

# metal casting

Metal Casting — Industry of the Future



Industry partnerships are advancing the state of the art in energy-efficient metal casting technologies and practices.



Office of Industrial Technologies



Office of Energy Efficiency and Renewable Energy  
U.S. Department of Energy



# partnership

## Collaboration creates tomorrow's industry today

### Tomorrow's industry today

*Ingenuity and new technologies are transforming the metal casting industry. Today's metal casting industry is innovative, high-tech, challenging, clean, and safe. The industry develops and applies the latest in computer-based design and simulation, energy-efficient practices, and waste-minimization technologies and processes.*

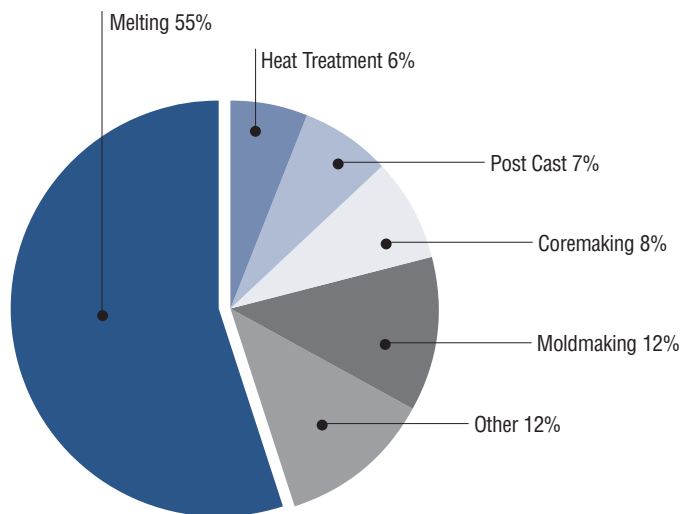
*Metal Casting Industry of the Future research has fostered many of these process improvements and technology innovations—from advances in lost foam casting, to computer-based visualization tools for die casters, to alternative molding media.*

Cast metal products are found in 90 percent of manufactured goods and equipment. From critical components for aircraft and automobiles to home appliances and surgical equipment, cast metal products are integral to our economy and our way of life. The U.S. metal casting industry is the world's largest supplier of castings, shipping cast products valued at over \$18 billion annually and directly employing 225,000 people. Metal casting companies are often at the heart of the economy in the communities where they reside. Of the 2,950 metal casting establishments located throughout the United States, over 80 percent are small businesses.

In 1995, leaders from the U.S. metal casting industry joined a unique partnership with the U.S. Department of Energy's Office of Industrial Technologies (OIT) Metal Casting initiative. This partnership is advancing the application of state-of-the-art practices and technologies at an unprecedented pace. It is also reinvigorating U.S.-based metal casting research and education—helping to attract a new generation of highly valued, well-trained professionals to the industry. It is helping to fulfill the vision for 2020:

- A globally competitive and environmentally responsible industry
- A well-capitalized and profitable industry
- A source of challenging and well-paying careers
- The preferred supplier of engineered, net-shape metal components
- The world's benchmark for technology and innovation

### Energy Use in Metal Casting



*Melting is the most energy-intensive process in metal casting. Research is focusing on improving melting efficiency as well as improving yield, thereby reducing the amount of metal which must be melted.*

Source: U.S. Department of Energy, Office of Industrial Technologies, "Energy and Environmental Profile of the U.S. Metal Casting Industry," September 1999.

## How do we measure success?

**Increased yield and reduced scrap**—Improving yield and reducing scrap decreases the amount of metal that must be melted, in turn saving energy.

**Melting efficiency**—Melting represents 55% of process energy costs. Improving melting efficiency saves energy and reduces production costs.

