a lot of very good people at Homer Labs, and we were working on interesting things. Everything I was learning about steel. I was working for Steve Hansen, who was a very energetic, knowledgeable person.

I learned a lot about steel in that group. Other good people who are doing a lot of good things today, we were working closely together [back then]. So, I think it was a pretty good environment. The company had been struggling for a few years. It was sort of early on in the transition where the steel industry was struggling in North America. So, I think projects were getting a little more short-term, a little bit more oriented to solving problems in the manufacturing locations. But, as a new PhD graduate, I was working on some things that were important but fairly fundamental. So, it was a little while before I started doing things that were more directly relevant to day-to-day plant operations or day-to-day customer needs.

00:17:55 Sheet Steel Product Development and Customer Support – Navy Shipbuilding Materials

Findley:

What sorts of applications were the projects you had?

Speer:

At first, I was working on plate steels. We worked on some fundamental microalloying effects. Then we applied those in the area of plate steels for towers and poles, actually. And we weren't necessarily developing new property combinations because the properties were specified by ASTM, but we were essentially trying to increase the mill productivity by doing thermomechanical processing at higher temperature. So, if you could finish the rolling process at higher temperature, it would take less time to roll

the plates, and the mill productivity for those products would be increased. That's the first area where I got involved working on some more direct product developments for customers with a more senior engineer, Halle Abrams.

If you know the Abrams Three-Circle method of metallography (grain size measurement), that was Halle, and he was a character. Then, the next thing I worked on was Navy shipbuilding grades. We developed HSLA-65, HSLA-80, and that was a new generation of shipbuilding materials. I took part of that over from John Paules, who had really done the early HSLA-80 development. And then, I handed it to Keith Taylor, who you also know, too, who developed some higher strength grades after I moved into sheet steel product development.

Findley:

Interesting. How much interaction did you have directly with customers during that time?

Speer:

I didn't have as much interaction directly with customers in my first few years. There were people with more experience and who were better at doing that probably than me. Then, when I moved into the sheet steel area, part of our responsibility was also customer technical support. And so, I ended up doing more and more of that. While I was in the plate product area, I was involved on some industry teams that we had [in place] to support either the shipbuilding industry or the machinery industry. And so, I was exposed to some more cross-functional activities in the company. [I was] getting to know people who did different things in manufacturing or marketing or selling or R&D. And so, it's sort of a process of learning.

Then, in the sheet steel area, we were doing direct customer support of problem-solving, direct operations support of problem-solving. And [also], longer-term customer support, which would be really trying to find out what their future needs were and how we could develop research programs that would put products in place to meet those future needs.

00:21:36 Facets of Leadership – More Than a Position of Authority

Findley:

Interesting. And you evolved into some leadership positions within the company. Can you tell us about those positions?

Speer:

I was a Research Supervisor for maybe my last eight years at Bethlehem. I had a group of researchers and technicians that I was responsible for. I had some training, I thought, that was very good. Bethlehem had some pretty good training programs, and so I found some of the management training was very insightful. Some things that were counterintuitive to me about leading people and leading people differently, depending on where they were in the career [in terms of] their experience and skills. Some people are better off being closely managed, like a new employee, and other people are better off [just] being encouraged and left to accomplish things. And, I had both kinds of people in my group, so that [training] was really helpful to me as we tried to accomplish what we were trying to do in the group.

Findley:

I guess there's some utility and understanding what your own personality is relative to the personality of the people that you're managing.

Speer:

Yes. I haven't really had a lot of direct supervisory responsibility since then. I haven't been a Department Head, for example. But, I think in our center, the things that we do together working with students, I [think] you're effectively leading and managing them. And so, I think that [supervisory] experience was really helpful to me.

[Also] I had some specific leadership training because we had some opportunity for that as well. I found [leadership training] also very insightful, [with] leadership not being the same as management. One of the ways to think about it is that, we're all leading or following all the time. Leadership isn't just about being in a position of authority and making decisions for a group. But, it's speaking up and providing input to someone else in authority when they really need that information, and it's risky. That's leadership, too. So, all of us are responsible for being leaders at the right time, at different times.

