# ALEXANDER McLEAN • IRON & STEEL SOCIETY

In front of a wall covered with certificates and diplomas, certifying Professor Alex McLean's standing in the world of metallurgy and materials science, stands a three-foot-high lectern. What is rather significant about this lectern is the fact that it is totally made of steel. A 1.5-inch-thick plate serves as its table. The table is in turn mounted on two 8-inch-wide I-beams that are welded to a base made from a 1.5-inch-thick steel plate. Further enhancing this unusual lectern are the wrist and leg shackles fastened to the lectern with heavy chain. Across the top of the lectern is welded "A.I.S.I. Distinguished Professor A. McLean" in 3-inch-high letters. The huge immobile lectern was constructed by the students of Professor McLean in the wake of his appointment as an AISI Distinguished Professor in 1982. Rather unusual you may think. Not really – not if you know the enthusiasm and the respect that Alex McLean inspires in those who know him.

Indeed, it is hard to describe the University of Toronto professor's enthusiasm for his work in the iron and steel industry. Sitting in his office on campus, listening to the Scottish brogue, complete with the rolling Rs, the "wee bits," the "cannas" and "folks." His enthusiasm about our profession and the direction of ferrous process metallurgy in our industry is quite contagious. I hope this interview will at least partially transmit the vibrancy of the 1985 president of the Iron and Steel Society.

***I&SM:*** Dr. McLean, you have served on the Society's Board of Directors for the past three years. Consequently, you have an excellent working knowledge of how the Society operates. Where would you like to begin this interview?

**McLEAN:** I think that I would like to talk about the Society's involvement in communications. One of the things we're doing is looking for additional methods to communicate experience from one group to another. For example, from researchers to people in operations, folks in the university to folks in the industry and vice versa. Surrounding all of this is the concept of communications.

***I&SM:*** Would you care to be more specific?

**McLEAN:** Just recently we've had the First Advanced Technology Symposium. That particular symposium was really quite different from any of the conferences that we've held in the past. It was also different from any of the short courses that we have run.

***I&SM:*** How so?

**McLEAN**: It was different in that we focused on a potential technological innovation; in this case it was horizontal casting of steel. We had folks coming from around the world. We had folks who were selling machines and we had folks who were using the machines. Those selling the machines were specifically invited to participate. There was a deliberate policy to bring these people together, manufacturers, users and researchers.

***I&SM:*** How does this relate to short courses?

**McLEAN**: When we were thinking of the Advanced Technology Symposium some of the logic discussed by the committee was that if you can identify an area of technology that is really right in the early stages, it's probably too soon for a continuing education course. But, if you pull in people from around the world and have an advanced technology symposium, out of that will come a number of papers. Once you have that package of information, if interest is generated in folks' minds that this is worth following up and they begin to implement some of that technology, then there will be a need for a short course.

***I&SM:*** You are advocating that the Society continue to sponsor continuing education?

**McLEAN**: I think the fact that industry is interested in in sending more and more of their people to these courses for training is indicative. Back in the sixties they never did. Even in the early seventies they were not doing this kind of thing. I think the steel industry's saying we need highly trained people. We need to have a better understanding of the fundamentals because it is a complex process, more so than ever before. I don't mean to take away at all from ingot casting and the skills involved in it. But it's a totally different package of skills that are called upon in continuous casting. It's almost like asking someone who can fly a glider to pilot a 747. It's a totally different package of skills.

There's a shortage of people with these skills and there are not too many schools in North America that are producing people with this kind of background. There are a few in the United States and a few in Canada. I think, speaking proportionately, that in Canada we're very well-off.

***I&SM:*** In what other areas do you think the Society is expanding?

**McLEAN:** Maybe we should talk a wee bit about interactions between our Society and other Societies. We don't operate in isolation. Coming up soon here in Toronto (June 2-5, 1985) is the International Symposium on Agglomeration. We'll run this in conjunction with CIM. In August there is the symposium on Statistical Process

# ALEXANDER McLEAN • IRON & STEEL SOCIETY

Control in Vancouver, run by the Metallurgical Society of CIM and jointly sponsored by CIM and the Iron and Steel Society.

***I&SM:*** You are an advocate of Society interaction also?
**McLEAN:** We cannot work in isolation. Here in Toronto, if we simply existed alone and hadn't any contact with the steel research going on at the various companies, it would be ridiculous. We receive so many benefits from talking to folks in the industry. The same thing is true for the Society. There has to be interaction, moving of information back and forth. And then if the parties involved are really interested in seeing something happen, really good things can then come about.

***I&SM:*** Where do you stand on the participation of the Iron and Steel Society and AIME in the American Association of Engineering Societies (AAES)?
**McLEAN:** I like the idea, yes I do like the idea – the concept. I think a body that can bring together information from various sources and then reflect these views can be very useful.

I'd be hard put to find something equivalent to AAES because it has such a broad base and such a range of disciplines. It very much depends upon the people who are involved in it and what they want to do with it. I think there could be great strength associated with the operation and it could be made to fly.