**Environmental benefits**—Improving energy efficiency in casting reduces emissions and helps protect the environment.

## Industry drives the process

Coordinated through the Cast Metals Coalition (CMC), the U.S. metal casting industry is implementing the Industries of the Future strategy and transforming metal casting processes. The CMC comprises the three leading technical societies representing over 80 percent of the industry: American Foundry Society, North American Die Casting Association, and Steel Founders' Society of America. By working together to identify common goals and priorities, the industry has created a powerful force for attracting and guiding public and private invest-

ment in technology development. Through technology showcases, seminars, conferences, trade press, and a network of thousands of local companies, OIT and the CMC are moving research advances into the marketplace.

The OIT Metal Casting Team has access to valuable industry expertise through its Industrial Oversight Panel (IOP). The IOP is an informal, ad hoc group of industry experts who provide DOE with individual, objective, and expert perspectives on the metal casting research portfolio.

### Vision

*Beyond 2000: A Vision for the American Metal Casting Industry*

The vision defines the 20-year outlook and is the foundation for the partnership. It was developed by and for industry.

### Roadmap

*Metal Casting Technology Roadmap*

The roadmap was developed by industry experts. It outlines pathways for near-, medium-, and long-term research in four critical areas: Manufacturing, Materials, Environmental, and Products & Applications.

### Implementation

In its short history, the Metal Casting initiative has provided nearly \$20 million in cost-share support for close to 100 research projects involving over 300 partners from industry, academia, and research organizations. In recent years, OIT has funded an additional \$28 million worth of research and technical assistance relevant to metal casters.

### Benefits to local communities and the nation:

*A cleaner environment*

*Improved energy efficiency*

*Higher-quality cast components*

*Competitive domestic industry*

### Metal Casting Research Is Performed Nationwide

- 
- Advanced Technology Institute
  - Case Western Reserve University
  - Climax Research Services
  - Colorado School of Mines
  - Copper Development Assoc., Inc.
  - Arena, LLC
  - Hayes Lemmerz
  - Intl. Lead Zinc Research Organization
  - Iowa State University
  - Materials Technology Laboratory
  - Mississippi State University
  - Oak Ridge National Laboratory
  - Ohio State University
  - Pennsylvania State University
  - Prince Machine Corporation
  - Tri-State University
  - University of Alabama
  - University of Alabama—Birmingham
  - University of Iowa
  - University of Michigan
  - University of Missouri—Rolla
  - University of Tennessee
  - University of Wisconsin—Milwaukee
  - Worcester Polytechnic Institute

*The Metal Casting Industry of the Future partnership includes universities, laboratories, and hundreds of companies from over 30 states. Broad participation has been a key to effective technology transfer.*

# results

The results of Metal Casting Industry of the Future research are being applied today. They are providing industry with the tools to

- Produce lightweight, high-strength castings for automotive and other applications, thereby improving transportation fuel efficiency
- Produce complex castings that meet increasingly demanding customer specifications and require few-to-no post-cast operations
- Expand opportunities for producing castings from the full range of ferrous and nonferrous metals

In addition to addressing industry research priorities, the Metal Casting Industry of the Future research portfolio is helping to meet national energy efficiency goals. Research to improve productivity in manufacturing is translating into higher yield and reduced scrap—thereby reducing melting requirements. Computer-based design tools are replacing in-plant tryouts with simulations enabling faster analysis and saving energy. Environmental research is addressing foundry emissions and increasing applications for foundry waste.



## Applying the Results

*Improving productivity, saving energy, and increasing the quality of cast metal products*

## innovation partners benefits



### CastView™

Simple-to-use die casting flow simulation yields extremely fast analysis times. Now available commercially.

Ohio State University and 11 industry partners

- Reduces scrap by as much as 20%
- Decreases energy consumption
- Improves casting quality and competitiveness



### Lost Foam

New process-control measures and technologies are resulting in higher-quality castings and increased use of the lost foam process.

University of Alabama–Birmingham and over 30 university and industry partners

- Improves energy efficiency by as much as 27%
- Reduces scrap
- Opens new markets



### Aluminum Alloy Microstructure Performance Interaction

Enhanced understanding of the impact of alloying elements on the properties of aluminum die casting alloys is enabling die casters to reduce the weight of automotive castings by as much as 7%.