Findley:

It's an interesting perspective. And, I guess another facet of leadership that's interesting is the ability to listen at the right times as well.

Speer:

Yes, knowing when to lead and when to follow sometimes, not that I have always made the correct judgments.

00:24:54 From Academics to Industry – Hitting the Ground Running and Learning Through Experience

Findley:

Were there critical skills that you had to learn as you transitioned from the academic graduate school environment to the industry environment?

Speer:

From academics to industry. As a student, I was researching uranium alloys, so one of the things I had to learn [in industry] was ferrous metallurgy. But, I did a lot of reading of classic ferrous metallurgy papers [in graduate school], because that's where a lot of the phase transformations background comes from. So, I was pretty well prepared to do that. And, I had really good colleagues who were very good and very knowledgeable, and so I learned a lot from them.

Obviously, anything in supervision/management/leadership was all new, and you had to learn that, but you didn't have to learn it overnight. I think students [now] are expected to hit the ground running, maybe to a much greater degree than I was. So, there was an expectation that your professional development would take some time, and you'd be exposed to a little bit more and then a little bit more and a little bit more. My style was to try to pick up as much as I can and watch other people and learn from them. And so, I don't know if I could put my fingers on what I needed to learn, but I feel like I was given a good opportunity to

learn those things through my experiences.

Findley:

I'll follow up on that. If students today are expected to hit the ground running at a quicker pace, does that mean that our educational model has changed or needs to change to accommodate more professional development early on to help them transition to the workplace?

Speer:

That's a good question. I think the educational model has changed a little bit. [For example,] students are doing, at Mines, the EPICS program. They're working in teams. They're doing senior design. They're doing meaningful internships where they're expected to be part of the team and accomplish things for the host company during their internship. So, I think the students seem to be pretty well prepared. Our graduate students, I think, are [especially] well prepared in that sense. The graduate students that we're working with are making presentations to industry twice a year to fairly big groups that I would've been nervous [to address] as a student probably, and I'm sure they are as well. But, they have that experience; they're writing professional quality reports. So, we demand a lot of them. I think they probably are a little bit better prepared a little bit earlier [than I was].

00:28:03 Pursuing an Academic Career at the Colorado School of Mines

Findley:

So, we've referred to the steel center at Mines, including just now, several times in conversation. So, you moved to Mines in 1997. I think I met you in 1998 as an undergraduate student here. What motivated your decision to pursue an academic career after several years in industry?

Speer:

Yeah, I just sort of fell into that, too. It was something I hadn't really ever been planning or preparing for. I didn't even have a resume prepared when I had kind of an informal conversation with David Matlock at SAE [annual Congress]. One year, [Mines was] searching for a replacement for George Krauss, and that might have been in March [of 1997]. I knew about that search in August or September prior. We just had [an informal] conversation, and they had already been interviewing, I think, multiple people. I didn't really have a great understanding of the university environment. I did my graduate studies overseas, so I hadn't been embedded in a US graduate program. But, I put a resume together one weekend and submitted it and interviewed soon after that. And, I ended up here in Golden. It was a unique position for me. I felt like the job description was a pretty good fit with who I was.

I hadn't really worked with students other than my summer jobs giving tennis lessons, and I worked with a church youth group. There's some parallelism between [those experiences] and working with students. Supervising early career researchers, people that I hired out of school was a little bit like teaching, or I convinced myself of that, I guess. But Mines had really the one [only] academic position in the country that maybe would've fit what I was doing. So, it was kind of interesting to think about, a big change, but [a new career] wasn't something I was really seeking. It just felt like it was the right thing to do at the time.

Findley:

So, the aspects that attracted you were working with students, the particular research direction, anything else?

