

# METALCASTING

## Project Fact Sheet



## CASTING-QUALITY MEASUREMENTS FOR POLYSTYRENE FOAM PATTERNS

### BENEFITS

- Could save 2.5 billion Btu of natural gas per installation annually
- Could save 0.11 trillion Btu annually by 2010
- Improves yields from 2% to 10%, reducing waste, energy use, and hazardous emissions
- Reduces costs of operating foundries
- Contributes to sustained employment
- Potentially reduces business lost to foreign markets

### APPLICATIONS

Technical services and pattern diagnostics offered by Industrial Analytics Corporation will be important to lost foam producers and consumers including vertically integrated foundries, contract suppliers, bead material manufacturers, mold designers, consultants, and academicians. Other industries in which the technology is applicable include shape and block foam and structural foam. Composites and forest products industries could also adopt the technology.

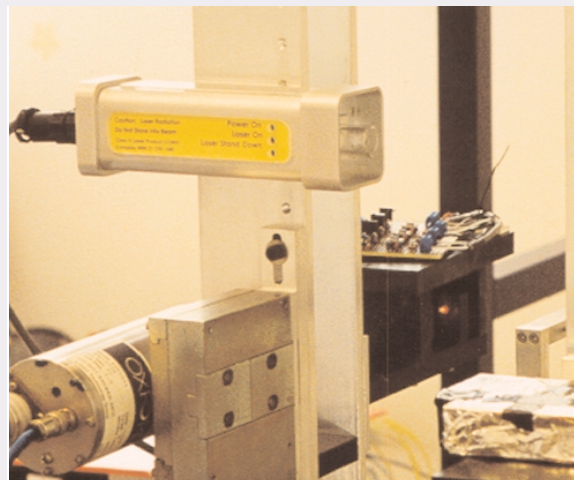
## A NEW TECHNOLOGY MEASURES LOST FOAM PROPERTIES, REDUCING DEFECTIVE METAL CASTINGS

Many mechanical parts, including automotive and marine engine components, electric motor housings, and other metal components, are cast by the lost foam process, which allows foundries to cast complex shapes not possible using more traditional casting processes. The process has significant advantages in virtually unlimited tool life, minimum energy usage and environmental emissions, and other desirable factors. However, several process variables specifically related to pattern quality can result in scrap rates and defects that could be significantly reduced through the proper quantifying and subsequent control of the pattern.

Current pattern quality control relies heavily on both the seller's and buyer's visual inspection. Such visual evaluations are very subjective and do not reveal the significantly varying foam properties invisible to the naked eye. Other pattern measurements such as gravimetric methods and physical breaking of the pattern and scraping of beads from the fracture are ineffective and counterproductive to developing professional quality standards.

Industrial Analytics Corporation has identified and developed pertinent methods to measure the critical pattern properties of density, foam fusion, and foam and coating permeability. The technology's ability to assess foam-pattern quality before coating will allow casters to increase their yields, reduce operational costs, and provide customers with tighter quality control.

### CASTING-QUALITY MEASUREMENT EQUIPMENT



The prototype testing machine, being developed by Industrial Analytics Corporation, includes both x-ray and laser-based systems to measure the critical properties involved in lost foam casting.



## Project Description

**Goal:** Build a reliable, nondestructive pattern measurement device and demonstrate its use in a casting improvement program with an industry partner.

Uncontrolled density, fusion, and permeability variations in a foam pattern occur during its manufacture because of uneven filling of the pattern mold. These are due to nonuniform pre-expanded bead filling and improper application of thermal energy during the fusion process. When these pattern properties are known and controlled, the pattern's metal fill can be smooth and high quality.

Density will be measured by transmitting a low-energy x-ray beam through a foam pattern and detecting the attenuation of the x-ray beam from the mass of the material. Bead fusion and gas permeability are related. Molded surface fusion will be measured using a laser beam. In addition, local permeability variation at any point in the foam will be mapped by measuring fluid uptake into the foam, using the x-ray beam. The fluid will fill only void spaces, which contribute to gas flow. Given the attenuation of x-rays and the fluid mass uptake, the density and permeability of the foam can be calculated.

Industrial Analytics Corporation is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the U.S. Department of Energy's Office of Industrial Technologies.

## Progress and Milestones

- Design and manufacture a prototype machine capable of reliable and consistent measurement of a pattern's critical parameters.
- Test the prototype and develop valid measurement criteria.
- Package the electronics design and automate the operation for easy use on the shop floor.
- Establish an industry track record by providing services to key customers.
- Prove the concept that the foam pattern measurements correlate to casting outcome.
- Publish the findings for the industry.

## Economics and Commercial Potential

The current yield for successful foam casting is 90% to 98%, but even small yield increases produce tremendous savings. The ability to measure foam patterns before coating could increase yields from 2% to 10%. A 1% yield increase in acceptable crankshafts could save \$240,000 per year. Similarly, a 1% improvement in engine block yields could save \$720,000 each year.

This technology could save an average of 2.5 billion Btu of natural gas per installation each year. First sales for the technology are expected by 2005. Based on 30% market penetration by 2010, annual savings could be 0.11 trillion Btu with 47 units operating. Market penetration of 60% by 2020 could save 0.25 trillion Btu with 100 operating units.

The market for foam patterns is about \$8 billion annually. The number of foundries using the lost foam process grew by 105% through the year 2000, and the market is expected to continue growing until it reaches maturity in 2015.

## INDUSTRY OF THE FUTURE—METALCASTING

*The metalcasting industry represented by the American Foundry Society (AFS), North American Die Casting Association (NADCA), and the Steel Founders' Society of America (SFSA) has prepared a document, "Beyond 2000," to define the industry's vision for the year 2020. OIT's Metalcasting Vision Team partners with metalcasters, national laboratories, universities, and trade/environmental/technical organizations to develop and implement energy efficiency technologies that benefit both the industry and the United States. Recently, the Metalcasting Team facilitated the development of the Metalcasting Technology Roadmap, which outlines industry's near-, mid-, and long-term R&D goals.*

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The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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