

# METAL CASTING

Project Fact Sheet



## UNCONVENTIONAL METHODS FOR YIELD IMPROVEMENT

### BENEFITS

- Increase in casting yield on current practices by 10%
- Develop techniques to improve yield by 25% on an optimized casting system
- Energy savings in melting estimated to be 1.8 trillion Btus per year when yield is increased by 10%
- Identified variables with strongest statistical influence on casting yield
- Identifying conventional methods and unconventional methods for improving yield
- Developed new engineering rules to determine riser size and location which can increase yield by up to 20%

### APPLICATIONS

Most steel foundries must melt about twice as much steel as will be shipped as finished product. The additional metal primarily is present in risers and is used to prevent holes or voids from forming inside the casting. This research is identifying techniques for decreasing the size and number of risers required to produce quality castings. Its goals are to develop techniques which will improve casting yield by 10% on current practices while maintaining quality, and to develop techniques which will improve yield by 25% on an optimized casting system.

## NEW TECHNIQUES ARE BEING DEVELOPED TO INCREASE YIELD IN STEEL CASTING THROUGH DIRECTIONAL SOLIDIFICATION

The results of this research, being performed by the University of Iowa, Department of Mechanical Engineering, demonstrate that substantial yield increases are possible by using alternatives to current rules for risering design. Researchers are identifying techniques for decreasing the size and number of risers required to produce quality castings. These techniques include:

- conventional methods (feeding rules, riser insulation, block chills)
- unconventional methods (active heating and cooling, directional solidification)

Novel yield improvement techniques are being developed promoting directional solidification through a variety of active heating/cooling schemes. It is envisioned that the techniques will allow certain castings to be produced with a yield that is at least 25% higher than the current level.

### VARIABLES IMPACTING YIELD IN STEEL CASTING

1. Tonnage per pattern (yield increases with its increase).
2. Percentage of pump and valve production (yield decreases with its decrease).
3. Percentage of rail production (yield increases with its increase).
4. Percentage use of in-house risering rules (yield increases with its increase).
5. Percentage of industrial production (yield decreases with its increase).
6. Percentage of corrosion-resistant production (yield decreases with its increase).
7. Minimum section thickness (yield increases with its increase).
8. Average section thickness (yield increases with its increase).
9. Percentage of wear-resistant production (yield increases with its increase).
10. Typical casting "box" volume/average casting weight (yield decreases with its increase).

**Listed in order of statistical significance in influencing casting yield, identification of these factors enables foundries to identify obstacles to increasing yield.**



## Project Description

**Goal:** To develop techniques which will improve casting yield by 10% on current practices while maintaining quality, and to develop techniques which will improve casting yield by 25% on an optimized casting system.

University of Iowa researchers are conducting a casting yield survey to determine the average metal yield in steel foundries. They also are developing novel yield improvement techniques promoting directional solidification through a variety of active heating and cooling schemes. It is envisioned that the techniques will allow certain castings to be produced with a yield that is at least 25% higher than the current level.

Another objective of the project is to re-examine the engineering rules that have been used in the steel casting industry for more than 30 years to determine riser sizes and locations.

Researchers also are developing accurate methods that allow those foundries that are already using computer simulation to predict the exact casting soundness level and design risers without going through extensive casting trials in the foundry.

## Progress and Milestones

- Casting yield survey was sent to 93 steel foundries with a response rate of 40%. Average casting yield was found to be 53.3%. The average best and worst case casting yields were found to be 72.7% and 33.2%, respectively. A variety of factors including steel type, geometry, risering methodology, production-related variables and end-use were found to significantly increase or decrease casting yield. The survey indicates that a 10% increase in yield would translate into an energy savings of 1.8 trillion Btus per year for melting alone.
- Extensive 3-dimensional computer casting simulations showed that present engineering rules for riser sizes and locations are overly conservative and result in poor yields. New rules, which can increase yield by up to 20%, are being developed and are being made available to foundries.
- Accurate methods have been developed that allow those foundries already using computer simulation to predict the exact casting soundness level and design risers without going through extensive casting trials in the foundry. Such simulations are especially important for complicated casting shapes where simple rules would not be applicable.
- Over five foundries are participating in casting experiments and case studies to verify new methods. A manual version of the techniques and procedures is being developed.



### PROJECT PARTNERS

University of Iowa  
Department of Mechanical Engineering  
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Cast Metals Coalition

Steel Founders Society of America

Over 39 U.S. foundries

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