Speer:

Yeah, I mean, coming to Colorado was kind of interesting. I think we benefit in our student-faculty recruiting from [being in] Colorado. But, I don't know if I knew enough about what I was getting into even to know how to answer that. It just it felt like [I was being guided that] it was the right thing to do. And, if I was ever going to do something like that [becoming a professor], that was the time to do it. I didn't have a great understanding of the academic environment. I did talk to some people that I knew in academia before I interviewed or decided to take the position.

00:32:01 Advanced Steel Processing Products Research Center – Discovering University Research

Findley:

So, one of your primary roles was a faculty member in the Advanced Steel Processing Products Research Center at Mines. And, you have a unique perspective, because you were both a sponsor of the center at Bethlehem Steel and a faculty member of the center since that time. Can you tell us about your perspectives in both roles? Were the perspectives different in both roles?

Speer:

Well, I'm sure the perspectives are a little bit different, but I understood the center, partially at least, from an outsider's perspective. I had been hiring some students from the center, so I had high regard for the center. David and George, who were leading the center, are highly regarded and people I looked up to.

The center had a good reputation, and [the job] felt pretty good. I'm not too sure if I remember all of the perspectives; what it felt like to be on the other side. I know some of the sponsors were enthusiastic about the fact that there was somebody [taking the position] that had a direct industry background because our sponsors are very strongly interested that the center projects and the students maintain an understanding of the relevance of the programs. And so, I had a background probably that maybe doesn't completely fit in industry and maybe doesn't completely fit academia - sort of a background that's a cross between the two. That was an interesting fit with the position.

I [sometimes] joke to the faculty and administration here at Colorado School Mines; I wonder if they would hire me today under the same circumstances. Because there are so many well-qualified candidates for faculty positions, the funding environment is probably better in the federal areas that are a little bit more fundamentally focused with a little bit maybe not less relevant, but let's say longer-term relevance. Big problems that people try to work on, and you may or may not be able to “individually” impact the solutions, I guess. I feel like many of the things we work on, we are able to have an impact in a, let's say, intermediate timeframe.

Findley:

Along those lines, did your experience working with the center as an industrial representative impact how you thought about designing and implementing projects as a steel center faculty member?

Speer:

Maybe not, actually. I think that when I came here, I had to change my thinking and was kind of starting over and trying to learn about what it was like to be a faculty member; what it was like to do university research. So, I think I was probably trying to kind of figure out what would work rather than saying, "Oh, okay, well, I saw this from the outside. I know what to do here." But, I think you bring whatever you have to the table in everything that you do, [so certainly my prior research experiences impacted everything. And so there probably was some of that important influences], but I don't think it was conscious.

00:35:47 Metrics of Success – Industry Collaboration and Student Engagement

Findley:

Were there any things that surprised you or you felt like you had to learn about in terms of things like technology transfer from the industry side and the academic side?

Speer:

So technology transfer - we had a very strong patent group at Bethlehem Steel that I worked closely with on some things, and they did a really good job. Mines has a strong patent program now, but when I came [to Mines], it wasn't something that we had really a strong capability in. There are some [developments] that we probably would've had a better chance of patenting, actually, if we were a little bit better at Mines [in those days]. But, technology transfer is a little bit different here, too, because, in the consortium, all of our member companies own all of our work.

And so, part of our job is to communicate what we're doing to [the sponsor companies]. When you're working at a company, [the] company wants to keep proprietary most of the work. So, it's a very different environment [than a university]. In some ways, at the university, you have a lot more exposure to people broadly around the world. You can talk about what you're doing. You can collaborate with anyone that you choose. And, that's an exciting opportunity, actually.

Findley:

Yeah, certainly. As you said, the Steel Research Center is a unique environment in terms of industry collaboration. It's been going for several years, which I guess could be one metric of success. What do you think other metrics of success should be for a center like this one?

