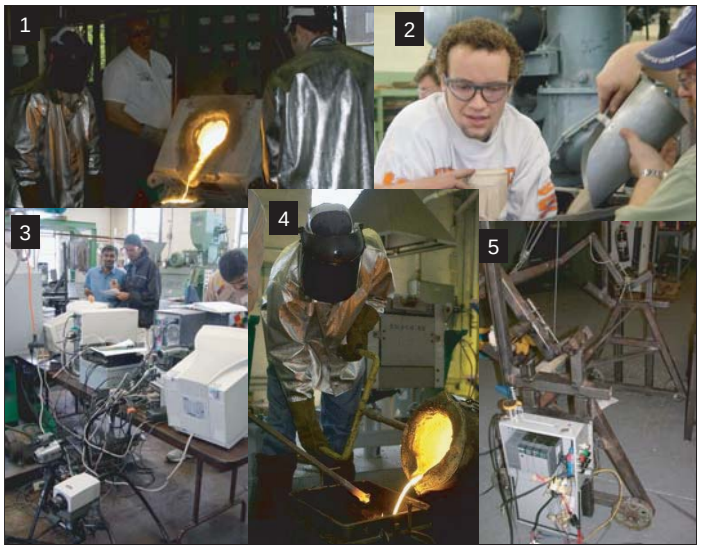
In-Situ Real Time Monitoring and Control of Mold Making and Filling Processes

The project aims at addressing two main casting methods: lost foam casting and green sand casting. Foam pattern/sand mold characteristics and the filling process are recognized as two main factors in determining final casting quality of a cast component. However, extensive studies of the effect of the pattern/mold making process on the pattern/mold characteristics and casting quality have been limited. Most traditional foundries using sand molds today do not have a detailed procedure for quality control over the molds. All of these foundries greatly rely on testing of sand characteristics with the assumption that controlling bulk sand characteristics would automatically yield good molds. Although bulk sand characteristics represent an important component, individual variances such as sand additives, mold machine, and operating experience enter into the process and affect the molding performance.

The past few decades have seen significant improvement in mold making technology, resulting in a reduction of scrap; developments include process automation and testing of sand properties. Further reduction in scrap and variation in casting quality still remain as one of the industry's high priorities, targeting 40 percent reduction in scrap by the year 2020. However, because optimization becomes more difficult as the process quality approaches the level of perfection, further reduction in the scrap level will require innovative technology beyond the incremental changes of bulk sand testing and open loop automation.



Students are an integral part of this multidisciplinary research project.
1) A casting trial at TTU foundry; 2) Students prepare for an experiment for monitoring metal fill in lost foam casting; 3) Technology merges with foundry traditions; 4) Manual pour during a casting trial; 5) A robot designed and built by students for automatic pouring.

Benefits for Our Industry and Our Nation

- *A 0.274 Trillion BTUs in direct energy savings by year 2008, 2.74 Trillion BTUs by year 2018, and* 4.94 *Trillion BTUs by year 2028.*
- *Reduction in primary carbon emissions and hazardous waste.*

Applications in Our Nation's Industry

This technology develops analytic methods and procedures to quantify a series of molds and patterns in terms of their primary properties. This would enable better control over the casting process, reducing scrap rate and variances in the casting quality in the Metalcasting industry.

Project Description

The goal of this project is to achieve the advancement of online measurement and control capabilities of a typical foundry to monitor the manufactured pattern/mold characteristics prior to and during the pattern/mold filling process. This project is focused on green sand casting and lost foam casting.

The objectives of this research are:

- Identify manufactured pattern/mold parameters that affect casting quality.
- Develop online measurements for mold/pattern characterization and monitoring of the mold filling.
- Develop a prototype of the system for online testing.
- Illustrate how to utilize the developed online measurement system with statistical process control to reduce variation in the casting quality.
- Illustrate automatic control of mold filling using the developed online measurement system.
- Increase awareness of the technology impact in the Metalcasting industry among students and the existing workforce, and enhance the image of Metalcasting industry where high tech opportunities exist.

Milestones

Results to Date

1. An investigation of promising sensing technologies for the characterization and filling of molds and patterns was completed.
2. Preliminary testing of cost-effective sensing technology was completed.
3. A prototype mold filling sensor system has been developed and used in laboratory simulations.

Future Milestones

1. Perform a root-cause analysis to identify mold/pattern characteristics related to casting defects.
2. Complete the development of sensors for foam pattern and green sand characterization systems.
3. Assess the impact of R&D activities on student learning and implement necessary curricular changes to integrate casting research into foundry education at TTU.
5. Develop a system for analyzing signatures from metal fill sensors and validate in an experimental foundry environment.
6. Organize and conduct a technology transfer conference for attendance by university and industrial partners, and members of the foundry and sensing technology industries.
7. Complete a final report.

Project Partners

Tennessee Technological University
Cookeville, TN
Arena Flow, Albuquerque, NM
Carbo Ceramics, Irving, TX
Citation Foam, Columbiana, AL
D8, Inc., Potlatch, ID
Foseco Morval, Inc., Bessemer, AL
GM Powertrain, Saginaw, MI
Hirsch USA, Peachtree, GA
MCT, St. Paul, MN
Oak Ridge National Laboratory Oak Ridge, TN
Walford Technologies
Oak Ridge, TN

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

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