Honoring a Legacy

Reflections on the 2023–2024 AIST-TMS John F. Elliott Lectureship

By Antoine Allanore

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Allanore received the 2023–2024 John F. Elliott Lectureship Award in recognition of his distinguished contributions in sustainable chemical metallurgy and green chemistry for the iron and steel industry and beyond. Allanore's bold, inventive work lies at the intersection of cutting-edge research and practical application for solving impactful problems such as sustainability of metals production and green electrification. His groundbreaking efforts in the field of metals will be of adamant importance in the transition to a new era of steelmaking.

It was a great honor and privilege to receive the 2023–2024 AIST–TMS John F. Elliott Lectureship Award. Although I never had the opportunity to meet Professor Elliott, his legacy is deeply familiar to me. After my last 15 years at the Massachusetts Institute of Technology (MIT) — where he spent his academic career — and nearly two decades working as a chemical metallurgist, I have come to appreciate the lasting impact of his research.

At MIT, I became acquainted with his academic lineage, including the late Professor Claude H.P. Lupis, with whom I collaborated after moving to the United States in 2010. The Elliott legacy also lives on in the endowed chair bearing his name, once held by Professor Donald Sadoway, who played a key role in bringing me to MIT to continue research on ironmaking. It was therefore especially meaningful to accept this award and embark on a lecture tour in Professor Elliott's honor, sharing my research on metallurgical processes and chemical metallurgy.

Carnegie Mellon University

This lectureship afforded me the opportunity to visit institutions that were new to me — places steeped in history and prestige, each a landmark in iron and steel education and research in the United States. Many of the lectures I delivered were integrated into undergraduate seminar series, giving me the chance to meet a new generation of metallurgists — curious, engaged and eager to understand how ironmaking can evolve to meet modern societal needs.

The Legacy Tour Begins at Carnegie Mellon

The tour began at Carnegie Mellon University, hosted by Professors Chris Pistorius and Bryan Webler. This starting point felt both symbolic and natural. Professor Lupis had conducted much of his teaching and research there, and it was a fitting venue to introduce my own research on electrification in metallurgy — just a stone's throw from the birthplace of the Pittsburgh Reduction Company, now known as Alcoa. The setting underscored the empowering potential of new technologies, such as electricity-based ironmaking, to achieve process intensification while mitigating environmental impact.

In an academic landscape increasingly shaped by medical, biological and digital computing disciplines, it's no secret that iron and steel research has receded somewhat from center stage. However, growing interest in reshoring industry and leveraging the U.S.'s unique energy resources is reviving attention to ironmaking — especially in landmark institutions like Carnegie Mellon. The momentum is real, and it's encouraging.

Across the Mississippi: Missouri S&T

My next stop took me westward across the Mississippi River to Missouri University of Science and Technology


Missouri University of Science and Technology

(MS&T) in Rolla. I had long known the work of Professor Michael Moats in electrometallurgy through TMS, and was warmly hosted by Professor Ronald O'Malley, himself a former doctoral student of Professor Elliott.

I found a department with remarkable breadth: continuous casting, foundry work, refractory studies, and a hands-on, industry-connected ethos that reminded me of my early career in France. MS&T has capabilities I have not seen elsewhere in the U.S., including advanced experimental research of casting processes and industrial-scale refractory knowledge. Though electrochemical ironmaking was relatively new terrain there, I was pleased to meet students and faculty who appreciated the critical role electricity has played in metallurgical innovation — from early electric furnaces to modern electroslag refining and beyond.

It is worth noting that iron remains the only major metal not produced through commercial electrolysis or electrorefining — for reasons I talk about in my lecture. Yet our industry has long pioneered the use of electricity — from the Héroult furnace to today's electric arc furnaces — and its electrochemical underpinnings are evident in processes like basic oxygen furnace decarburization and electrogalvanization. The integration of these principles into education and research is both timely and necessary.

Colorado School of Mines

At the Foot of the Rockies: Colorado School of Mines

After Missouri, I traveled to Golden, Colo., home of the Colorado School of Mines. There, I was hosted by Professors Kip Findley, Emmanuel De Moor and John Speer. Part of the campus — steeped in the legacy of Kroll and its process for titanium production — reflects a proud tradition of extractive metallurgy.

What I found was a vibrant and expansive department with a strong emphasis on steels, alloy design, mechanical testing, and joining technologies — supporting industries from automotive and oil and gas to chemical processing and water treatment. Our discussions ranged from alloying thermodynamics to the implications of intermittent power sources on ironmaking. The nearby "solar steel" business model reminded us that while innovation and investments are vital, technological constraints remain. Yet it was heartening to see renewed interest in using electricity for iron and steelmaking — clearly, new ideas and technologies are needed.

The Final Leg: University of Alabama, Tuscaloosa

The final leg of the tour brought me south to the University of Alabama at Tuscaloosa, arriving by car from the AM/NS Calvert LLC steelmaking site in Calvert, Ala. This journey underscored the regional character of metallurgical education in the U.S. — a vast country where industry and academia must be closely intertwined at the regional level too.

Many of the people I met at AM/NS were proud alumni of the Alabama program. On campus, I encountered a vibrant research community, with facilities supporting advanced mechanical testing, joining, and electrochemical studies. I had the pleasure of engaging in deep discussions with Professor Ramana Reddy on topics ranging from graduate education in chemical thermodynamics to slag-metal interactions — bringing us full circle to the work of John Elliott and the continued need for rigorous education in chemical metallurgy.

Looking Ahead: Bridging the Melt Gap

While I've only visited a portion of the U.S. institutions active in iron and steel research, it's clear that those I encountered represent some of the field's vibrant centers. When it comes to chemical metallurgy — particularly hot metal production, scrap melting and iron refining — I observed a wealth of modeling and simulation efforts, many relying on experimental data gathered over half a century ago.

A recurring concern among colleagues is the dwindling number of facilities capable of working at high temperatures with molten iron or steel. This lack of experimental and testing infrastructure — in terms of both small-scale

University of Alabama, Tuscaloosa, with
Prof. Steve Daniewicz

University of Alabama, Tuscaloosa, with
Prof. Ramana Reddy

thermophysical studies and large-scale (1-metric-ton class) melting or refining experiments — is, in my view, a serious limitation to the future competitiveness of U.S. metallurgy.

With the rising importance of domestic scrap recycling, new pig iron and direct reduced iron production, and the reshoring of ferroalloys and diversification in supply of refractories, it is imperative to reestablish large scale experimental capacity for the molten state. While computational tools can model impurities and trace elements down to ppm levels, real-world process deployment at the 100,000-ton scale requires steady-state operation at an intermediate, yet industrially relevant throughput.

If we are to improve productivity and reduce costs in modern iron- and steelmaking in this country, researchers must not only model hot metal, but also experiment with the melt at a meaningful scale. It requires letting the melt reach some form of equilibrium in the vessel, similar to the one observed in the meltshop. In order to replicate actual industrial conditions, this has to happen at a scale of at least 1 metric ton of hot metal.

It is my hope that such facility will soon be deployed on an academic campus — perhaps at MIT? — such that professional development and education can happen in conjunction with testing new research ideas at a scale that a meltshop manager can recognize and that impact the country's iron and steel industry.

I am thankful for the nomination and selection by the AIST committee, the faculty generosity with their time to organize the visits and send my best memories and wishes to all the people I had the pleasure of meeting during this rewarding journey. ✦