AMERICAN INSTITUTE OF MINING,
METALLURGICAL, AND PETROLEUM ENGINEERS

ORAL HISTORY PROGRAM

Alexander McLean: Building Bridges Between Industry and Academia

2021

PREFACE

The following oral history is the result of a recorded interview with Alexander McLean conducted by Paul Wu on April 12th, 2021. This interview is part of the AIME and Its Member Societies: AIST, SME, SPE, and TMS Oral History Project.

ABSTRACT

Dr. Alexander McLean has pioneered industrial practices in the steel industry and has become an inspiring mentor to countless future engineers. McLean grew up in Blantyre, Scotland as the son of a foundry man, and he found himself drawn into the field of metallurgy. Under the guidance of his mentors, McLean pursued his PhD at the University of Glasgow. McLean has had many influential figures in his life, who have influenced his career in industry and academia, and their wisdom led him to pursue his passion for academia. Now, 50 years at the University of Toronto, McLean is a professor emeritus. McLean's work on steel re-oxidation reactions revolutionized industrial practices, and he helped transform the University of Toronto's metallurgy department into materials science and engineering. McLean is an AIME Honorary Member, an AISI Distinguished Professorship awardee, and a recipient of the Queen Elizabeth II Diamond Jubilee Medal, a rare honor. Sharing his philosophical lessons, McLean highlights the benefits of professional societies and emphasizes the importance of communication and knowledge transfer within industry and academia. McLean has had a meaningful impact among industry, professional societies, academia, and, especially, his students.

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.

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PART 1

00:15 Introduction

Wu:

Hi. This is Paul Wu of Cleveland-Cliffs, a member of AIST. Today is Monday, April 12th, 2021. We're doing an interview via AIME's Zoom conferencing with Dr. Alex McLean, Professor Emeritus at the University of Toronto. Dr. McLean is also a Distinguished ISS and AIME Member. This interview is being conducted as a part of AIME's oral history project.

Dr. McLean, welcome and thank you for spending some time with us today.

McLean:

Most welcome, Paul. Most welcome.

00:49 Growing Up in Blantyre, Scotland – Meeting My Wife, Betty

Wu:

Well, let's start with the early years. Tell me about where you grew up?

McLean:

Well, Paul, I was born, as you probably well know, in Scotland in a small, a very small town – a little bit bigger than a village – called Blantyre, about nine miles south of Glasgow. Blantyre was the place where the missionary, David Livingston, was born. Just a small town but, as I say, about nine miles from Glasgow, about three miles from another place called Hamilton, Hamilton in Scotland. There's a lot of Hamiltons around, but that was Hamilton in Scotland.

I lived there until we got married. Betty, my wife, and I met – Betty was also from Blantyre – and we met together attending the same church there. After we were married, we moved to a small town called Largs, L-A-R-G-S, on the west coast of Scotland. And, we lived there for a couple of years before we moved to Canada.

02:05 Foundry Beginnings – Visiting My Father at Work as A Young Boy

Wu:

That's very nice. So, what did you do? What did your parents do for a living?

McLean:

My mother, she was a homemaker. She looked after things at home, did a great job there. And, my dad, he left school when he was 14. That was what they did in those days, most of the people. He left school when he was 14 and joined the local foundry, metalworking plant, located also in Blantyre. So, I remember as a boy growing up, if my father was working overtime at the foundry, I would take him his sandwiches for his meal in the evening. He would take his lunch with him, but, if he was working late, I would take an evening meal and meet him in the foundry and sit there with him.

And, it was great to sit beside the foundry men because, of course, in the foundry, at least in those days,

they never had fridges. So, they always would take their tea black. In other words, their tea was taken without milk. And, up until that point, I'd always taken tea with milk, but when I would take my father's sandwiches to him for his evening meal and sit there beside him and the other men, oh, I just felt so grown up. Because they would give me this tin mug, you never used glass cups; it was a tin mug with black tea. And, ever since then, I've always taken my tea black – although I take milk in my coffee.

But, all of that to say, right in the very early days, I used to visit a foundry. And, of course, there's very distinctive smells associated with a foundry because there are small furnaces there, [and] sand casting [and] then processing the metal: cutting and filing and shaping and so on. So, I had a kind of foundry beginnings in that sense.

03:58 Studying Metallurgy – The Marvel of Local Steel Plants and My Father's Guidance

Wu:

So, would you say that your father had a tremendous influence on the fact that you have become an engineer later on in your life?

McLean:

Aye, I would say that's absolutely right, Paul, based on what I've just mentioned to you. But, I can remember one day, while I was still in high school and getting ready to prepare to go to university, my dad coming home from work, and I was sitting at our table together where we were having our evening meal – there at five o'clock in the evening, we generally had it. And, he said to me, "So what are you going to do when you leave school?" And, I said to him, "Well, I think I'd like to be a painter."

And he said, "Do you mean an artist?" "Oh, no, no," I said, "Just a painter, somebody that paints walls."

"Why would you do that?" he said. I said, "Well, I like the smell of paint." This was before the days of drugs and things like that, you know. Maybe I was a druggist at heart, I don't know. But, I liked the smell of paint.

I said, "The other thing is, you start at one end of a wall and you get to the other, and you can look back and you see what you've done. So, I think I might like to be a painter."

He said, "Well, you really don't need to go to university. if you're going to be a painter." He said, "What do you like doing at school?"

And, I said, "Well, I like math and chemistry and physics."

And, he said, "Maybe you should be a metallurgist." Over here we say a metallurgist, in Scotland we said metallurgist, and I didn't know what that was. I said, "What's a metallurgist?"

He said, "Well, I'll arrange for you to visit the local steel plant, and you'll see them making steel there. They always need metallurgists, and, if you study metallurgy, you would always have a job here in Scotland." Because we had a number of steel plants locally, being very close to Glasgow, as I'd mentioned, there were a number of steel plants locally. So, that was a major source of employment.

So, sure enough, I visited a local steel plant, and I saw them. At that time, we didn't have BOFs or converters, Paul. They were still open hearths and electric furnaces. I watched them tap open-hearth furnaces into ladles and pouring ingots, because we didn't have continuous casting either. But, boy, the smoke and the flames and the heat and the dust; I thought, this is marvelous! To be able to do chemistry at

1600 degrees centigrade, that would be a great thing to do. So, that got me hooked on it. Then, from there on, I decided, oh, I'll study metallurgy, which I did. So, that was how I got started. So, very much as you have suggested, my dad had a big influence in my decision-making there.

Wu:

So, it sounds like you like everything pyro related, or you like high temperatures and fire?

McLean:

That's right. Yeah. A pyromaniac.

06:56 The Only Metallurgy Department in Scotland – Royal College of Science and Technology

Wu:

It's a great segue into your education background. So, in addition to receiving an applied chemistry degree from the University of Glasgow, you also receive an associateship from the Royal College of Science and Technology, now the University of Strathclyde, and why did you choose that school?

McLean:

Well, that's a good question Paul. It turned out, at that time, as you say, it's now the University of Strathclyde, but, at that time when I was about to enter it, it was called the Royal College of Science and Technology. And, it had an interesting linkage to the University of Glasgow. It turned out that the professor, who was chair of the Metallurgy Department – as they called it, the Metallurgy Department at the University of Glasgow – the department and the chair was actually located at the Royal College. So, it was the Royal College that I would be attending rather than the University of Glasgow, as it turned out. But, even beyond that, at that particular time, that was the only department of metallurgy in the whole of Scotland. There were several departments in England, but there was only one in Scotland. So, to study metallurgy, it was the Royal College of Science and Technology that I would attend, which I did and thoroughly enjoyed my time there.

08:30 Interning at Dalzell Steelworks – The Birthplace of the Titanic and Queen Mary's Steel

Wu:

Well, that's great. And, while pursuing that, the degrees that you received over at the University of Glasgow, did you take any internship? Taking on any internship while you were there?

