2021–2022 GRANT RECIPIENT REPORT

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DIGITAL TRANSFORMATION TECHNOLOGIES GRANT

The Enhancement of a Digital Twin Solution for Continuous Casting project took existing work done as a proof of concept with the Cleveland-Cliffs Burns Harbor plant and further developed some of the data visualizations to try to make a smaller, more complete software that can see some direct use at the plant, and expand from that. The focus of this project will be based around the gap, alignment and bend data for the rollers on the chosen caster at the plant site.

The project work is being performed primarily by students with the supervision of staff at the Center for Innovation Through Visualization and Simulation (CIVS), with a combination of graduate student work and undergraduate student project work. It provided students with an opportunity to work hands-on with industry and learn about the casting process they were working with. Work on the project was supported directly by Cleveland-Cliffs, the industry team at Burns Harbor, and supported indirectly by the Steel Manufacturing Simulation and Visualization Consortium (SMSVC). This project work is slated to continue with support from Cleveland-Cliffs.

Student engagement and outreach activities were also conducted throughout the project period with the help of team members working on the technical project, and some students helping with logistics and clerical work. This ranged from Material Advantage student chapter meetings, attending AIST Midwest Member Chapter meetings and participating in the student research day at Purdue University Northwest, to attending research presentations with the Steel Manufacturing Simulation and Visualization Consortium, and attending keynote speaker presentations during CIVS's Steel Week.

The technical portion of this digital twin project has two primary focuses, the first being coming up with better ways of integrating the data produced from roller collection data into a digital twin caster solution. This allows for easy analysis of the data and enables anyone working on the caster to analyze the roller conditions. Additionally, the digital twin caster would show the errors a roller may have, reducing the amount of time it takes an operator to determine if there is an error worth dealing with on the caster. The second focus is finding areas that would be more appropriate for continued development and planning for testing and deployment of work created through this project at the plant.

Cleveland-Cliffs Burns Harbor was chosen as the site for the development and continued testing. The focus was on a specific caster where some previous work had occurred in 2020 between the plant and a group of students regarding data visualization utilizing some different data sets generated at the plant. The particular area that was explored in this project is data visualization of data collected by a gap sled that is routinely run through the caster to measure many things; primary among them is the gap of the roll pairs, the outer alignments of the rollers and the bending of the rollers along the length inside the caster. These values are used to determine whether there may be unacceptable quality issues or possible breakout conditions if left unchecked. The tolerances for these values are typically measured within several thousandths of an inch, and because of the scale of the operations, are difficult to detect by the naked eye without the assistance of a device like the gap sled used.

This project work has been presented twice at AIST events, the Digital Transformation Forum in 2022 and AISTech 2022. If the project work continues into next year, there will also be additional conference/journal papers about the work submitted to AIST and other steelmaking publications.

Work on the project was conducted almost entirely by students. The main project work was done by a team of one graduate student studying computer science and a senior undergraduate student in mechanical engineering. At the beginning of the summer, an additional two electrical and computer engineering graduate students readied themselves to begin continued work on the project throughout the summer and the coming fall semester. These students participated in weekly meetings about the project and would occasionally join external calls with the Burns Harbor team to discuss ideas and implementations.

To increase awareness about the project, the students were encouraged to take part in the student research day on campus and to present their project, as well as participate in the presentation at AISTech 2022. They also participated in the summer events such as tours and camps at Purdue University Northwest.

There was also an annual event hosted on campus that the students in the project were particularly encouraged to attend, and that was CIVS's Steel Week, held coinciding with a Steel Manufacturing Simulation and Visualization Consortium meeting. This was culminated by having students participate in viewing two days of technical presentations on the work done by CIVS students on research in many different areas of steelmaking, and to mingle with the researchers, operators and managers that attend.

There were two trips out to the Burns Harbor plant to meet with the industry advisor and to discuss with them the scope of the project for the grant period, and to get feedback on the writing and development. These visits usually involved tours of the caster site that was the basis of the project, the cast floor, the rollers during downtime and one of the gap sleds at the plant. It was important to learn about the scale of the caster, how the process actually works, and to get the students engaged in the project. ✦