STEEL CURRICULUM DEVELOPMENT GRANT

Year-End Report **2024-2025**

A final report is due on 30 June. Your final report (in year-3) will be posted to the AIST website for others to view and may be included, in whole or in part, in the AIST *Iron & Steel Technology* magazine. Along with your report, please submit the following:

- An action photo of yourself and your students while working on a project for this grant.

Project Title: Apply a Contemporary Steel Design Challenge (Characterization of a Duplex Steel) as a Case Study in a Required MSE Course @ Michigan Tech *(updated title, see Project Details)*

Name: Paul Sanders
Title: Patrick Horvath Professor of Materials Science and Engineering
Department: Materials Science and Engineering
University: Michigan Technological University
Phone: 906 231 4118
Email: sanders@mtu.edu
Address: 509 M&M, 1400 Townsend Dr, Houghton, MI 49931

Team Members (include name, class and major)

1. Isabella Jaczszak, staff, MSE, MS with SDI and Nucor on steel strengthening mechanisms
2. Alexandra Glover, faculty in MSE
3. Molly Wrobleski, undergraduate student TA for Spring 2025 semester
4. Amber Shaw, undergraduate student TA for Spring 2025 semester

Project Summary: Transition the required *MSE3120 - Material Characterization I* hands-on course from a variety of materials to a focus on duplex steels.

Project Goals: To take a real-world application course and change materials while maintaining the concepts and educational impact.

Project Details:

This is the second year of the project. During the first year of this project, a steel strengthening mechanism curriculum was being developed for *MSE3190 - Materials Design*. This well-established course uses in-lab experimentation and modeling to explore the viability of using AA7075 for automotive applications. In Fall 2024, the opportunity to redesign a different core course presented itself due to changes in faculty roles.

MSE3120 - Material Characterization I has been a core part of the Materials Science & Engineering Department's core curriculum for decades, providing students with hands-on experience in assessing the impact of composition and processing on material properties. This course represents the first opportunity for students to acquire practical characterization skills over a full semester.

Historically, course samples included low-carbon steels, Al-Cu alloys, and metallic powders, with samples rotated throughout the semester. While this approach exposed students to various materials, it hindered their ability to integrate structure-processing-property relationships derived from each characterization technique.

YOUR COMPLETE REPORT MUST BE SUBMITTED ELECTRONICALLY IN PDF FORM TO lwharrey@aist.org BY 30 JUNE. PHOTOS MUST BE EMAILED SEPARATELY.
Questions should be directed to Lori Wharrey at lwharrey@aist.org or +1.724.814.3044.

Dr. Alexandra Glover, a new faculty member teaching the *MSE3120 - Material Characterization I* course, specializes in steel design and characterization. Her steel research and connections to industry were a substantial motivator for changing the *MSE3120 - Material Characterization I* curriculum to be steel-focused instead of Materials Design.

For the Spring 2025 semester, the course underwent a comprehensive redesign, focusing exclusively on the characterization of six different sheet steels with varying austenite-to-ferrite ratios. Students employed quantitative light microscopy, energy dispersive spectroscopy, electron backscatter diffraction, fractography, and x-ray diffraction to characterize the microstructure, while mechanical properties were assessed through hardness and tensile testing (Figure 1). In addition to these hands-on laboratory exercises, a Thermo-Calc modeling lab was introduced to enable students to learn about a predictive tool that demonstrates the effect of processing on steel microstructure. This streamlined approach allows students to compare results across characterization methods, enhancing their understanding of the MSE tetrahedron as it relates to steel materials.