McLean:

Yeah. The sessions over there were a little bit different from what we have here typically in North America. The session would begin in October, and it would run through till June. So, the months – July, August, and September – you were off. So, between my first and second year, and second and third year, and third and fourth year, and then immediately after my fourth year, I spent three months at each of these times working at a company called David [Colville] and Sons. That was the major steel company in Scotland, and they owned a number of steel plants.

The one that I worked in was the one that I'd actually visited, that my dad had arranged me to visit while I was still in high school. And, it was called Dalzell Steelworks. And, it was located in Motherwell, which was about four miles from Blantyre, Burnbank, two villages close to each other where I grew up. So, it was very

easy to get to Dalzell.

So, Dalzell Steelworks had a great history. It was the place where the steel for the Titanic was actually made. Now, as you probably know, Paul, the Titanic was built in Belfast in Ireland, but the steel came from the Dalzell Steelworks. The Queen Mary, which is now located at Long Beach – if you ever visit Long Beach, you can visit the Queen Mary – the steel for that vessel, which was built in 1936 and, at the time, was the biggest ship built in the world, that steel also came from the Dalzell Steelworks. If you ever visit the Queen Mary at Long Beach, and you go down to the engine room, and you look up at the big steel beams, you'll see imprinted on these beams, "Dalzell Steelworks Motherwell."

So, that's where I spent my internships, and, again, thoroughly enjoyed that experience: working on an open-hearth shop and watching and observing and participating in the casting of ingots and the rolling of slaps.

11:00 Why the Titanic Behaved as Brittle as Glass

Wu:

Wow, what a fascinating connection! So, I was just curious, for the Titanic, when was it built? And, how was that-well-known event connected to metallurgy?

McLean:

Normally, trials at sea for a new ship might take a couple of weeks, but, for the Titanic, it was one morning. One morning outside Belfast [in 1912], that was it, and then it was on its way. In fact, they were in such a rush to sail and get across the Atlantic, it turned out that the crew that they used for looking ahead to see if there's any problems – there were a couple of members of the crew up in the mast, right at the front of the ship, called the crow's nest, with binoculars normally watching for any ships or icebergs. It turned out they were in such a rush to sail, they sailed without any binoculars. And, if these guys up there in that crow's nest had been equipped with binoculars, they would probably have spotted the iceberg a little bit sooner than they did. And, that alone might have saved the Titanic.

You know, it's often reported, and it's true that the Titanic had steel with a high sulfur content (with 650 ppm), but that was typical sulfur for steel at that time. It's just the ship was not built to be an icebreaker; it was meant to sail the ocean. That steel was sufficient for that purpose, but it sure was not appropriate when it hit an iceberg where the temperature of the seawater was probably about zero [degrees Celsius]. At that temperature and 0.065% sulfur in the steel, subsequent tests – in fact I have a piece of that Titanic steel that was brought up from the Atlantic Ocean, received it from the Mines Branch in Ottawa – that steel, when you do a charpy test on it at that temperature, zero degrees C [Celsius], it had the ductility of glass. In other words, no ductility at all, brittle as glass. So, it was a very unfortunate combination of circumstances that led to the disaster of the Titanic.

13:16 Pursuing a PhD in Chemical Metallurgy – The Influence of Professor Robert Hay

Wu:

Fascinating story, fascinating connections. And, later, of course, you completed your PhD in Metallurgy at Glasgow as well. And, what convinced you to pursue an advanced degree, and why chemical metallurgy?

McLean:

Well, a couple of interesting questions, Paul, because, as it turned out in those days, it's very different from today, because it's some time ago. In those days, the head of the department who happened to be a very fine gentleman called Professor Hay, Professor Robert Hay. He was close to retirement when I joined the department and finished my bachelor's degree. But, he approached myself and one other student in the class, a chap, a good friend of mine by the name of Archie Vetters. He stopped Archie Vetters and myself in the hall just after we had completed all our exams for our bachelor's degree, and he said, "How would you two fellows like to do PhDs?" Because we didn't do masters at that time, you went straight to a PhD. So, we both looked at each other and thought, yeah, that might be a good thing to do.

And then, Professor Hay, he said to Archie and myself, he said, "Vetters," that was Archie's second name, "Vetters, you're better than McLean at math. So, you'll do physical metallurgy." And he said, "McLean, you're better than Vetters at chemistry. So, you'll do chemical metallurgy." So, each of us ended up doing that. But, the interesting thing was Professor Hay had got it back to front: I was actually better than Archie at math, and he was better than me at chemistry. But, we didn't dare contradict him. So, he ended up doing physical metallurgy. Did very well. Worked in Scotland for a while, and then ended up as director of the Welding Research Institute in Australia. And, of course, as you know, my path was then in the field, through the field of chemical metallurgy. So, that's how I got started in it.

Wu:

That's great.

15:35 Post-doctoral Fellowship at McMaster University – Relocating to Canada

Wu:

After receiving your doctorate, you relocated to Canada within a relatively short time. What event prompted that move?

McLean:

Well, I was still at Glasgow, of course, at that time. I was actually an assistant lecturer. They'd appointed me as an assistant lecturer, so I was getting some experience of what it was like in academia. Professor Bell that I had worked with there at Glasgow, he received a letter from a gentleman called Professor Robert Ward, who came originally from Sheffield – a steel center in England – and had moved to McMaster University in Hamilton, Ontario – not Scotland, Hamilton, Ontario. He was in charge of steel research at McMaster. And, Professor Ward had received funding from one of the local steel companies there; the two local companies, one was Stelco, the other was Dofasco. And, Dofasco had provided money to bring in a post-doctoral fellow to work on inclusions and [deoxidation].

So, he wrote a letter, Professor Ward wrote a letter, to Professor Bell saying, "Do you have anybody there that's just finished their doctorate, who might be interested in coming to Canada for a couple of years and working in association with Dofasco on deoxidation and inclusions?" So, Bell suggested to me that that would be a good thing to do for a couple of years, good experience. So, I discussed it with my wife. We had been married at that time for a couple of years and thought, well, this might be an interesting activity, to move over to Canada. It's a two-year appointment. So, we decided we'd make a move, said goodbye to our parents, and sailed over from Glasgow to Montreal, took the train to Hamilton to work at McMaster for a couple of years with Bob Ward.

17:34 How Two Years Turned into A Research Associateship with Dofasco

Wu:

And, it turns out it wasn't just two years, was it?

McLean:

No, no. That's right, as the two years came to an end, because that was the length of time that you're allowed to hold a postdoctoral fellowship, I'd had a good two years there -- really appreciated and enjoyed very much working with Ward's group there and visiting Dofasco and various other companies. But, at the end of two years, I remember visiting again Dofasco with Bob Ward and meeting with the vice president there, a very fine gentleman called John McMulkin. He was responsible for bringing the converter steel making process known as the BOF, at that time it was called the LD, Linz-Donawitz process. He was responsible for bringing that process from Austria into North America. Dofasco was the first company in North America to install an LD.

So, it was nice to work with McMulkin. However, all of that to say, Bob Ward and myself visited Dofasco and Ward told McMulkin, "Well, the post-doctoral fellowship is coming to an end, and McLean will be heading back to Scotland."

And, McMulkin said, "Is it not possible for him to stay here a bit longer?" And, I would just sit listening to all of this. I wasn't involved in the conversation. I'm just listening to Ward and McMulkin talking away there.

And, Ward says to McMulkin, "Well, he could stay on, he could stay on, but he can't stay on as a post-doc anymore. He would need to be promoted to what we call a research associate."

So, McMulkin, who liked to kind of poke fun at me as a Scotsman – he had a kind of Irish background, I think, back in his heritage – but he used to tell me his wife had a Scottish background, and this caused him a lot of problems, he said. So, he said to Ward, "That probably means we'd need to pay McLean more money."

And, Ward said, "Oh, yes, you'd need to pay him more money, if he moves from a post-doctoral fellow to a research associate."

