AMERICAN INSTITUTE OF MINING,
METALLURGICAL, AND PETROLEUM ENGINEERS

ORAL HISTORY PROGRAM

Patrick Taylor:
Challenges and Opportunities of a Metallurgical Professor

2018

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00:15 Introduction

Free:

Today is Thursday, August 30th, 2018. This is an interview with Patrick Taylor who is a long-time member of TMS and a metallurgical engineer. The interviewer is Michael Free.

This interview is being conducted as part of the American Institute of Mining, Metallurgical, and Petroleum Engineers oral history project. We are sitting in the Western Ottawa, Ontario hotel in Canada, and we're going to discuss Patrick's experiences in the metallurgical industry, in the engineering profession, and his contributions in the field.

00:54 Influences in Choosing Metallurgical Engineering

Okay. Let's start. So Patrick, can you tell me a little bit about your growing up years and how that had some influence on you, in terms of choosing metallurgical engineering as a career?

Taylor:

Sure. I grew up in Denver, Colorado, and, when I was a Boy Scout, one of the merit badges was rocks and minerals. I don't know if you remember that? I got very interested in going out in Colorado and looking for minerals and stuff. And then, in Denver, particularly Colorado School of Mines has a big reputation, so I'd always wanted to go there and study rocks and minerals and stuff.

But I ended up being a metallurgist because when I first started, I looked at geological engineering. But then, I met a metallurgist and he started explaining all of the stuff they do to make metals out of minerals, and I got excited about it. So I went to school there and did that.

1:59 Interest in Chemistry and Extractive Metallurgy

Free:

Was there anything in particular that excited you about looking into the metals aspect? The rocks were interesting to you. Was there anything that kind of drove you more? What aspects did people tell you about metals and metal processing that interested you?

Taylor:

I always also had an interest in chemistry and extractive metallurgy, particularly; it's really a chemical process. It allows you to take a mineral and make a metal or whatever product out of it. So when I met some metallurgists, when I was a metallurgy student, when I was a student, and they started explaining what they were doing and what they were learning, it made me want to do the same thing. But, I think it was the chemistry that really got me most involved.

Free:

Do you remember anything from a chemistry class that kept feeding that interest or other influences that kind of drove that?

Taylor:

Well, once I got into metallurgical engineering, and once I got to take a few classes involved with understanding the chemistry of extractive metallurgy, I got more and more excited. And also, when I found out that I could do ... one of my degrees was in mathematics, so when I found out you could use mathematics to describe processes, it made me even more excited about it.

I had a professor when I was an undergraduate, Gerry Martins, who got me involved as a junior in his laboratory and his work and his interest in modeling things, which was fun.

Free:

What did you do in Professor Martins' lab that was particularly interesting to you?

Taylor:

Well, at the time, there was a lot of interest in modeling gas/solid reactions. Jim Evans and Julian Szekely published their first papers on the grain model. We thought maybe we could take that model and do some experiments to demonstrate that it could predict the behavior of these things.

And so, I started doing modeling of two-dimensional kinds of reactions, and I started to look at, first, after I graduated and started graduate school, building an experimental apparatus where I could measure these rates of these reactions and develop the model to go with it.

Free:

Were there some other classmates, other lab mates, that also were encouraging or maybe provided some mentoring that was a good, nurturing environment to help further that?

Taylor:

Oh, yes. I mean, there were many of them. Both undergraduate program and graduate program.

At the time, I went to graduate school, both Dr. John Hagar and Gerry Martins had big research groups, and we were right across the hall from each other. So, we got to know each other very, very well. Once we did all the work, we'd go drink beer and talk about metallurgy.

Undergraduates, there were a whole bunch of them, and I still keep in contact with quite a few of them that were my lab partners or my friends as undergraduates. It was always nice to have people that you could hang out with back then.

I was a little bit older than most of the students because I had gone to Vietnam, and I had gotten married and had kids, and then I went back to school. But, still, I made a lot of good friends, and, still today, I talk to them, see them.

5:46 Family Encouragement/Support

Free:

Were there any things that you can think of, like just going back maybe a little bit further with the family aspect, and even as you grew up, were your parents in any way kind of encouraging towards science engineering? Or, maybe, as you got married and stuff too, did you have some encouragement on those fronts that influenced it?

Taylor:

My parents' encouragement was mostly just loving me. But, I was the first college graduate on my father's side of the family. My dad worked for the railroad. His dad worked for the railroad. His dad worked in a coal mine.