Speer:

For a center like ours. Obviously, at a university, probably student success should be an important metric of everything that we do. And, I think we're all proud of our students, and they're doing really well. I think if we can impact the companies with the work that we're doing or impact their thinking about things that they might do later, we're doing pre-competitive work. So, we might be able to think about projects without some of the shorter-term pressures that the corporate researchers are doing.
And so, if we can do things that the companies appreciate, it's hard to measure that. But, I think that's an important metric. Maybe one of the main ways to measure that is whether our sponsors remain engaged with the program. And, I think largely they are engaged, and that engagement is part of why we succeed. But, that's an important metric. And then, there are other metrics that are important from the university standpoint, as far as viewing the department or the faculty or the students as being productive, and so we're trying to do those things, too.

00:39:27 Innovating Impactful Solutions – Growing an Intuition for Good Ideas

Findley:

In terms of innovation; you've been a part of a lot of innovative technologies. One of the primary ones is quenching and partitioning technology which you developed, I guess in 2003, as a start. Broadly, as you've been a part of these innovations, do you have insight about how you identify a problem and come up with an impactful solution to some of these types of really interesting research projects?

Speer:

I think everyone does it [innovation] probably differently. And, what ideas you have that you decide to work on is important. Who knows, if we've had really good ideas that would've turned out great if we worked on them, but we decided they weren't great ideas. I guess the way I view things, though, I try to, if I see something, in quenching and partitioning, for example, there were fundamental pieces, there were mechanisms operating that we hadn't thought about before. So, if we could understand those mechanisms and employ them, then we might be able to do something [useful with them].

That particular development started in that way, as did some of the earlier microalloying pieces in my career. So, I try to start off by understanding the fundamentals as well as [I] can and then trying to understand how those fundamentals fit with possible applications and then where it fits the best. Are there any ideas coming out of that? And, of those ideas, which ones are good and which ones aren't so good?

I feel as a researcher, knowing what you know and what you don't know is important. And, I don't know if that's a skill or it's just a sort of intuitive thing, but I feel like I have some strength there. And, I feel like I've been fortunate in making some decisions about what ideas are good and what ideas aren't good. Because often the ideas that are good are not necessarily being enthusiastically supported by other people, and you have to develop them [in spite of discouragement from others]. You have to make a decision that you're going to take time outside of [the] other things that people want you to do, to try to develop those ideas. And, those things, a few of those things, have kind of worked out [for me].

Findley:

So, there's a filtering process to decide what's a good idea and a bad idea, but there's also a process by which you have to develop enough information to communicate whether the idea is a good one or not?

Speer:

Yes, well, actually, it takes time before you have something that you can communicate in a way that people perceive it as a good idea as well. So, you have to [take a risk and] develop [your idea], and you might have to show people, and even then, it's not like people will necessarily be wildly enthusiastic about the idea, but some people might be. In the quenching and partitioning development, we were very fortunate that one of the companies that became a sponsor company, Baosteel, had some early interest]. They heard about some of the early work we were doing [from my student and now colleague], Amy Clarke, who gave a presentation at a conference that we organized. And, they were in the process of designing a [new] processing facility. And, it was easy for them to, well, relatively easy; nothing is easy. But, they were able to design some [new] capability [for our process] into that process, and the facility would allow them to be an early adopter of the technology, and the ideas went from there.

00:44:08 Becoming a Global Research Center – International Professionals Solving Common Problems

Findley:

In your time as a faculty member in the steel center, the center has evolved from being an entirely North American sponsored steel research center to a global research center. Can you talk a little bit about that?

Speer:

Yes. That was really an interesting evolution. I think when the center began in 1984 -- and that was about at the time I was beginning my career at Bethlehem Steel -- I remember Professor Krauss actually coming to Bethlehem to talk about their efforts and starting the center. But, it was a North American-only membership. The Industrial Advisory Board wanted the center to be focused on North American companies. There was, a little protectionism [at the time]. It was very competitive. They wanted to keep the intellectual property within North America. But, the industry evolved a lot over the next 15 years or so where the companies themselves were tying up globally, were buying overseas companies, were merging.