And, McMulkin says, "Well, how much would we need to pay him?" And, at that time, I was getting $5,000 a year as a post-doctoral fellow, which was good money. And, Ward, to my astonishment, Ward says to McMulkin, "Oh, we'd need to increase it to $10,000," doubling what I was getting.

And, McMulkin said, "Oh, that's a lot of money," he said, complaining about what it would cost. Dofasco's an outstanding company, at one point, it was the most profitable steel company in the world. But, he agreed. So then, I carried on as a research associate. It was the only time in my career I ever doubled my salary in one go, and I stayed on as a research associate. So, that was what happened.

20:29 My Mentor and Friend, Bob Ward

Wu:

Well, Professor Ward is what I would call a wonderful mentor, who is also capable of doubling his associate's salary. That is a great story. I gather that Bob Ward eventually moved on to Australia? What can you tell us about that? What happened to your career afterwards?

McLean:

That's right. Bob received an invitation from BHP in Australia inviting him to join the company, a steel company, the major steel company in Australia, to join them as the director of research. They had major research facilities in a couple of locations, but they wanted to start a new one in Melbourne; and, that was going to be a physical metallurgy lab. They wanted Ward to head that up. So it's going to be based in Melbourne. And, I remember him saying to me, "This is going to be a physical metallurgy lab, but I would like to continue doing some work in that location on chemical metallurgy. Why don't you come with me to Australia, and you can look after the chemistry laboratory inside the major physical facility?"

Oh, I thought about it. "Oh no, Bob, it's a long way to Australia, to get back from Australia to visit Scotland. Oh, that's an awful lot more difficult than traveling from Toronto to Glasgow." Because you can do Toronto to Glasgow in just under six hours. It's a lot longer from Australia. I said, "No, I don't think I want to do that."

So, he left and went to Australia, and we kept in touch right through many, many years until he passed away a few years ago. He was a very good friend, gave me a lot of good instruction, advice, and mentoring. But, I stayed on at McMaster. It turned out, when he left, that created a faculty position. No, I didn't move into the full professorship that he held, but I did join McMaster as an assistant professor. And, I continued in that role for a couple of years, and then I got tenure, and they promoted me to associate professor.

22:50 A Change from Academia – Working Full Time in Industry

Wu:

Yeah. It's an astonishing achievement that you received your tenure within just two years. And, shortly after, to the surprise of many, you went on to join a steel maker. Where did you go and what motivated you in making that decision?

McLean:

Well, that's an interesting kind of scenario, Paul, because I thoroughly enjoyed my time at McMaster. I thought I was going for two years. In fact, I ended up being there five years, and, as I say, I really enjoyed the work I had there, worked together with a couple of other professors. We formed a small group and really enjoyed working together, but it was a situation where my university research had really become really too consuming. Too consuming at the expense of family life, and, in that sense, I realized that this is not good. When I received a phone call from a steel company in Pittsburgh called Jones and Laughlin, they were looking for somebody to head up a deoxidation and casting group and asked me if I would be interested in moving. And, when I put the two together, I thought, boy, maybe I need a change from academia.

I certainly would appreciate working full time in industry because I had been doing some consulting work for industry while I was on the faculty at Mac. But, there's a big difference from being a consultant and, as you would well know, from working full time in industry. And, I thought, here's an opportunity to move to a steel company, a steel company that is regarded very highly. Because I'd heard their presentations at conferences and the papers were generally coauthored by people from research and also people from production, and that intrigued me. That the production people and the research people were working together and publishing coauthored papers, I thought, boy, I like that. So, when I got a call from that company asking me, would I be interested in joining them, I thought, this is the opportunity to make a change. And, I did, moved to Pittsburgh and joined J&L.

25:17 Jones and Laughlin Steel Company – Industry vs Academia Relationships

Wu:

Yeah, I've heard great stories about J&L. And, as the supervisor, you joined the steel deoxidation and casting research group, as the supervisor of that group. What were your job duties like?

McLean:

Well, it was a great experience, I have to say, Paul, because in that capacity – what was then called no longer exists, I'm afraid, but was then called Graeme Research Laboratory in Pittsburgh – I was involved in conducting laboratory experiments and having a team of people conducting laboratory experiments. Also, they had an excellent pilot plant, which I was responsible for, and that allowed us to scale things up and work with larger sized furnaces before going on to do actual tests on production facilities.

So, it really was a marvelous opportunity to follow something through from laboratory scale experiments through pilot plant trials and then, as I say, testing on production facilities. At that time, J&L had steel plants located in Pittsburgh, in Detroit, and also Cleveland. So, I had the opportunity to visit these different plants, taking part in different trials and so on. It was just a great experience, one I never, ever regretted, never did. It was so good for me.

Wu:

And, were there any particular challenges you recall from transitioning to industry from academia?

McLean:

I think the biggest challenge for me, because while I was an academia, sure, I reported to the chair of the department, but that's a pretty kind of relaxed linkage. Whereas, when you're in industry, there's a pretty tight chain of command that goes through the system. While in academia, you may be working with your own research group and students working with you. Again, as you know personally, once you're into conducting plant trials – and, again, you'd be very much aware of this yourself, Paul – you have to rely on receiving a lot of help from shop floor operators. And that, to me was very much a different kind of relationship from working within academia.

It was a great challenge, and I thoroughly enjoyed it, I must say, and made some very good friends. Because, in conducting these plant trials, you don't do it by yourself or even with your own team from research. It involves the people on the shop floor, and you're very much relying on them for their support and their input and for their advice and their observations that they have collected over many years. So, again, a great learning experience for me, and I never forgot it.

28:16 "You Can't Lose" – Pursuing Passions in Academia and Industry

Wu:

Absolutely. Collaboration is key in the industry. And, while you were at J&L, did you have any particular influences or mentors that you found were very helpful and you learned a great deal from?

McLean:

Well, when I look back, Paul, names that kind of stand out, and there were a good number of names that stand out, first, the gentleman that recruited me, his name was Bill Dennis – another Englishman, I seem to always end up working for Englishmen, strange thing. But, Bill Dennis had taken his doctorate at Imperial

College in London, England working with Richardson, working on chromium/carbon relationships and stainless steel. He was the one that had hired me, and he gave me a lot of good advice.

I can remember when I first had an interview with him, and I was trying to determine where I should go. Should I leave university and join J&L? And, he said an interesting thing to me, which I never forgot. He said, "Well," he said, "Look at it this way, McLean," he said. "If you join us, even if you only stay with us for two or three years," he said, "if you go back to academia after being at J&L for two or three years, do you think you would be a better professor or a worse professor?"

And, of course, the answer was obvious. "Oh," I said, "I'd be better if I spent time in industry, I'm sure." And, he said, "Supposing it turned out that you join us, and you prefer industry to academia, it would be a good thing you made the move."

I thought, boy, that's right. He said, "So, you can't lose." I never forgot that. He said, "You can't lose by joining us." So, he was a great friend, and he kept in touch with me after I left J&L and went back to academia and was responsible for a number of activities that happened later on while I was in academia at U of T.

30:20 Folks Who Greatly Influenced My Research

McLean:

Another person that I reported directly to, was in charge of the various groups there at J&L, was a gentleman by the name of Egil Aukrust. And, he came from Norway originally, and he had a great background in steel research. I learned a lot from him, too. Then, another gentlemen that I still keep contact with, he worked as a member of my group, but he really was senior to me. His name was Leon Luyckx, and he came from Belgium originally. Boy, did he know stuff about inclusions. He had studied back in Belgium, mineralogy and geology.

So, he was a great microscope man, and, boy, when we would go into the plants – he had been there of course many years before me – although I was his boss, he knew an awful lot more about what was going on than I did. And, he was a great teacher to me, and I never forgot Leon. I owed him a great deal because he sure helped me when we would go into plants to conduct trials and so on. And, he really gave me a lot new understanding of the factors that influenced the formation of inclusions, not only deoxidation, but reoxidation and interactions with slag and refractories and that kind of thing.