I mean the opportunities that they had were not the same as I had when I was at that time because it was very difficult for people to go to college during the Depression and during the war years and stuff. So they encouraged me in the sense that they loved me, and they supported me, and they wanted me to do well.

Free:

That's a lot of encouragement.

Taylor:

Yeah. That's all you need.

Free:

Right. So, did you have any, were there any kinds of scholarships or grants or things that also helped to facilitate this, that maybe otherwise it would've been out of reach?

Taylor:

Very much so. The G.I. Bill, as an undergraduate, paid. My wife worked and put me through school. When I got to graduate school, they had, at the time, Newmont had several fellowships that allowed me to do my graduate work. Mostly, it was my wife put me through school.

Free:

That's great.

Taylor:

Yeah.

7:47 Steering the Choice to Become a Professor

Free:

Are there any other factors that come to mind, that kind of helped in steering your career choice?

Taylor:

To be a professor, there was. I attended my first AIME meeting in 1975. I was a graduate student. It was in Las Vegas, and back then, it was SME, TMS, and ISS, all met together. It was a wonderful meeting, in terms of looking and seeing what the different parts of metallurgy were all about.

But when I got there, I was giving a paper again on gas-solid reaction modeling, and I'd read all the papers by these famous people, Julian Szekely, Rocky Sohn, Jim Evans and they were in the audience. And I was so nervous giving a paper to them, But, afterward, they all came up to me and said, "You've done a wonderful job. You ought to think about, maybe, being a professor and getting your Ph.D." Rocky did anyway.

And, so, that kind of encouragement really helped me to think I could get a Ph.D., and I could be a professor somewhere.

Free:

That's great. Those are some nice stories.

9:12 Rewarding Aspects of This Career

What are some of the most rewarding things or aspects of your career that you have?

Taylor:

I love teaching, and, so, I feel rewarded by still being able to teach classes and try to turn young men and women into good engineers. The graduate students (I'm up to about 80 graduate students or so), and everyone's been a joy to work with. Well, nearly everyone's been a joy to work with. To feel like you're making some kind of contribution to their being developed, to be better engineers and better metallurgists, I mean, there's a lot of joy in that.

The friendships I've made at professional societies meetings, like you, and like many others; I mean there are a lot of rewarding aspects to having a university position. I may have not made as much money as I could have if I had gotten into industry, but I certainly enjoyed what I've done.

10:27 Challenges in Career and in the Industry - Transitions

Free:

What are some of the biggest challenges that you've had in your career, and let's talk about that. And, then, we'll talk about some of the technical challenges that are faced by the industry.

Taylor:

To be a successful university professor, as you know well, Mike, you have to be able to be a pretty good salesman, you have to be able to bring the money in to support the students, to be able to do the work. And in my career, there's been several transitions.

When I first went work at Idaho, my first teaching job, there was money for mining-related extractive metallurgy. And so, for quite a few years, we looked at complex ores and different things. But, then, the mining industry stopped funding things. The Bureau of Mines, who I got a lot of money from, didn't

exist. So, I had to find another way to be able to support my graduate programs.

And, I said, ”What's like pyrometallurgy?” And, I thought about it, and I thought about it, and I came up with thermal plasma processing. So, I was able, with Bob Bartlett's help, to get a power supply and a plasma torch. And, we built some reactors, and that led to funding from NSF and DOE and a variety of funding agencies that I would not be able to get funding for in extractive metallurgy.

For a big chunk of a period of time, probably from the mid-‘80s to 2000, my research was really directed more at thermal plasma processing of materials, making fine ceramics or destroying waste. We still did a little bit of extractive metallurgy when the projects came along. And, so, that was a big challenge, transitioning there.

And, the other big transition was when they decided to get rid of the College of Mines at Idaho, and I started looking for another job. I went to Tennessee, and I was the Department Head of a materials science and engineering program. And, of course, I'm not a materials scientist, I'm a metallurgical engineer. But, I was pretty darn successful at that job.

And, then, all of a sudden, they had this Endowed Chair in Golden to go back to Colorado School of Mines. So, we came back to Mines. And, the Department Head at that time was John Moore, and he wanted to rebuild the extractive and mineral processing program in that department. It kind of diminished over the years.

My major task was to try to reach out to the mining companies and the funding agencies, to try to see if we could build up that part of the program again. And, we've done it pretty well, I think.

Free:

You've been very successful there.

Taylor:

Challenges ...

Free:

Go ahead, yes, challenges in the industry, and, maybe, if you want to talk about the field, too.