And, shortly after I came to Colorado School of Mines, we had a strategic planning discussion that sponsor representatives participated in. They encouraged us to go ahead and try some participation of overseas companies. POSCO was our first member company from overseas, and now we've had involvement from Korea, Japan, China, Brazil, Netherlands, Sweden, Germany, France, Austria, Brazil, Argentina, Mexico, Canada [Belgium, Saudi Arabia, India, etc.]. And so, the center has this, what to me has been a really exciting opportunity to bring all these people [steel experts] together from across the world to work on common problems, to understand what's going on in ferrous metallurgy in different parts of the world, to have steel users working with steel producers globally with our students. And so, that's been a hugely rewarding and enjoyable part of my job. It's a little bit stressful sometimes. We've traveled a lot, except during COVID, in order to try to maintain face-to-face contact with the ASPPRC sponsors. But, it's been, I think, a unique opportunity for all of us who have been able to be part of ASPPRC that way.

00:47:19 Future of Steel Research and Development – Advancements in Sustainable Production

Findley:

As you've kind of described it, the steel industry and the research development environment today clearly has a lot of exciting opportunities in steel, though it's not always perceived that way by the general community. What would you tell someone that they might not recognize about steel research and development, about opportunities that they might not be recognizing if they weren't aware of the field?

Speer:

That's a hard question. People are looking for the newest thing sometimes, right? What's completely new to the world, and how can I make an impact on that? Whereas steel has been around, or iron and steel, for as long as you can think of and has been an important part of the economy for 150 years, if you think about where different steel products have impacted different kinds of infrastructure. And so, steel is used in huge quantities around the world and in all sorts of applications, and we take it for granted.

And, the new things that are happening in steel at any given time are a little bit opaque to the general public. If the steel on your car is much stronger than a car that looks just like it that you used to own, you

might even not know it. So, the technology that's embedded there isn't necessarily transparent to the public. Although if you think back over time, your parents probably remember well the car rusting through after a few years or the muffler and tailpipe being replaced every 12 to 24 months. And so, there are technology enhancements that have come along, and those are no longer [problems]. My children wouldn't even be familiar with having to change the muffler or something like that.

I think that's a lot of the reason that maybe the public perception isn't the same as the reality. And then, there were difficult times for manufacturing industries in general, not just the steel industry, as the economy was becoming more globalized and exchange rates and trade issues and all that were coming into play. But, it's a complicated question.

Findley:

Yeah, it is. And, I guess along those lines, steel probably is going to play a major role in future sustainability efforts. I was wondering if you might want to comment on that role of steel going forward?

Speer:

Sustainability efforts are going to play an important role in activities around steel processing and steel production. It's an area that hasn't really been a central expertise of mine as a microstructure developer, if you want to, sort of take my expertise to the most specific area. But, it's clear that sustainability is growing in importance and growing really quickly right now. The decarbonization of global industry is getting a lot of attention. And, the steel industry, to the extent that it uses coal in the blast furnace or uses coal-based electricity, generates a lot of carbon dioxide.

And so, there are technologies being developed with hydrogen, particularly in Europe; but there are other technology opportunities that the next generation is going to have a great time researching and developing to transform steel production. And then, on the product end, there are going to be continued pressures for higher strength, light weighting of vehicles, for example. Recycling of scrap is going to take a different role, perhaps. And so, there's a lot of technology development that's going to be a great opportunity for the students going forward.

00:52:49 Teaching Students at Mines and Changes in Classroom Technologies

Findley:

What courses have you enjoyed teaching at Mines?

Speer:

So, I've enjoyed teaching all of the classes. I've taught undergraduate and graduate, from freshman to graduate students, a freshman success seminar, Introductory Materials, Phase Equilibria and Phase Diagrams, which is a core class that I teach, and a ferrous physical metallurgy graduate course called Current Developments in Ferrous Alloys. The latter two are the ones that I teach most of the time.