These were folks that, when I look back, had a big influence on the kind of research that I then subsequently got involved in when I returned to academia.

31:54 Returning to Academia at the University of Toronto – Following Benjamin Alcock

Wu:

And, returned to academia you did. And, as you have mentioned, after working for J&L, you did return to academia, and this time to the University of Toronto. And, for more than half a century, you stayed at the University of Toronto. Why did you choose Toronto?

McLean:

Well, I looked at different schools that had interest, obviously in steel making, and the thing that caught my attention at Toronto, they had a very good guy there by the name of Professor Harry Ross – who was

looking after ironmaking and steelmaking, but his particular strength was really blast furnace ironmaking, iron ore, direct reduction processes as well. He did a little bit of steelmaking, but his background was really iron making. I thought maybe they might be interested in somebody with a background more in steelmaking?

Just about that time, a gentleman – another Englishman, again – by the name of Benjamin Alcock, again from Imperial College in London, England, he moved from Imperial College to Toronto. That would be a 19... Let me think, it would be 69, 1969, he moved from Imperial. At that time, he would be in his early forties. It struck me, if he is – and he was a senior professor at Imperial – if he is moving with his family from England to Canada, to Toronto, specifically, that's going to have a big impact on Toronto. So, I contacted him to see whether there was any possibility of a position at Toronto in the area of steelmaking.

And, things were very different from how they are today, I have to say, Paul. I had an interview with him on a Saturday morning, I met him in his office in Toronto on a Saturday morning, just him and I, and we talked together. At the end of it, he said, "Well, you would be a good partner for Harry Ross because Harry Ross is an ironmaker. You would come in as a steelmaker, and I would like to strengthen the area of iron and steel in Toronto." And, that was it. I got the job. Today, oh, you'd have to have a search committee established, you would advertise the position, you'd go through all kind of things. It would take weeks, and maybe two or three months, before an appointment was made.

In my case, it was all over. It was all over in the morning. Maybe today I wouldn't have been able to get that job, but I did then. And, boy, Ben Alcock turned out to be a great mentor and a great friend, also. He was the one that said to me after I'd only been there, I guess, maybe two or three years, "If you really want to accomplish significant things in your research group, make sure you have a good second IC."

In my ignorance, I said, "What do you mean by a second IC?" And, he said, "McLean, a second-in-command. You need to have a good second-in-command. Somebody that knows all that's going on so that you're not trying to do all by yourself. Because if you try to do it yourself, you'll limit how much you can accomplish." And, I never forgot that.

And, over the years, I ended up with three at one point, three at the same time, three seconds-in-command, all people that had their doctorates, some of them experienced in industry. And, boy, that really strengthened the group and allowed us to do things, to broaden our areas of activity that we could never have done if I had been doing it just by myself.

35:32 The Ferrous Metallurgy Research Group's Milestone – AISI Distinguished Professorship

Wu:

And, it's a great research group you had, and this research group, called Ferrous Metallurgy Research Group, you have built this up over the years, and it was recognized and funded by industrial partners. What was a major milestone that helped establish the group back in the day?

McLean:

Well, there's no doubt in my mind, the trigger that really kind of set us off on a good track, and that was when the American Iron and Steel Institute, AISI, they decided in their wisdom, that they would award, or create, a new type of award called AISI Distinguished Professorship. They created two of them at the same time, and one was awarded to the late John Elliott at MIT, and I received the other one at Toronto. And, this AISI Distinguished Professorship carried with it research funds of a hundred thousand dollars a year, for five years. So, having that foundational funding, a hundred thousand a year – which was a lot of money at

that time – for five years, really gave us a great foundation to build on for subsequent support from other steel companies because, of course, many, many steel companies were members of the American Iron and Steel Institute.

And so, presenting papers at AISI meetings, and meeting other folks from different steel companies, that, it was like a rocket taking off for the moon. That really gave us a great boost. It was a great boost to have that professorship for five years. I remember when I did get that so-called distinguished professor, one of the students – certain things stay in your mind – one of the students said to me, which I thought was marvelous, he said, "Remember, after distinction comes extinction." It was a very humbling experience. Fortunately, extinction hasn't happened yet. So, I'm still here, but that was his advice. Remember after distinction comes extinction.

37:56 Measurement Comes First, Model Comes in Support – You Can't Control What You Can't Measure

Wu:

That is a great phrase there. What is your research philosophy you run in that group?

McLean:

Well, I think at this particular age that we're in, there is a great deal of time that researchers spend on computer modeling. I think it's important that we don't forget the importance of measurements, because these measurements then provide a proper basis for models. And, it's not a case of saying measurements or models. They really should be considered as two interdependent entities when evaluating, say, current operations or investigating possible new processes. They really go together, but measurements are crucial. And, when I think of measurements, I think of Lord Kelvin.

Lord Kelvin, I'd like to tell you, was a Scotsman, but he wasn't. Lord Kelvin came from Ireland, but he moved to Scotland when he was only two years old with his parents. Lord Kelvin, of course, we know the name well from the temperature scale; we've got degrees Celsius, degrees Fahrenheit, and degrees Kelvin. He gave his name to that scale. Lord Kelvin became the youngest professor of physics, actually appointed at Glasgow University. He was also responsible, in charge of the team, that laid the first communication cable between the United Kingdom and North America, and that had a lot to do with him receiving his knighthood.

So, all of that to say, Lord Kelvin, he knew the importance of measurements. And, he said an interesting thing, which I used to quote to the students when I was still teaching. He said, "When you can measure what you're speaking about and express it in numbers, you know something about it. When you cannot measure it, your knowledge is meager and unsatisfactory." That was strong language. In other words, he was really saying a phrase that we've used throughout our group, as you know well Paul, "You cannot control what you cannot measure; so, measurements are crucial, a crucial part of models."

Wu:

Absolutely. Measurement comes first, model comes in support. And, that's a great phrase.

41:55 Transforming the Metallurgy Department into Materials Science and Engineering

Wu:

And, during your time at the University of Toronto, you also served as the department chair for a number of

years, and it was during a time where the undergraduate curriculum was being transformed to materials engineering from the metallurgy-heavy department to reflect a broader learning area. What challenge did you have to overcome during this time?

McLean:

It was a very interesting period at that time, I have to say. That was between '92 and '97. I served as chair, and our undergraduate numbers were not large. We tended to have small numbers, maybe of the order of, oh, 15, 20, 22, 24 students. But, that was small in comparison to the numbers in departments such as electrical engineering, mechanical, chemical engineering. So, the faculty really wondered, with that small number of students, should we continue to exist as a department?

And, a committee was formed within the faculty to look at how we might proceed, and consideration was given to the possibility of splitting the department, in what seemed a very logical way to split it, between chemical metallurgists and physical metallurgists. The chemical metallurgy people would join the chemical engineering department, and the physical metallurgy people, they would join the mechanical engineering department. And, all of that seemed very reasonable because in many other universities, that's exactly where you would find these people. The chemical guys would be with chemical engineering, the physical guys would be with mechanical; however, the department, needless to say, did not feel good about splitting in two. We did not like that idea at all.

So, there was a big effort made, a big campaign within the department, to visit high schools. And, I have to say, that the faculty within the department did an extraordinary job in making a major blitz of high schools to inform them, not just what metallurgy was about. But, because we were moving into other materials such as biomaterials and dental materials, the name of the department was going to be changed to recognize that. Then, it would be called Materials Science and Engineering.

And, these two things, changing our name and changing our program structure, and recruiting many more students, so that now the undergraduate students are generally 50 to 60 per year, that made a big difference back then. The decision was made by our faculty, thankfully, that we could remain as a united department rather than splitting us up. And, of course, since then, we've had excellent leadership with Doug Perovic serving for 10 years as chair, you [Paul] knew him well, and Jun Nogami, another 10 years, and now, Glenn Hibbard leading the department. It's well and truly established as one of the leading departments in North America.