Taylor:

I think, in our field, in the extractive area, being able to come up with ways to economically treat these complex ores that have many impurities, you know, the metallurgy of the past has to be adapted to the new type of ore bodies that you're seeing.

There are many examples; for example, there are enargite ores with high arsenic in them. You can't just float them and ship them to a smelter. You’ve got to do some new magic, some new chemistry, to make them suitable for mass smelting or the hydrometallurgy has to be developed to the point where you can deal with it. So, arsenic, those kinds of impurities that occur in the deposit, are becoming more and more important.

Water is a big thing now in the mining industry. Finding ways to reuse or recycle processed water into plants, whether it's flotation or hydrometallurgical plants, has become more and more important.

Reagent regeneration has become a very important topic. Can we take the products of an acid leach, say, sodium sulfate, and make acid again or a base or whatever? And these are some of the fun challenges for extractive metallurgy.

The biggest challenge for extractive metallurgy in the U.S. is maintaining educational programs that do this. There are very few of them left. Utah, Colorado School of Mines, I will name a couple more, Montana Tech. And the trend is, and has been, instead of emphasizing mineral processing and extractive metallurgy, to turn these programs into materials science programs. And, it's really diminished our ability to train the extractive metallurgist of the future, I think. That's the challenge.

Free:

There's always opportunities and challenges, so that's good.

Taylor:

I believe in that too.

15:46 Important Technical Contributions

Free:

Can you share some of your career contributions from the technical side? What would you say are the two or three most important contributions that you're most proud of?

Taylor:

There's several. When I went to Idaho, and the Bureau of Mines was looking to expand the generic centers, I wrote a proposal for a critical materials institute. But, we called it strategic materials at the time. And, I bundled it with Utah and Montana Tech, and it was to look at things like chromium and cobalt. Those things that are important to the defense of the country.

And, of course, we sent it off, and our senators loved it. And, so, it was funded. But, they put it at Idaho National Lab. But, I was the instigator of that strategic materials generics center. It was my proposal, with a little help from other people that got that funded, which I was pretty proud of. I was the University of Idaho director of that part of things. That was a fun thing.

In 1985, I organized the first international symposium on recycle and secondary recovery of metals. That was in 1985; it was a TMS symposium in Fort Lauderdale. It was a book, and it was highly successful. Who else was ... Noel Jarrett from Alcoa and Rocky Sohn from Utah were the co-organizers. I feel proud about that because it led to a lot of research in the recycling area I probably wouldn't have had if I had not done the symposium.

More recently, I was helpful as part of the initial team to get the Critical Materials Institute. It was Alex King, Gerschmider, Rod Eggert and I put together this concept of putting together the earth resources part that could be brought by Colorado School of Mines, with the rare earth metal and alloy experience

that Ames had. So, we put together this plan.

I was part of the instigation of that, if not ... so I still am the associate director for mines for the CMI. That's been a big deal. There are probably others, but you look for challenges, you look for opportunities, and you try to take advantage of them.

18:32 Awards and Recognition

Free:

Those are some really great contributions. So, let's talk a little bit about, well, let me ask you this,"Sso, are there some awards or recognition that you've received that have been particularly meaningful to you?"

Taylor:

Several. From TMS, I received their Distinguished Lecturer award a few years ago. What they call the Distinguished Service Award from TMS. I was a luncheon speaker. TMS has been very good to me. From SME, I received the Wadsworth Award a few years ago. I'm proud of that because Milt Wadsworth was one wonderful person. From AIME, I received the James Douglas Award a couple years ago. I'm proud of that.

Those are probably the major ones in terms of- and being able to do this interview with you, Mike, that's a big award, too. But anyway, those are the ones that I'm most proud of.

19:43 Member Society Affiliation

Free:

Those are great.

Tell me a little bit about your experience with TMS and AIME.

Taylor:

Again, I started coming to TMS meetings in 1975 as a graduate student. I've only missed a few out of the last 43 years, however long it's been, because of professional conflicts. There are other professional societies, under AIME, that also I attend.

I started in '75. I've been a long-time member. I've served on numerous committees. I chaired and served on the professional registration committee to write the PE exam for about 25 years. Because of our short courses and stuff, I served on that committee for a while. It used to be the physical chemistry committee. I'm not sure what it is now. We served on forever, but which was fun ...

And, it's always a joy to come to these meetings because you see old friends, you learn new things, you get a chance to brag a little bit about what you're doing and your papers or presentations. For me, it's been an invaluable part of my professional development.