It's great being in the classroom with the students, so I enjoy teaching all of the classes. The face time with the students is great. Preparing for class and grading students' assignments, that's not the fun part, but being in class is great. And, I think that probably my [Current Developments] class is a little bit unique. We don't use a textbook, but I think it's really good information that the students get in my Current

Developments class. A little bit the same, I kind of constructed it around my background. Professor Krauss taught it before he retired, and I replaced him, but we probably have a little bit different content. But, I think that that class is really good for our students, not just in the steel center but doing physical metallurgy in general.

Findley:

Has the way that students have approached learning changed over your time at Mines? And, I guess there's a pretty abrupt change that we all had to deal with last year with COVID 19, but in general, has the way that students have approached learning changed?

Speer:

Yes, [change] happens so slowly that I'm not sure if I notice it, but clearly, digitalization is growing in importance. And, I wouldn't say that I'm necessarily an early adopter of classroom technology. The more junior faculty who are exposed to newer technologies earlier and have less invested in existing technologies probably are adopting things earlier. Obviously, COVID was a big shock. We went not just from digitalization but to actual remote learning. Software systems that support the educational process, there are many more of those than there used to be. When I started teaching, if we wanted to show a microstructure on the screen, we were using transparencies for that. So, even the idea of bringing a PowerPoint file into class is something that's changed over my teaching career.

Findley:

I guess the inverse of that, has your approach evolved over time in terms of how you mentor students in the research process or teach students in the classroom?

Speer:

I'm sure it has. I'm not sure I could exactly put my finger on the changes, but you change as a person as you have more experiences. I'm probably more willing to delegate different things to my graduate students than I would've been early on and let them struggle with them without helping, to give them that experience of struggling. Not that I don't want to throw a life preserver if they're struggling with something, but I want to let them swim around a little bit until they really need it. And then, when they don't need it anymore, sort of take it away, and let them develop a little bit more independently. So, I think I allow the graduate students to be a little bit more independent. With the undergraduate students, I'm not sure how much my style has changed, although the technologies of the classroom have changed. I've probably gotten a little bit "easier" [in my] grading over time.

Findley:

You have two daughters. Has seeing how they learn and are educated affected your perspectives on the educational environment at universities at all?

Speer:

Probably, I don't know if I've ever thought about anything around that question, but being a parent, I think, affects just everything...the way you look on life and understand people and interact with people. So, it probably does have important impacts, but I might have to think a little bit more before I could give you a

coherent answer on that one.

00:58:18 Associate Vice President of Research – Developing Research Programs at Mines

Findley:

You've had another interesting position at Mines, a unique position as the Associate Vice President of Research for the university. I know you had some opportunity to do some impactful things. Can you describe what the appeal was for that position and what you enjoyed about that position?

Speer:

Well, the position gave me some [broader] exposure to the university and the university leadership and what was happening from that standpoint. We interfaced with a lot of different visiting national labs and companies. The role is to help develop research programs, research funding for the university, as well as, in some cases, administer policy kinds of things. So, it was a fun experience. [We stimulated a variety of interactions and proposal submissions.] And, as I mentioned before, one of the ways that I learn is by watching people do things. I had the opportunity to watch the academic leadership and learn how different things work at the university and see people use their gifts in particular ways; and so, you learn from all those kinds of experiences. It was very different, and it's fun to do different things from time to time as well.

So, I thought it was a good experience. More specifically, I think as far as "what programs did we actually have particular impacts on:" we were deeply involved early on developing the Critical Materials Institute, that's still going strong. It's a Department of Energy large program related to rare-earth minerals. REMRSEC was [developed] early on, and we helped a lot to help REMRSEC thrive.

Findley:

REMERSEC is?

Speer:

Renewable Energy Materials Research Science and Engineering Center. REMERSEC has been replaced by other activities; but, they made some great faculty hires at the time, and those faculty are thriving. It's an important area for the Colorado School of Mines. So, that was a fairly big impact as well.

We worked really hard on a NIST Construction Grant program [proposal] that I think we got very close to [winning] but weren't successful. And then, the other thing that was fun about it is really working with faculty across campus and getting to know the other faculty on campus, because we don't have as many opportunities to get to know each other across the university outside of serving on different committees together. But, in that particular role, I got to work with all the researchers on campus, which was kind of fun.