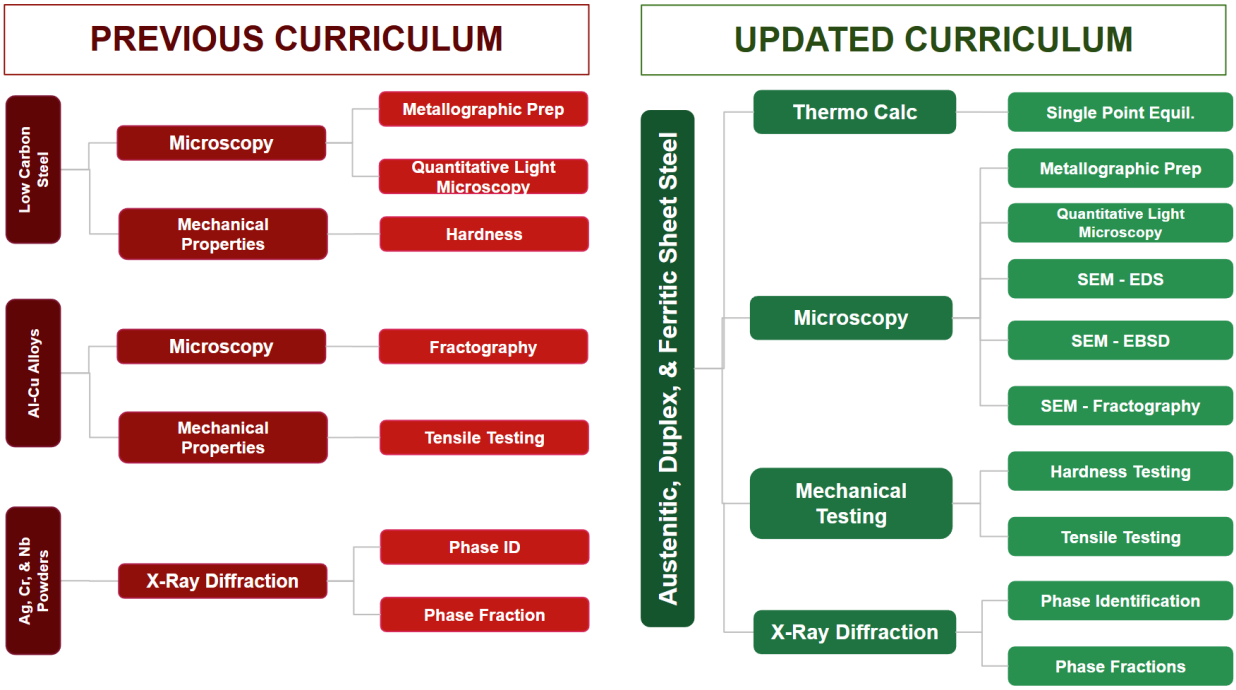

Figure 1: The updated MSE3120 curriculum provides a more standardized and comprehensive analysis approach to a single set of sheet steel samples as compared to the previous curriculum.

Dissemination of Results: The Michigan Tech MSE department surveys the students each year regarding the “usefulness” of all courses in the curriculum. During this project term, we will monitor student assessment of the course and hopefully show improved performance. In addition, we will track student employment, especially related to internships in the steel industry.

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References:
The collaborative document annotation website NB (nb.mit.edu) was used to assign students readings from the following textbooks and steel characterization publications.

1. Cullity, B. D. & Stock, S. R. Elements of X-Ray Diffraction. (Pearson/Prentice Hall, Upper Saddle River, NJ, 2001)
2. Van Aken, D. C. & Hosford, W. F. Reporting Results: A Practical Guide for Engineers and Scientists. (Cambridge University Press, Cambridge ; New York, 2008).
3. Goodhew, P. J., Humphreys, F. J. & Beanland, R. Electron Microscopy and Analysis. (Taylor & Francis, London, New York, 2001).

Project Schedule: Revisions are currently being made to the curriculum implemented in Spring 2025 to improve the course for the Spring 2026 semester.

Project Cost: $25k

Student Participation: Undergraduate student TAs assist in implementing the curriculum. The course ran in the Spring 2025 semester with 21 students.

Steel Plant Interaction:

1. Nucor visits Michigan Tech twice a year, stopping in several classes to explain what they do.
2. Michigan Tech has fall and spring career fairs, and in 2024-25, Cliffs, Gerdau, Nucor, Steel Dynamics, and US Steel recruited on campus.

Project Duration: 3 years total

How many students from this university have accepted employment in the steel industry upon graduation?

Over the last 5 years, 52 Michigan Tech students have accepted full-time employment in the steel-making industry (Figure 2). With respect to the ranking (Column 2), Cliffs is the 24th overall employer of Michigan Tech students. For Materials Science and Engineering, 10 students were employed in steel-making, and with an average of 30 MSE graduates a year, 10/150 or about 6.7% are employed in the steel industry.

Michigan Tech Students Employed In Steel Making

5 years: FDS 2020 to FDS 2024 + 2025 (In-Progress)

Employer Name	MTU Rank	# MSE	Total MTU
Cliffs	24	4	19
Nucor	55	2	13
Gerdau	95	2	8
US Steel	157		5
Valbruna Slater Stainless	242	1	3
ArcelorMittal	337		2
North American Stainless	610	1	1
Charter Steel	610		1
Total		**10**	**52**

Figure 2. Michigan Tech students hired by steel producers over the last 5 years.

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Future of Grant:

x I have just completed year two of the three-year grant.

❑ I hereby confirm that the plan contained in my original proposal will continue during the next academic year and request funding (US$10,000/Year 2, or US$5,000/Year 3) to continue the Steel Curriculum Development plan as submitted in my original proposal.

❑ The plans contained in the original proposal are now complete. I have $_____ remaining and request permission to continue promoting the steel industry to engineering students at my university using these funds. I agree to provide an annual report to AIST until the funds are depleted.

❑ The plans contained in the original proposal are now complete. I agree to the final results being posted to the website, shared with other universities, shared with AIST members, added to the AIST Library, or presented at a conference.

Signature of Professor and Date

Paul G Sundin 7/9/25

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