And, for my students, too. My deal with my graduate students is, if you get a paper accepted for

presentation or a publication, a professional society meeting, we pay for them to come to the meeting. I think it's so important for them to be able to be a part of these kinds of professional gatherings, to get up there and try to tell people how good of work they've done. It's really good for professional development of the students as well.

What else?

21:44 Why Students Should Become Involved in TMS

Free:

Are there any other things that you can think of in terms of the benefits? So, you talked about the meetings and the connections there, are there some other ways in which TMS has helped you or that you feel TMS would be of service and help to students and other reasons for them to become involved in TMS?

Taylor:

What else? I'm trying to think what it might be.

For me, I think the major value of every professional society organization is the ability to get together with people who are working on similar disciplines or topics and to learn what's going on and to be a part of pushing the technology forward in whatever way we can. For me, that's the most important thing.

Long term membership in TMS has many, many benefits because you get to know so many people that can be helpful to you. I've done a lot of work in pyrometallurgy, and TMS has always had a very strong smelting group and getting to know some of the people, some of the big smelters, and what they do and stuff. If I have a question, I know who to call or talk to for these kinds of questions. The university professors who come, you get to know all of them. You know if you have a question, you call them on the phone, they can be helpful. The professional contact part of this is very important too.

Scholarships, travel scholarships, all of those are good things. But, really, it's getting to know people and getting to be able to be a part of a meeting.

23:37 Attracting Students to Metallurgical Engineering - Making a Difference

Free:

One of the challenges that are out there, at least in terms of the metallurgical engineering and this is broader also, even for the materials in some sense, is that there aren't maybe enough students in this field. And, so, what do you think can be done to help attract more students?

Taylor:

The growth in materials science has opened up other areas that we didn't have in the old extractive metallurgy, physical metallurgy field. I mean, we have ceramics, we have polymers, we have a whole range of other materials topics that might attract students.

For me, what's attracted a lot of my graduate students in recent years is they want to feel like they can help by understanding recycling, for example. If they get involved in, say, taking a hard drive and figuring out the best way to recycle the aluminum, the steel, the rare earth magnets, they feel like they're making a difference.

So, we pump up our recycling program to potential graduate students, and we get very high-quality graduate students from big universities who want to do that kind of work, who want to be process engineers but are trying to make a difference, if you like, by improving the ability to recycle materials. There are probably other topics that could be developed that would be helpful.

But, for our field, attracting young men and women that want to go work at a mine and mill and stuff, it's very difficult, unless they come from that heritage, unless they come from a Butte, Montana or a mining camp someplace. But, we do still get some of those who want to do that and do very well at it. But it's a hard sell.

Free:

It's challenging. So, what's been your favorite part about working in the field? You talked about some things that have been very rewarding for you. If you were to say what's the favorite part about it, what would you say?

Taylor:

We kind of covered that before. My favorite thing about working in the field, I suppose, is the friendships I've developed over the years. And the fact that there are so many really intelligent people you can hang out with, that allow you to feel like you're part of a community. I mean, it is a community. That's my favorite part.

26:33 Advice for Young Leaders in the Engineering Profession

Free:

What advice would you give to people entering the field, some of today's young leaders in the engineering profession?

Taylor:

I'd like to encourage many of them to look at the possibility of being university faculty. There aren't that many trained in extractive metallurgy that would like to go on to be professors. There are some of them, I think ought to do that, just because I'm getting older, and I'm going to retire. It'd be awfully nice to have somebody who wants to do that.

But anyways, what else? What I tell my students and I'm sure you feel the same way, is all we can do in a university is begin to teach you how to learn. And, that once you get into the professional society or a professional job that you might have, that's when the real education begins. And, I tell my students to go to work for operating plants or operations. You're not going to be able to do a good job just sitting at a computer; you've got to go out, you've got to understand what the plant is doing. You've got to get to know the operators and stuff. Otherwise, you're not going to last very long in that world.

What else? Mike, I'm running out of ideas here.

Free:

You're doing great. You've got a lot of great ideas to share. Was there anything else that you'd like to share, anything that you would like to bring out that we haven't asked?

Taylor:

No, not really. I just want to say that, I'll say it again, my being a part of AIME that is TMS and SME, as a member and as a student member, has been a big part of my professional life. And, both have been extremely valuable to me, in terms of my professional career.

Free:

Great. I've enjoyed immensely my association with you over the past couple of decades or so. And, we're very appreciative of you spending time to have this interview done and appreciate you sharing your story with AIME.

Taylor:

Thank you, Mike. Appreciate it.