***I&SM:*** That seems to be the problem, AAES is having trouble flying.
**McLEAN:** Synthesis is the word that comes to me. I remember when I went to work for J&L. Bill Dennis was my boss. He said an interesting thing that I have never forgotten – even though we professors are known to be absent-minded. Bill said that very often a criticism can be made of folks who have taken a doctorate where they have focused in on a very specific topic and become experts in a very narrow field. They are able to take that topic and subdivide it, and he said that the word you might use to describe this is analysis, and he said there was a great need for that. But he said there's also a need for folks of very wide vision that are able to perceive strengths in different areas and bring them together, and that's the opposite of analysis. This is synthesis, the bringing of things together. If AAES can achieve this synthesis, then it will be successful.

But the further you go in joint organizations, the more essential carefully-defined objectives become. You know in soccer you really must know where the goal posts are if you're going to score the goal. You have to define objectives. The more encompassing the group, the more sharply you must define the goals, so that you know at the end when you have accomplished something. Hopefully, that goal is something that individual groups would never do on their own.

***I&SM:*** Let's talk about the technologies relating to horizontal casting and plasma arc steelmaking. They seem to encourage the micro-mill concept. Do you agree?
**McLEAN:** I think the philosophy of small tonnages of high-quality materials is certainly one that is valid. I believe that we will see, for example, a process where we have an induction furnace, possibly with a graphite electrode with gas injection through the electrode to establish a plasma. This would allow us to have a fluid slag because of the plasma. We would also have an inert atmosphere. Then directly linked into the induction furnace we have a mold so that we can horizontally cast. So plasma grade alloys made in very small batches, one-ton, three-tons, would be produced.

This would eliminate all the transfer operations. This is one of the major sources of contamination. There's no furnace to ladle, ladle to tundish, or tundish to mold transfer. You eliminate all transfer operations. You take the metal, you melt it, you refine it, you control its temperature. You can mix it with a porous plug in the bottom, and you can cast it horizontally, directly from the furnace. Obviously, the product would be a very high-quality, low-residual alloy on a small scale. That kind of concept could very well form the basis for micro-mills. Micro-mill is probably too big a term. Someone suggested calling it a nano-mill, an order of magnitude down from a micro-mill.

***I&SM:*** What volume of production are you talking about?
**McLEAN:** You would probably be able to run a nano-mill making high-quality alloys on the order of 8 to 10 thousand tons a year. You wouldn't necessarily set up a plant to do that alone. It might fit more with an existing plant making 80 to 100 thousand tons a year or more of certain grades of steel. Then alongside that operation you could place a nano-mill and use the facilities and people to produce very high value small tonnage products.

***I&SM:*** You're saying that the nano-mill will in existing mills that have finished facilities, especially cold mills?
**McLEAN:** I would like to think so. You would put something like this alongside a plant where a man has his bread and butter and allow him to get some of the jam. The nano-mill would run on demand, able to start and stop, unlike a blast furnace. Because of the technology that's coming about based on plasma melting, plasma refining and horizontal casting, I think this combination gives us the opportunity to make very closely controlled chemistries.

***I&SM:*** You're talking about horizontally casting billets, rounds, and blooms?
**McLEAN:** Or a small slab. A slab is probably the wrong way to describe it, but it would be a small plate-like section which could be rolled out for narrow strip.

***I&SM:*** With the nano-mill concept you have turned 180 degrees from today's

# ALEXANDER McLEAN • IRON & STEEL SOCIETY

practice. No ladle metallurgy, in fact, no refining outside the furnace. How do you attain the quality product?

**McLEAN:** If we're going to horizontally cast quality steel, then the steel that goes out through the mold will have to be clean. There's no opportunity for separation of impurities once you're in the mold. Whereas in vertical casting we have a last opportunity to separate non-metallics by fluid flow control into a synthetic slag layer. The last opportunity to do that in horizontal casting is in the tundish.

If you go back to the concept of casting directly from the furnace, the furnace is where you would establish your cleanliness and that can be done. The big factor in this picture is that we're eliminating all transfer operations. So the pickup of oxygen, nitrogen or hydrogen from the atmosphere is gone.

***I&SM:*** Let's talk about vertical casters in larger plants. What do you see happening in this area?

**McLEAN:** I think that what we'll see in the latter part of the eighties is tundish metallurgy. Whether you have a small tundish or a large tundish the opportunity exists to do some chemical work in the tundish. And the tundish is really a kind of unique vessel in the sense that it is not a batch reactor the way a furnace or ladle is. You fill the ladle and you empty it but the tundish is continuous. You're feeding into the tundish continually and feeding out continuously. The tundish is really a unique part of the system which allows us to do things that we could not do in the same way in a batch process. So I sense that in the last half of the eighties tundish metallurgy will become very important. At the moment many companies are working with dams and weirs. We have done a lot of work here (at the University of Toronto) in modeling to try and control the fluid flow in the tundish to improve the cleanliness.