Worcester Polytechnic Institute and over 20 industry partners

- Saves energy in melting (est. 1.9 TBtu/yr in 2020)
- Creates new markets for cast aluminum components



### Cupola Process Control

Software to optimize furnace control is reducing coking coal requirements by as much as 5%. Now commercially available.

Idaho National Engineering and Environmental Laboratory and 8 industry partners

- Saves 400 MBtu/yr/unit
- Decreases coke emissions
- Improves casting quality

*For more information on these and other Metal Casting research projects, visit [www.oit.doe.gov/metalcast](http://www.oit.doe.gov/metalcast)*

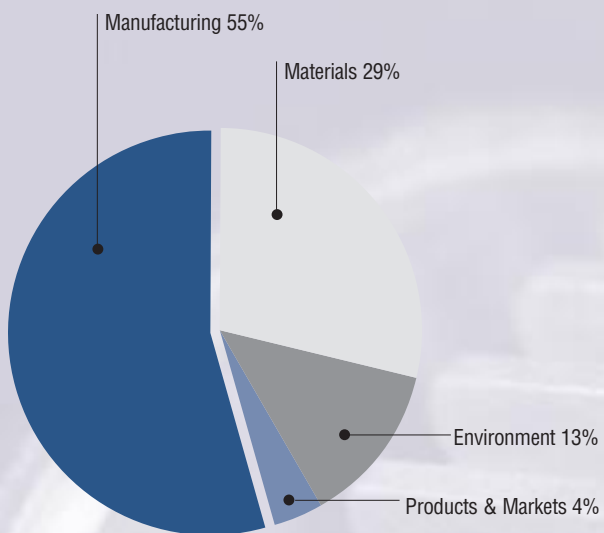
## Involving universities and students

Metal Casting Industry of the Future research is addressing one of industry's most pressing needs— attracting a sufficient and well-trained workforce. The program partners with over 20 universities nationwide, training dozens of students in the latest advances in metal casting. When these students undertake careers in metal casting, they bring the latest in technical knowledge and process advances to the shop floor. Metal Casting Industry of the Future alumni are now working in many sectors of the metal casting industry, including the automotive, industrial machinery, consumer goods, and other sectors.

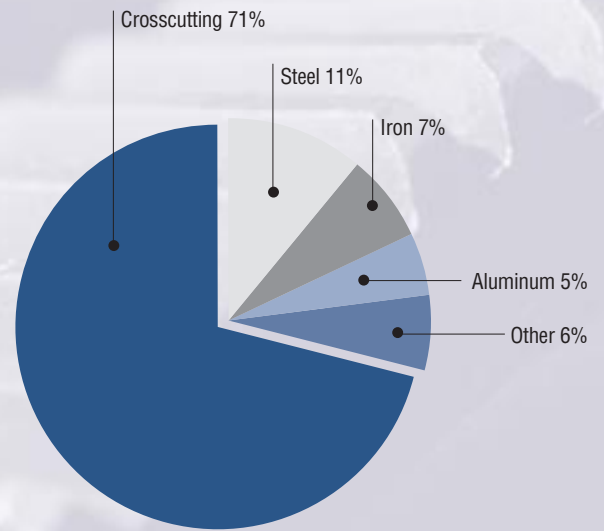
## Showcasing new technology

Lester Precision Die Casting opened its doors to the casting community and showcased the state of the art in die casting technologies that have resulted from Metal Casting Industry of the Future research. The event also showcased the many energy-saving practices available through OIT technical assistance programs. Allen Adams, from Lester Precision Die Casting, said that these technologies are evidence of the company's "attempt to find ways to achieve higher productivity and plant performance." Initial implementation is saving 5 billion Btu annually and has the potential to save 30 billion Btu per year. The showcase demonstrated the opportunities possible through government-industry partnerships.