Wu:

Yeah, during that turbulent time, it's safe to say that, under your leadership, the department was saved, and I am very grateful for that. For having the opportunity to go through that program myself, and it was truly an outstanding program. So, thank you.

McLean:

Most welcome.

Wu:

Thank you for saving the program and the department.

PART 2

00:28 The Forth Bridge – New Technology, New Materials, and Collaboration Abroad

Wu:

Do you have any particular examples that you can think of that made working in this field particularly meaningful to you?

McLean:

Well, when I think of that, Paul, I really think in terms of bridge building, as I see bridge building as being a very important aspect of the involvements of an engineer. And, perhaps by way of example, to illustrate what I'm really getting at, I would mention the Forth Bridge - that's F-O-R-T-H, the Forth Bridge named after the River Forth in Scotland - just a few miles from Edinburgh, the capital of Scotland.

The Forth Bridge was constructed in 1890, and, at the time it was built, it was based on the cantilever structure. And, a cantilever structure, of course, came from the Far East where bridges were built of bamboo. When the Forth Bridge was being designed, based on this cantilever structure, it was also the intention to use as a raw material, steel. And, there was great concern by the British government about using this, what was then called, a new material. That was the terminology, a new material called steel, for a major structure that was proposed like the Forth Rail Bridge.

It was a train bridge to carry train lines for the railway - the Forth Rail Bridge. Because a few years earlier, just a little bit north of the River Forth, is another river called the River Tay. And, the Tay had a bridge built over it, built of cast iron. Unfortunately, on a Christmas night in a heavy, heavy storm, a train going over that cast iron bridge, the bridge collapsed, and the train went into the River Tay. Many lives were lost. So, the government was very concerned this accident, that happened a few years before, using a conventional material: cast iron, the proposal was now to build a bridge over the River Forth, using steel, a new material. So, they were very suspicious, very worried.

So, the designers concluded they would prepare a model, and they prepared a model, and they put this on show at the Royal Society in London. I said the Royal Society, the Royal Institute - the Royal Institute in London. And, the model consisted of two men sitting on chairs. You've got to picture this: one man sitting on a chair with his arms outstretched, up like a cantilever, and another gentleman a little bit away from him, his arms up, outstretched like a cantilever. And, suspended from each of their arms, their outer arms, there was a load of bricks to carry the load. And, in the center between the two men, there was suspended on a small platform, a Japanese gentleman. The reason the Japanese gentleman was sitting in that suspended seat was to pay tribute to the fact that the concept for this bridge had come from the Far East. It was not something developed in Britain.

The cantilever principle was knowledge that had been brought from abroad, and the Japanese gentlemen sitting in that seat was a testimonial to that knowledge transfer process. Of course, the bridge indeed was built, and that steel bridge is still there today. And, it still carries the main train line from London through Edinburgh, across the River Forth and up north to Aberdeen. The bridge is still there. It's a great example of new technology, new materials, and collaboration involving knowledge transferred from different sources.

Wu:

Definitely.

05:31 Consequences of Modeling Without Measurements – The Icelandic Volcanic Eruption of 2010

Wu:

Can you think of an example where models without measurement can be an issue?

McLean:

Well, Paul, there's one that I have used in some of my lectures, not so much now, but back at the beginning of, I guess between 2010 and 2015-2016. In a number of lectures I gave, I would use, as an example – because if you recall back in May 2010, there was an eruption of the volcano in Iceland, and, of course, Iceland is noted for volcanic action, Back in May 2010, the volcano erupted there and resulted in closing of all the airports in Britain. But, one in particular was Heathrow, the closing of Heathrow. The airports were closed by action of the Civil Aviation Authority. It turned out, subsequently, that this was a mistake. It had been reported that the level of dangerous black ash, which comes from the volcano, of course, in the air over London was above a safe threshold. That was actually reported, the black ash is above a safe threshold. But, when the Met Office sent up a plane to check the dust levels in the sky, there was no dust there. The dust levels were safe, there was no evidence of any concentration of black ash, so the airport had been closed for no reason.

The British Airways Chief, a gentleman by the name of William Walsh, he reported – and it was published in the Daily Mail, May 18th, 2010 – he reported, "I am very concerned that we have decisions on the closing of airports based on a theoretical model." Boy, that had tremendous consequences on the traveling public, and that decision had actually been based solely on modeling with no measurements taken at all. So, it was a great warning: be very careful with models, make sure you have measurements to support them because otherwise the models can be misleading and can lead us astray.

Wu:

Absolutely. It just doubles the careful nature that we need to have with measurements and have measurement-supported models when we're making decisions.

08:36 Educating the Next Generation of Engineers – Humorous Students and Fond Memories

Wu:

I'd like to move on here. You're definitely a great mentor to many, your students call you “The Chief.” Do you have any particular moments that you can recall which represents all the years that you have devoted to educating the next generation of engineers?

McLean:

Well, I'll tell you, Paul, it has been a great career. No question, I've thoroughly enjoyed it. I'm reminded of a story about my daughter, Helen. My daughter, Helen, when she was still in junior, junior-high school, the teacher went round the class and was asking the different students, " What does your father work at?" When she got to Helen, Helen said something that I've never forgotten. They say professors are absent-minded, and I would agree with that, at least for myself. I don't have a really good memory, but I do remember this. Helen's reply when asked, "What does your father work at?" Helen's reply was, "My father doesn't work. He's a professor, and he just talks."

I've thought a lot about that. I thought, that's right, I really don't work because I enjoy what I'm doing.

When you enjoy what you're doing, it's not really work. The people who are doing the work are the students. The students have to take exams, they have to study, they have to do research to prepare papers to write theses. The students do the work, and I've benefited from all of the enjoyment and the fun, too, that comes with working with students.

When I say that, I'm reminded of the fact that, back at the time when I got that AISI Distinguished Professorship appointment – back in the early '80s – the graduate students did a great thing. They built a steel podium, a full-size podium, equipped with two handcuffs – a handcuff each side of the podium, if you can imagine it. On the platform of the podium, the actual podium where you would lay your papers, they had imprinted on that by welding metal the title AISI Distinguished Professorship. But, the idea of the two handcuffs was to keep me locked at the podium, so I didn't drift away and go off on trips and visits.

11:11 My Students' Jokes, A Ball and Chain, and A Cop's Inquiry

McLean:

A year or two later, they carried that even further. At dinner, a student banquet, a student annual dinner, they presented me with a ball and chain. Again, they had made it in the foundry, and, boy, that steel ball, it was about six inches in diameter. I could hardly lift it. It was attached to a chain – if you can picture it, the chain – and, at the other end of the chain, it could lock onto my leg. So, that's what they did at the banquet. They locked this chain onto my leg, and I had to hold and carry this ball as I moved around. Then, towards the end of the banquet evening, they gave me a ring with about a couple of dozen keys on it, so I could unlock the padlock that had locked this thing around my ankle. Well, after I had tried about three or four or five keys, I thought I'll bet the key that unlocks this padlock is not even among these keys they've given me. I was right, it wasn't.

But, fortunately, they took pity on me and gave me the key that allowed me to unlock the bangle thing around my ankle. And, I was able to get the ball and chain off and carry it down into my car, and put it into the trunk of the car. And, I drove off. I was driving out along the main street by the university, did a left turn through a light, moving down through the street. And, suddenly, I see a flashing red light behind me – 7:30 at night. A police car stops me. Policeman gets out, comes to the window – all I can see is the side of his gun looking through the window. He said, "Open the trunk of your car. You just went through a red light."

I said, "No, no. I didn't go through a red light." I said, "I went into the middle of the intersection, the light was at green, I waited on people completing the crossing; and, when they had completed the crossing, the light turned to red, I cleared the intersection."

"Out," he said. "Open your trunk." I thought, I've got that ball and chain in the trunk, if I open that and he... So, I explained to him. I said, "I've got a ball and chain, and I told him the story of the students, how they'd given me it and so on, and that I hadn't really escaped from prison. Opened the trunk, sure enough, there was the ball and chain. He said, "We just wanted to make sure there's no drugs there," and, of course, there wasn't.