01:01:43 Professional Societies – A Broader Community of Professionals

Findley:

The other role that faculty members have is service, including external service to the community that

they're involved in. And, that includes professional societies. You've been involved in professional societies for a long time, including AIME member society, AIST [Association for Iron and Steel Technology]. You've also been involved in SAE and ASM international. How did you first become involved in professional activities like these?

Speer:

My first involvement was ASM, and I received a student scholarship and attended a Lehigh Valley chapter meeting as a student. So, that was my first exposure. I [also] had a little bit of student exposure when I was in the UK. And then, when I came back, some more involvement in ASM and TMS. Although, at the time, TMS wanted steel to be a little bit less important component of TMS. And so, the ferrous part of TMS migrated to ISS. Now, TMS more recently has emphasized and brought back pretty strongly a ferrous component.

I got involved in SAE – really, I was doing that in part to help the company when I was at Bethlehem Steel, on the [SAE] Ferrous Metals Committee. We were doing a lot of organizing for SAE. I was developing automotive products at the time and applications technology. I continued doing that [SAE] for quite a while, while I was at Mines.

AIST started in the early two-thousands, although I had some involvement with ISS before that, which was part of what came together [to become] AIST. I also, just before the merger, had some involvement with AISE [Association of Iron and Steel Engineers] on the training side. So, I got more involved with AIST; we were organizing some conferences in the steel product development area. And, I think that's been a series of conferences that were fairly important. And then, I was nominated to serve as a trustee of AIME after that and then eventually became an officer of AIME.

Findley:

So, in today's societies, what role should they play in the development of young engineers? And what kinds of roles should young engineers pursue in these societies today?

Speer:

Well, it depends on the person, but I think the professional societies are valuable for people to interact to get at a broader view, to participate in conferences and see what other people are doing, to have a sense of community that they belong to this broader community of professionals that work in their fields. And then, if people want to get involved in leadership, that provides them other opportunities to interact, although it also gives them more responsibilities.

So, people, I think at different times in their life, might have more time or less time to do that. But, I think that the people who are involved in professional societies value that involvement. If they're involved in leadership, I think they value that involvement as well. So, I think it's beneficial to the community and beneficial to the people who are participating in leading. For young professionals, if they're involved in leadership, it gives them experiences and background in leadership as well.

01:06:11 Supporting the Legacy of AIME – Governance Changes During My Time as President

Findley:

Can you talk about your time and accomplishments in serving as President of AIME?

Speer:

That was enjoyable. We got to interact with all of the other engineering societies to see different perspectives, engage with that community. So, that was fun.

We also distributed funds to our Member Societies. AIME [is a quasi-] foundation, and the trustees are responsible for growing the principal and distributing funds and doing other programs. There were some nice things around that.

I think one of the challenges that the board struggled with while I was a board member of AIME — AIME has a long history; we're having the 150th annual meeting this coming weekend. So, AIME has a long, proud tradition. And, AIME was the origin of what are now four independent professional societies: AIST, TMS, SME, and SPE. And, these are four very large, very successful, very important professional societies that were all once part of AIME and now are independent but [collaborate] under the AIME umbrella. AIME itself now is somewhat small [in comparison]. So, we always struggled with what the identity of AIME should be relative to these incredibly successful member societies. My feeling about that is really [that] the legacy of AIME is the success of those member societies. And so, [I focused on trying] to direct my efforts into supporting the success of the Member Societies.

We had some governance changes while I was president of AIME. And, I wouldn't say that I really drove those governance changes, but I guess I'd say I facilitated them. [There were] some changes in the board structure, closer alignment with the needs of the member societies; and, I guess we'll find out how that all works out at the 200th anniversary of AIME. But, that challenge to the identity was sort of stressful at times, and my hope is that people that are really serving AIME now [and in the future] have lower stresses and are really able to accomplish the things that AIME can do to support the Member Societies.