***I&SM:*** How does fluid flow relate to cleanliness?

**McLEAN:** Because the steel coming into the tundish will contain non-metallics, potential inclusions, we would like to separate these non-metallics in the tundish rather than carry them into the mold, and then try to separate them at that stage into a synthetic slag. That's one reason why we're trying to control fluid flow in the tundish. Another is temperature. In a four-strand caster we'd like to be able to deliver the same metal quality at the same temperature to each mold, rather than make different quality steel in each strand. So dams, weirs and baffles are used to control fluid flow; the use of porous plugs in tundishes, to set up fluid flow patterns that will help to separate non-metallics, is also possible.

***I&SM:*** You are talking about bottom stirring the tundish?

**McLEAN:** Yes, with inert gas for stirring. Of course, if we are going to remove inclusions in the tundish, there has to be somewhere for them to go. This suggests that there will be increasing attention paid to synthetic tundish slags. In ladle metallurgy, ladle slags are important. In the mold, fluxes are going to become more important. People are going to build slags in the tundish. The one vessel in between is the tundish. You can see where tundish fluxes are going to become more important. People are going to build slags in the tundish. Now the question is, what's the most appropriate slag for the particular quality of steel passing through this continuous reactor?

***I&SM:*** It sounds like you're going back to the old way of steelmaking that says steel is a byproduct of slag?

**McLEAN:** I think what all of this says is that the old steelmakers' dictum 'look after the slag and the steel will look after itself' is just as true today. However, they also used to say 'steel is made in the furnace.' That's no longer true. We really cannot say that anymore. We're beginning to make the steel with the selection of raw materials for the blast furnace, and the subsequent treatment of hot metal, and the melting and refining furnace. We're continuing to make it in the ladle, we're continuing to make it in the tundish and we're still making it before it freezes in the mold.

Each of these locations need slag, but there are different slags in each place because we're asking the slags to do different things in the furnace, ladle, tundish and mold. So more than ever I see an increasing emphasis on slags and slag chemistry and a knowledge of how these slags will react with metal. How do they interact with refractories? How do they behave with respect to the atmosphere above them?

Going back to the education side, folks in the industry are becoming more aware of how the composition of these slags influences the structure and properties. Things like viscosity, melting characteristics, their ability to absorb non-metallics versus their ability to dissolve refractories. We obviously have to design specific chemistries for specific locations such as the furnace, ladle, tundish or mold. And that's all part of quality steelmaking.

***I&SM:*** Speaking of education again, how has the current economic situation impacted on recent graduates from your classes?

**McLEAN:** We have found that the students coming through with master's degrees have not had any problem obtaining jobs in the steel industry. It's interesting that the last two students that graduated with master's from our steelmaking group both worked in the areas of continuous casting. Both of them received offers from steel companies that don't have continuous casting at the present time. But both companies indicated that they will have casting lines in the very near future.

At the undergraduate level there has been more of a problem, but I believe we will see a change. I think our industry is looking for people with higher levels of education. I think people going on to do

# ALEXANDER MCLEAN• IRON & STEEL SOCIETY

graduate work in ferrous metallurgy have a good opportunity to work in conjunction with steel companies during their studies. The companies get to know them. They attend our conferences to present papers, they hear presentations, they mix with people and that really opens some doors.

While I certainly agree there's shrinkage of the industry, I don't think there's a shrinkage taking place in the demand for people with something to offer. I am convinced there's going to be an increasing need for highly-trained people.

Alex McLean has been a member of AIME since 1965. He has been quite active in the Process Technology Division since the early seventies. He was chairman of the division in 1981/82, and served on the Iron and Steel Society Board of Directors from 1981 through 1983. He was elected a Distinguished Member of the Iron and Steel Society in 1983. He served as chairman of the Iron and Steel Section of the Metallurgical Society of the Canadian Institute of Mining and Metallurgy (CIM) from 1978 to 1980. In 1980 he delivered the Arnold Markey Lecture to the North American Steel Bar Mills Association.

Dr. McLean graduated with a B.Sc. degree in applied chemistry (1958), and a Ph.D. in metallurgy (1963) from the University of Glasgow. In 1958 he also received an associate-ship from the Royal College of Science and Technology in Glasgow, now the University of Strathclyde. After five years in the Metallurgy and Materials Science Department of McMaster University, Canada, first as a post-doctoral fellow and subsequently as an associate professor, he moved to the Graham Research Laboratory of Jones and Laughlin Steel Corporation (now LTV Steel Co.) to become supervisor of their deoxidation and casting group. In 1970 he joined the Department of Metallurgy and Materials Science at the University of Toronto, where he is responsible for teaching and research in the field of iron and steelmaking. Professor McLean resides with his wife Betty, his son Tom and daughter Helen in Oakville, Ontario, which is midway between Toronto and Hamilton.