So, I was okay, but can you imagine, Paul, what would have happened if I had still been wearing that ball and chain, and he asked me to step out the car? He would probably have shot me, at least in the foot. So, I was very thankful the students gave me that key that allowed me to un-padlock the padlock and travel without the ball and chain round my leg. So, great memories when I think back of experiences with the students in my time teaching. Thoroughly enjoyed it.

14:23 The Core of Education is the Transfer of Knowledge

Wu:

You're definitely well loved by your students, and your students are humorous and definitely talented, so a really good story. Thank you for sharing that. In your opinion, what is the core value of education?

McLean:

Well, I'll tell you, Paul, where we are in university, it's really a place – again, you know from your own experience – where knowledge is generated, hopefully validated, and certainly a place where we should communicate what we have found. So, if you sum all of that up, it's a place for the transfer of knowledge between groups, between industry and academia, between different professors, between different schools.

The core of education is the transfer of knowledge. When I think of that, I'm reminded of a good example of the influence of effective communication, say between a teacher and a student; and, that example concerned Socrates. Socrates was a great thinker, a great teacher, but he never wrote a book, never wrote a book. But, his teachings and his philosophies were recorded by one of his own students, Plato. Plato recorded them, and then Plato, in turn, he went on to become a noted philosopher. Plato established what we know as the world's first academy in Athens. At that academy, at the age of 18, Aristotle joined the academy, and he studied under Plato. After leaving the academy, Aristotle was invited by Philip, the king of Macedonia, to tutor his young son. And, the young son, we now remember as Alexander the Great. So, to me, this is a great example of teacher-student interactions and the chain of influence that extends from one generation to another: from Socrates to Plato, from Plato to Aristotle, and from Aristotle to Alexander the Great. It's a great example of effective communication.

Wu:

So. pass down of knowledge, being able to pass down true and important knowledge to the next generation.

McLean:

Yeah.

17:34 Friendships Are Established, Contacts Are Made – Benefits of Professional Societies

Wu:

That is fantastic. So, you have been also a very active member in a number of professional societies. How did your involvement progress over the years?

McLean:

Well, if I go back to my time at McMaster, Bob Ward was the first person that introduced me to the Iron and Steel Society. At that time, it was the Iron and Steel Division of the Metallurgical Society of AIME - it was a division of the MetSoc of AIME. I first attended conferences with Bob, and that got me started in these society meetings. Of course, within Canada, we have the CIM, Canadian Institute of Mining, Metallurgy and Petroleum, with the annual Conference of Metallurgists. I think through these conferences, great benefits were obtained. You are meeting different people, you are interacting with folks with totally different backgrounds: folks from industry, folks from research departments.

Over the years as your involvement increases, and, again, you've experienced this personally, Paul, you become involved in the committee structure. Serving in these committees I always found was a great thing because they were very functional committees. These committees within societies existed for a purpose, and they always had very specific items of business that needed attending. So, it was never wasted time. In fact, you always felt that things were being achieved and things were accomplished. Over the years, I served in a number of capacities, and, finally, for the Iron and Steel Society, I served as president in 1985. Of course, during that time – the years on either side of it – I served on the AIME board and met the people from the other societies, the societies that are members of the AIME. Again, friendships are established, contacts are made, communication. It has been tremendously beneficial throughout my career, and I've always encouraged, as you know, Paul, encouraged the students to participate in the professional societies.

20:12 AIME Honorary Membership

Wu:

Fascinating contribution. Of course, in 1992, you were recognized by AIME with the honorary membership, one of the institute's highest honors to recognize the contributions you have made to the professional society. The citation of that recognition reads, "An outstanding teacher in the iron and steel industry whose contributions to the Iron and Steel Society and the field of ferrous metallurgy have yielded significant benefits to practicing engineers and managers in the industry." What can you tell us about this?

McLean:

Well, Paul, knowing that this has been done for AIME – and being very appreciative of the fact that they kindly made me an honorary member back in 1992 – I got my AIME medal out of the glass case that it's in here at home, and decided to wear it, right at this point in time. So, I'm now wearing my AIME medal. I hope you can see it there. It has been a great honor; it really has to have that recognition from AIME. What a wonderful establishment it is, and has existed so many years now, so many years, and, influencing in so many ways, not only our profession, but the mining profession, the metallurgical profession, the petroleum profession. It has had a great influence on people.

Personally, just being involved within AIME – and, of course, specifically within the Iron and Steel Society, and now the AIST – the opportunity to participate in short courses was a great help. These short courses were sometimes held at conferences, but sometimes they were stand-alone events held within specific company locations - certainly within the US and Canada, as well as some countries abroad. To me, these short courses for plant people, people involved in operations – as well as research – it was a great chance to share experiences.

22:51 Knowledge Through Experience – Monitoring Processes Through Vibrations

McLean:

I remember one particular course; I was talking about an experience I had had when I was visiting Hungary. In Hungary, I visited a steel plant. And, for the first time, I saw them monitoring the vibrations that are generated when gas is bubbled through molten steel contained in a ladle. Now, the bubbles rise up through the steel, as you well know, and send out vibrations. And, these vibrations go right through the refractory to the steel shell, and the Hungarians were measuring that vibration. But, in addition to that, they were also listening with a microphone and listening to the bubbles breaking the surface.

Now, all of that, the vibration and the sound of the bubbles, is influenced by the surface tension of the steel, which in turn is influenced by the sulfur content. So, when they were desulfurizing the steel by

injecting desulfurizing agent with a carrier gas and listening to the bubbles, as the sulfur decreased, the surface tension increased and the vibrations and the sound changed. By monitoring the vibration with a monitor and listening to the sound, or doing either one, they could follow the desulfurization process. So, monitoring with vibration as a control tool, to me, was fascinating. So, I was telling this to the operators in this particular steel plant, and one person, an operator, he said, "Oh, I do that where I work."

I said, "Oh, what exactly do you do?"

He said, "I'm in continuous casting."

I said, "How do you use vibration there?"

He said, "I use vibration to tell me when slag is coming through from the ladle and going into the tundish." Again, Paul, as you know, that's one of the things you want to avoid as much as possible is slag carry-over from the ladle into the tundish, which happens when the level of steel in the ladle is getting close to the bottom. He said, "I put my foot on the stand that holds the tundish." And, he said, "The steel comes from the ladle through a submerged nozzle into the tundish." He said, "When the slag begins to come in, instead of steel, it vibrates differently." He said, "If I've got my foot on the side of the tundish, I can feel it, and I know the slag is beginning to come over, and I stop the pour."

Well, man, oh man, I'd never heard of that before, but there was an example of an operator. And, when he told the story, there were other operators in the room, and they didn't know that story either. He'd never told anybody else about it. So, maybe one or two people knew it, but certainly a whole host of them didn't.

So, here was an example of where experiences generated by the operator is often lost and not transmitted to other folks who might be able to make use of it in other locations. Now today, we monitor vibrations in blast furnaces and ladles, and BOFs, and submerged entry nozzles, all kinds of things. But, at that time, it was a very unique kind of thing. It was a lesson to me that, if you can, get in touch and keep close contact with the operators on the shop floor because they've developed a lot of experience and knowledge over years. And, it's not necessarily published, and it's not always transmitted. So, my message there, listen to the operators.

Wu:

That is another great example of how measurement is very, very important. You've got to be able to measure, and then you can learn something from that measurement.

26:48 Professional Societies, A Vehicle for Communication and Knowledge Exchange

Wu:

Definitely, would you say that because of your involvement with your professional membership that has brought you to these particular experiences, that you were able to learn and come back and share with the committee and with the professional society at large?