01:09:30 National Academy of Engineering and Spreading Knowledge of Materials Science

Findley:

Along those lines but also under the category of some of your accolades, you've also recently become a member of the National Academy of Engineering. And, I was wondering if you might want to comment on that major accomplishment: what that accomplishment means to you and your role in the National Academy of Engineering?

Speer:

I guess I'd say I've been fortunate to be blessed with some of the accolades. I hope I deserve some of them. But [with respect to] the National Academy and in academia, I think we view it as an award or an accolade. I think the Academy views it [more] as an opportunity to serve the country. So, I want to be a little bit careful about characterizing the Academy membership as an award. I think most of the Academy members are involved in trying to support [NAE] on a volunteer basis with some technical needs of the country. I'm involved in a global industrial sustainability program on behalf of the academies right now. I know our colleague, David Matlock, was involved in a program related to hydrogen-related failures.

So, [it's] doing things that are important to the country. But, by the same token, being an Academy member is also a great honor. It was great to go to Washington. I took my family for the induction, and so it means a

lot to be an Academy member, to be viewed as somebody that's done something that's worthy of that kind of election to Academy membership.

Findley:

Absolutely. Going back to professional societies and your role in education, what role do you think societies, universities, faculty members should play in recruiting students to engineering and specifically to material engineering professions?

Speer:

I was brought up in a steel-producing town. So, I knew that metallurgy was a field that existed. My father had a metallurgy degree. A lot of our students that go into engineering don't know that metallurgy or materials engineering, materials science exist. In fact, I've researched that a little bit, and I talk to the students about it, looking at what students sign up for as possible university programs when they're taking the PSAT exam. There are very few of them that identify materials as something they're thinking about studying, whereas there are massive numbers of students who identify with other [fields]. And so, as a discipline, as a profession, we need to inform students, often after they arrive at the university, that we exist, what we are, why we're valuable, and recruit students into the discipline. [Professional society activities like the ASM Materials Camps are also helping to inform students about our discipline.]

I think we have a good message because our students are in demand in every kind of industry. And so, at least at Colorado School Mines, our student numbers have been growing through the time that I've been here. That makes some things difficult; teaching is a little bit more difficult. We don't have the ability to have the same kind of personal relationships with the undergraduates that we did when the class sizes were half what they are now. But, the students are getting hired even in bigger numbers. So, I think we're doing some things right.

01:14:13 Evolution of Materials Engineers in Industry and Universities

Findley:

It has been a little bit of evolution at universities where materials people are present as faculty members in multiple departments, which also impacts the educational programs. How does that affect the recruitment and education and evolution of materials engineers going out into the field?

Speer:

That's interesting. The materials field, I guess, has become much broader. The kinds of backgrounds that people have who consider themselves to be materials people is broader. So, there's a more interdisciplinary characteristic to us. While we have broad materials backgrounds across campus, within the actual undergraduate materials program, there's probably a more closely contained curriculum that provides students with the specific kinds of backgrounds that employers expect from metallurgy and materials graduates. But, in the graduate programs, people are doing all sorts of things, and it's probably both healthy and complicated.

Findley:

Absolutely. I just have one final question to wrap up, and it ties into a theme that we've been talking about

throughout this conversation about leadership. What advice do you have for young leaders in the materials profession in general?

Speer:

Young leaders, well, engage in whatever you're doing. Don't take yourself too seriously, sometimes. Try hard. Be prepared. Be thoughtful. Life has ups and downs, so everything comes with challenges. Be prepared to deal with the challenges. The world is always changing, so the challenges are always changing. Most people are not spared difficult times in their life, so be prepared to deal with those in some sort of resilient way as well. Try to serve whomever is your client, if you will. What are the needs that you're trying to fulfill through your efforts in your career?

Findley:

Well, thanks, John. That's a really insightful answer. I've enjoyed this conversation. I learned a lot from you, as always. So, thanks for the discussion.

Speer:

Well, thank you, Kip. I hope some of it is valuable.