► Vallourec Soluções Tubulares do Brasil

► Global Steelmaking:

Reflections of the 2016–2017 John F. Elliott Lecturer

"Finding and Tweaking Inclusions in Steel"

By P. Chris Pistorius

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► What is the John F. Elliott Lectureship?

The lectureship honors the late professor John F. Elliott of the Massachusetts Institute of Technology; the aim is to tell students and engineers about opportunities in chemical process metallurgy, showing examples of how ironmaking and steelmaking have been improved through better process understanding — also highlighting the many advantages of AIST membership. The Iron & Steel Society (forerunner to AIST) and The Minerals, Metals and Materials Society established the lectureship in 1990 at the Elliott Symposium on Chemical Process Metallurgy.

The name of the Elliott Lecturer is announced at the annual AISTech conference; shortly thereafter AIST sends out a message to universities that they can invite the lecturer. Where the lecture gets to be presented depends in part on who is quickest and most persuasive with their invitation.

► Where did I go?

The Elliott Lecturer should present the lecture at three or more universities. I added the Elliott Lecture to other trips, and so managed to visit many more universities (Table 1) in seven countries. It was the first time that the Elliott Lecture was presented in China.

► Northeastern University

► Clemson University

► Table 1

Institution	Location
University of Pretoria	Pretoria, South Africa
Northeastern University	Shenyang, China
Universidad Autónoma de Nuevo León	Monterrey, N.L., Mexico
Missouri University of Science and Technology	Rolla, Mo., USA
University of Montana	Bozeman, Mt., USA
University of Wollongong	Wollongong, NSW, Australia
Swinburne University of Technology	Melbourne, Vic., Australia
Clemson University	Clemson, S.C., USA
University of Alabama	Tuscaloosa, Ala., USA
Colorado School of Mines	Golden, Colo., USA
McMaster University	Hamilton, Ont., Canada
University of Toronto	Toronto, Ont., Canada
Universidade Federal de Minas Gerais	Belo Horizonte, MG, Brazil
Pontifícia Universidade Católica de Minas Gerais	Belo Horizonte, MG, Brazil
Instituto Federal Minas Gerais	Ouro Branco, MG, Brazil
Universidade Federal de Ouro Preto	Ouro Preto, MG, Brazil
Universidade Federal do Rio Grande do Sul	Porto Alegre, RS, Brazil

► McMaster University

► Missouri University of Science and Technology

► University of Pretoria

► What was the lecture about?

I talked about inclusions in steel, one of the major areas of the Center for Iron and Steelmaking Research at Carnegie Mellon University. I mentioned factors that have transformed the ability of steelmakers to control the composition and concentration of inclusions in liquid steel; in my opinion, the three most important are as follows.

First, the steelmaking industry has an excellent culture of information sharing. I have worked with several industries during my academic career. The steelmaking industry is unique in its readiness to share technical information and eagerness to develop young engineers. The annual AISTech conference and other more specialized conferences like the Clean Steel series and the Conference on Molten Slags, Fluxes and Salts provide excellent opportunities to exchange best practices and learn.

Second, it is now possible to measure the composition and sizes of microinclusions taken from liquid steel, accurately and quickly — in much less than an hour. In several plants, the scanning electron microscope that is used for automated inclusion analysis is right there in the steelmaking building. Frequent and accurate inclusion analyses build up a detailed picture of normal processing and upsets and greatly contribute to quality control. Inclusion analysis has been done for many years — but the instruments are now much faster, allowing rapid feedback to the plant.

Third, readily available thermodynamic descriptions of liquid steel, slag and non-metallic inclusions enable accurate, predictive models of changes — intentional or not — of inclusion composition during liquid steel processing. This is not new in principle; similar thermodynamic descriptions have been available for many years. Dr. Elliott's own *Thermochemistry for Steelmaking* (published in 1960) is one such compilation. What has changed is the comprehensive nature of the descriptions and the availability of computer programs that can rapidly calculate local multi-phase, multi-component equilibria as part of a kinetic model.

► How did it go?

I trust that my audiences gained some new insight into the possibilities of modern steelmaking as a technically challenging and rewarding career. There is truth to the saying that the lecturer often learns more than the audience, though. For me, it was inspiring to interact with students and colleagues at many different institutions. I was on the receiving end of many insightful questions.

AIST has many programs to spread the word about steelmaking. It has been my honor and pleasure to be the 2016–2017 Elliott Lecturer.

► Testimonials:

"Professor Pistorius did an excellent job showing how good science can be used to control the quality of steel. I personally found it fascinating the details he provided about how inclusions can dramatically change chemistry and morphology during heat treatment."
— Geoffrey Brooks, professor, Swinburne University

"I think he chose a good topic because it was interesting without being too complex and going over a lot of people's heads. He was easy to understand and he kept us listening with some audience participation."
— Kim Dyhouse, student, Missouri University of Science and Technology

"It was a great experience to interact with Prof. Pistorius, who is a stalwart in the field of chemical process metallurgy. His talk significantly helped me gain insights into the steel/slag/refractory/inclusion chemical reactions taking place during steelmaking reactions. There are very few people around the globe who are working on this field, and I am sure organizing talks such as the present one will go a long way in spreading the word and educating more people about the same."
— Saikat Chatterjee, University of Toronto

"The John F. Elliott Lecture delivered by Prof. Chris Pistorius at the University of Pretoria provided valuable insight into the increasing demands on steel in terms of its cleanliness and the need to decrease the amount of impurity elements to produce so-called 'clean steel.' The emphasis was on decreasing the amount of inclusions in steel and part of achieving this is by gaining a better understanding of the way inclusions form, as well as identifying inclusions for the purposes of quality control in the steel production process. Prof. Pistorius managed to engage and challenge a diverse audience, ranging from inexperienced students to experts in the field of steelmaking."
— Jehane du Toit, University of Pretoria

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► Swinburne University

► University of Alberta

► University of Toronto