McLean:

Absolutely. Absolutely. There is no doubt in my mind, Paul, that, through the society... without the society, I doubt very much, if all of this would have happened. To me, membership of the professional society has been an integral part of our research activities at Toronto and of this whole business of knowledge

exchange. I use the word exchange, it's obviously two way. It's not just the knowledge transfer from academia to industry, it's knowledge being transmitted from industry back to academia. So, it really is an exchange. It's like a good telephone conversation, if only one person is talking and not listening to the other, it's really not communication. It takes two to communicate. The whole idea of the word communication, it's the same root that goes to the word communion and community. So, it takes more than one person to be involved in it and working through the society has been a great vehicle for communication.

Wu:

How do you see societies benefiting the people in industry today?

McLean:

Well, as I say, Paul, it's been a great opportunity and is a great opportunity still for people in the industry to be involved, as I say, in committees: to establish new friendships, to perhaps meet with people that normally they wouldn't meet. They wouldn't be in the same room because they operate in different sectors. So, by participating in these kinds of activities, it sure opens up doorways and pathways for exchanging knowledge and communicating from one sector to the other. I think anything that helps to do that is a good thing. And, I cannot praise enough, the AIME and the various societies that I've been involved in through that. It has been an excellent experience and a very profitable experience, and I would encourage people who are maybe coming into the industry today, make sure you get involved in a professional society.

29:30 Encouraging Students to Become Involved in Society Conferences and Committees

Wu:

Great. If you were to recommend your member society that you have been actively involved in to a new graduate or present student going through the engineering program, what would you tell him or her about it?

McLean:

Well, if they have the chance to do it at all, and, of course, there's members of our group at Toronto. You well know, Paul, a very important aspect of all of that was students spending time preparing presentations, preparing posters, writing up manuscripts for presentation at the conferences and publications and journals. The social events that are associated with these conferences, plant visits that are often associated with the conferences, potential contacts with possibly future employers, all of that comes about through attendance at these meetings and conferences.

To me, it was time very, very well spent when students were going through these kinds of activities and then going on to visit and participate at society meetings. So, I would always encourage students, as soon as possible, take out student membership, become involved, because some of these committees involve student members as well. They look to have student members and getting them involved in the society. It's a great part of the learning experience. Whether you're an undergraduate or a graduate student, it's a great part of the training program, and, I have no doubt at all, subsequently has tremendous benefits on your professional experience and professional development.

Wu:

I couldn't agree more. I think personally, having gone through and still actively involved in conferences and committee meetings, knowledge exchange and being able to meet people are definitely one of the most crucial parts in career development. So, thank you for promoting that aspect.

31:57 The McLean Symposium – An Evening Adorned with Highland Dress

Wu:

ISS, Iron and Steel Society, helped organize a McLean Symposium in recognition of your contribution, which was held in Toronto. Are there any particular moments from that event that you could share with us?

McLean:

Yeah, that was a memorable time, I have to say, Paul. It was so very kind of Iron and Steel Society, and the folks involved in that society. It was a group of about a dozen of them that formed a committee, led by Allan Smillie, who used to be, of course, at AK Steel in years gone by. Allan Smillie did his doctorate with Harry Bell back in Glasgow, the same as I did, a few years after I did. It was a great time because people got together that I had known over the years that came from a number of different countries to Toronto for that event: from Japan, from Mexico, France, USA, Canada, other places. It was a great gathering that we had together at Toronto, and papers were invited on various themes that reflected the kind of areas that I had been involved in with our research group over the years. And, it was just a lovely gathering.

I remember thinking back, and this came as a total surprise to me, because, at the banquet, I had decided I would wear my Highland dress outfit and have my kilt on and so on, and Betty, she was wearing her kilt. But, what I did not expect, there were 11 other gentlemen at that conference, and they had all went out and rented kilts, some of them for the very first time in Toronto, to wear them at the banquet. Some of these folks wearing kilts, they weren't all from Scotland. There were a few who were from Scotland, no doubt about it originally, now lived in the US or Canada. But, I remember very clearly, there was actually a gentleman from Mexico, and there was another gentleman from France wearing the kilt. They had rented the Highland outfit.

So, I have some lovely photographs of these fine friends from different parts of the world, all attired in Highland dress, complete with sporran. So nothing but good memories and great appreciation for the good work of Allan Smillie and his committee that pulled that event together. It really was a wonderful time, I must say.

34:52 Queen Elizabeth II Diamond Jubilee Medal, A Rare Honor

Wu:

In 2013, among other key and important recognitions from ISS, CIM, and Royal Society of Canada, you received a Queen Elizabeth II Diamond Jubilee Medal, and you were among the five recipients at the University of Toronto. Congratulations on this very rare honor.

The Jubilee Medal recognizes Canadians who have made distinguished contributions to Canada. Your pioneering work on steel re-oxidation reactions in all facets, including thermodynamics, kinetics, and fluid flow studies had a revolutionizing impact on industrial practices. What can you tell us about this particular experience?

McLean:

Well, Paul, I've got it here, I hope you can maybe see it, the Queen Elizabeth II Diamond Jubilee Medal? Of course, at this time, there's a lot of coverage in the news of the unfortunate passing of the Queen's husband, Prince Philip. There's a lot of information with regard to the Royal Family in the media at the moment. At the time when I received that particular medal, it came very much as a surprise, I must say, and totally unanticipated.

And, as you had mentioned, the Royal Society had actually approached the University of Toronto to ask them to suggest some potential recipients, and the university selected five, and very kindly included me as one of the five to receive that medal. The medal was subsequently awarded at U of T by the president of the university there, and we had a family gathering, of course, and a nice gathering of students from our department, including yourself, Paul. It was a memorable time. One that I certainly will not forget, and it was very much appreciated. Very kind of the folks involved.

Wu:

And, you were in your Highland outfit as well.

McLean:

Yes, that's right. I was dressed in my Highland dress outfit again. That's right.

37:28 My Second-in-Command, Dr. Yindong Yang

Wu:

That was fantastic. Good memories. Now that you're retired, what is keeping you occupied right now?

McLean:

Well, I tell you Paul, I should have brought it in and held it up in front of the screen. I have a cushion, and on that cushion it's imprinted, "I'm sorry, I'm too busy. I'm retired." But, I thoroughly enjoy my retirement. I'm really enjoying it. I still have an office at the university. I don't do any teaching anymore. I still have some research funding from our Canadian government, from NSERC.

I have a senior research associate that you know well, Dr. Yindong Yang, following on the advice of – going back to the earlier part of our discussion – Professor Alcock, to have a good second in command. Dr. Yindong Yang has been a second-in-command with me for over 25 years now. He did his doctorate in Sweden before joining me in 1994, and he looks after our day-to-day activities in the laboratory. His background, of course, is from China, and he still has a position back at his home university there, at the University of Science and Technology, Beijing.

He goes back to China, generally, a couple of times a year – not at the moment, of course, because of the COVID – but, he generally goes back to China twice a year, visits various universities and institutes there, as well as steel companies in China. And, because of that, we usually have a couple of people, visiting doctorates who are taking their doctorates in China – universities in China – but, they come over and spend a year with us, and then go back again. And, we also have people come over from steel companies.

We had a group of six engineers, which was quite surprising, six engineers from Wuhan Steel, senior people came over and spent a year with us, and then they went back to Wuhan. And then, a second group of six engineers came over from Wuhan and spent a year with us. None of that would have happened without the second-in-command, Dr. Yindong Yang.

All of that is good for our own undergraduate and graduate students, because we have undergraduate students do their bachelor's thesis with us. Generally, three or four students a year do that, and we usually have maybe a couple of master's students doing a degree with us. But, again, it's only possible because of Dr. Yang.

40:01 Retirement Activities – Award Committees, Watercolor Painting, and Time with My Family

McLean:

Other activities I'm involved in, very enjoyable, I must say. I participate in the preparation of award nominations for different people and also participate in a number of award committees for different institutions, societies. That's a very pleasant and pleasurable activity, I thoroughly enjoy doing that.

Another thing I've got involved in, in the last 20 years or so, since retiring, is watercolor painting. I do some water coloring. I remember I said to my dad I'd like to do painting. Well, I don't actually paint walls. I still don't paint walls, but I am doing watercolors. And, I enjoy doing that. Some of my paintings involve metallurgical topics, some are countryside scenes, some involve people. So, I'm involved in that.

And, of course, I spend a fair bit of time with the family. My son, Tom, and his wife, Sharon, have two grownup children and grandchildren. Our daughter, Helen, and her husband, Les, they also have two children. Both sets of families only live about 40 minutes away from us. We generally see them under normal circumstances every weekend or every second weekend.

And then, obviously, I spend a lot more time now I'm retired with my chief executive officer and my chief financial officer, i.e., my wife, Betty. We'll be celebrating our 60th anniversary this year. And, I have to say, and you've met Betty, Paul, so you know her well, without Betty's support going through all these years – back in Scotland, in Canada, the United States, back in Canada again – and without her staunch support, none of the things that we've been talking about and described at work, none of them would have been possible. She has really done so very, very much. Particularly when I was very much involved in research activities at one point, more than I should have been. She held things together. So, I'm very, very thankful to Betty. So, all of that to say, I'm retired, I've a number of things going on.

One of the things we're not doing at the moment is traveling, because we also like to travel and take cruises when we can. At this time of year, we would normally have been in a repositioning cruise sailing from Fort Lauderdale over to Southampton, and then spending two or three weeks up in Scotland before flying back again. But, unfortunately, we haven't been in Scotland last year. I don't know whether we'll be in Scotland this year or not, but we're sure looking forward to it.

Wu:

Well, congratulations to the 60th anniversary, the most important anniversary, and then thanks to Betty.

43:05 A Great Privilege, Working with the Younger Generation

Wu:

Even after retirement, you have been continuing to contribute to the field that is meaningful to you. What has made working in this field so enjoyable that makes you still dedicated to working and contributing?

McLean:

I think, Paul, it's interaction with people, predominantly. Again, as you would well know, predominantly the people that I interact with are the students. And, of course, generally speaking, they're younger people, they're young people. I have the impression, the feeling, that working with young people is a great privilege. It helps to keep me young, at least it helps me, I think, to keep young.

Obviously, over generations, young people's training changes. Now that I'm coming really towards the end of my involvement, I've another two or three years probably, and I'll finish with my grants that I'm holding at the moment. Younger professors, students need to benefit from younger professors rather than older professors. In fact, the university recognizes that, because if I were supervising a person like yourself now, a doctoral candidate – when you used to be a doctoral candidate – if I was supervising a doctoral candidate, I'm only allowed to co-supervise. I have to have a younger professor involved at the same time.

That to me makes a lot of good sense because the younger professor brings the younger ideas and perhaps the older professor, he can contribute something just from his experience. But, that's very important, I think, today that the younger people coming out now are exposed to younger professors rather than just the folks that have been in the field for a long time.

So, all of that to say, working and being allowed to continue to work with young people, although I'm officially retired, has been a great privilege. And, it’s been very meaningful to work in that capacity within the field.

45:37 Building Bridges – Facilitating Communication and Knowledge Exchange

Wu:

Well, thank you for your contribution. Before we conclude, do you have any advice that you would give to today's young leaders in the engineering profession?

McLean:

I think, Paul, really thinking back on what we've talked about, I would say to young engineers, "You've just graduated, whether it's a bachelor's degree or master's or doctorate. Moving in to the production industry, government, or even academia later, regardless of where we work, I think all of us, all of us wherever we are, we have a great privilege of participating in what I would call the bridge building process."

You know in life we're either doing, I think, one of two things: we're either building walls around us and shutting people out, or we're building bridges between people and helping to do things together. And, we have to decide what do we want to do? Are we building walls or are we building bridges? And, when I think of bridges, I'm thinking bridges of education that would enhance what we've talked about, knowledge exchange, bridges of innovation. Bridges of innovation that would have the potential to transfer industrial operations, like where you are at the moment, Paul. Then maybe most important of all, bridges of friendship.

Bridges of friendship that facilitate communication, there's that word again. Communication between different cultures. Whether it's industry, government, research, academia, the opportunity to build bridges. I think we've a great challenge, young people in front of us, to participate in the bridge building process.

Wu:

And, just provides another great reason for us all to be involved in professional societies where we can build these bridges.

48:21 "For All Big Discoveries Are the Results of Thought" – Philosophy of Alexander Graham Bell

McLean:
I think, Paul, following that on, in these societies building these bridges, I would give you a quote from – again, one that I have used a lot in my lectures over the years – a quote that comes from Alexander Graham Bell. And, in a sense, it's Scottish propaganda. You know, I accept that it's Scottish propaganda because Alexander Graham bell was born in Scotland and came to Canada when he was in his early twenties with his parents and lived just about 20 miles away from where I am at the moment, in a small town called Brantford. There, to this day, there is the Bell Homestead, which you can visit and, of course, it's now a museum.

Bell spent a number of years there before moving to Boston, and, in Boston, he opened up a college for teachers, teachers who would be involved in training young people who were deaf how to speak. That was their challenge. And, he himself, Alexander Graham Bell, while in Boston, and also when he came back for visits – as he did to his family here in Brantford – he began to investigate the same kind of thing: ways by which children who were deaf and couldn't speak, how they might learn to communicate. It was through these experiments that he was doing – he tried to help deaf children speak – that he came across the basis for his invention of the telephone. In one of his talks to young people, and this has struck me very forcefully, one of his talks to young people, he said this, and it's quite a big quote so bear with me.

He said, Alexander Graham Bell, "We are all too much inclined, I think, to walk through life with our eyes closed. There are things all round us and right at our very feet that we have never seen, because we have never really looked. We should not keep forever on the public road, going only where others have gone. We should leave the beaten track occasionally and enter the woods. Every time you do that, you will be certain to find something that you have never seen before. Of course, it will be a little thing, but do not ignore it. Follow it up, explore all round it: one discovery will lead to another, and, before you know it, you will have something worth thinking about to occupy your mind. For all really big discoveries are the results of thought."

And to me, there's so much truth and so much to be learned from Bell's philosophy, and for young people, particularly; it represents great advice.

51:57 Final Remarks – Malcolm Muggeridge, Words to Ponder

Wu:

What a great quote for all young leaders today. I'm sure we can all look around and find details that are worth investigating and learning from. Is there anything else you would like to say in closing?

McLean:

I think, Paul, first, let me say thank you for guiding and preparing and taking me through this interview session. I appreciate it very much, Paul. It was a delight to have you do this, particularly because you were not only an undergraduate student at Toronto, you were a master's student and a doctoral candidate in my research group, published award-winning papers, participated in many of the things that we've talked about here. And, I can't think of a person I would've preferred more than yourself to participate in this activity. Thank you so much, Paul.

I would close just with a comment from Malcolm Muggeridge. Malcolm Muggeridge was a noted British writer and philosopher. And, in a lecture that he presented at the University of Toronto back in the early 70s, shortly after I had joined the department there in 1970, I think it might have been about 1973 or so, but certainly in the early 70s… Malcolm Muggeridge came to Toronto and presented a lecture in Convocation Hall, a place that you know well Paul, and he shared this thought, this experience with the audience. I'm not sure I've got it word perfect, but I've remembered it, and it was words to this effect.

He said, "When I was a young man, there were some things that were, for me, very important. And, there were other things that did not matter much at all." And, he went on to say, "Now that I am in my senior years, those things that used to be so important to me do not matter anymore, and the things I did not consider worth bothering about, have become the most important things of all."

Words to ponder. Words full of significance and full of meaning. Thank you, Paul.

Wu:

It has been a great privilege to spend this time with you, and thank you very much for sharing your fascinating career and life, and of course, all the philosophical lessons that you have shared with us today. Thank you so much again for your willingness to share your story with the AIME.

McLean:

Thank you, Paul. Thank you, again.

Wu:

Thank you.

McLean:

Bye-bye.