## Diverse Metal Casting Research Portfolio



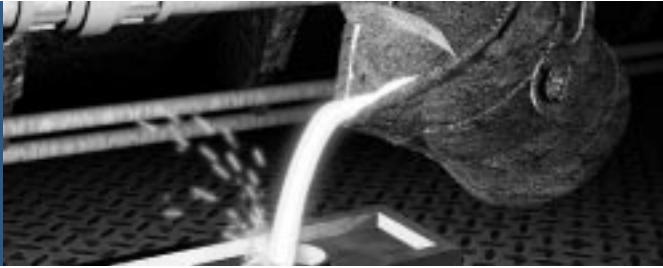
*Metal casting research crosscuts all roadmap priorities. Emphasis on manufacturing targets opportunities for saving energy.*



*Metal casting research can be applied across all categories of metals.*

# RESOURCES

## An integrated approach to assisting metal casters



OIT's **Enabling Technologies**, **Best Practices**, and **Financial Assistance** programs are strategically designed to provide integrated, targeted assistance to the Industries of the Future. In addition to the \$5 million annual metal casting budget and cost-share support for the industry, OIT has in recent years funded over \$28 million in research and technical assistance relevant to the metal casting industry through these programs. For example, OIT's Combustion program, part of Enabling Technologies, is funding research in Oscillating Combustion, which holds promise for improving energy efficiency in melting.

Cross-industry support comes from OIT's Aluminum and Steel Industries of the Future, which cost-share research of importance to the metal casting industry. Joint projects include Development of an Innovative Vertical Flotation Melter and Scrap Dryer and Novel Method to Process Electric Arc Furnace Dust into Saleable Product.

OIT's Integrated Delivery of technical and financial assistance and advanced research offers many opportunities for metal casters. For more information, visit the OIT web site at [www.oit.doe.gov](http://www.oit.doe.gov).

### Enabling Technologies

OIT works with industry, the national laboratories, academia, and others to research, develop, and commercialize enabling technologies that can benefit a wide range of industries, including metal casting. In **Industrial Materials**, the focus is on strong, durable materials that can withstand harsh, high-temperature industrial environments. Efforts in **Combustion** target clean, cost-effective technologies that will increase productivity, improve energy efficiency, reduce emissions, and enhance fuel flexibility. Research in **Sensors and Controls** addresses such challenges as improving sensor reach and accuracy in harsh environments, and providing integrated measurement systems for casting systems.

### Reclassifying spent sand in West Virginia

Simply by applying the Industries of the Future model, the State-Level program fosters partnerships among state agencies and local industry to address local energy, environmental, and economic needs. In West Virginia the Industries of the Future—West Virginia Metal Casting group successfully convinced state regulators to reclassify spent foundry sand. The result: The West Virginia Division of Environmental Protection published Spent Foundry Sand Beneficial Use Guidelines, effective June 1, 2000. These guidelines allow nonhazardous spent foundry sand to be used for other materials, including flowable fill for highway construction and other products.



## BestPractices

Through the BestPractices program, OIT helps foundries, die casters, and other manufacturers apply existing technologies to save money, cut emissions, and reduce wastes. OIT alerts companies to opportunities for funding, tools, expertise, and potentially applicable technologies in OIT's extensive portfolio of crosscutting products and services. The returns for industry can be significant.

BestPractices also offers **plant-wide assessments**, helping manufacturers develop a comprehensive strategy to increase efficiency, reduce emissions, and boost productivity. Through the BestPractices program, a metal casting company was recently awarded a competitively solicited plant-wide assessment valued at \$75,000. Several metal casting facilities have taken advantage of the **Industrial Assessment Centers (IAC)** program, which provides no-charge assessments to small and mid-size manufacturers through a network of engineering universities. Recommendations save companies an average of \$55,000 annually and help to train students for careers in industry.

## Financial Assistance

OIT offers two Financial Assistance programs to accelerate technology development and application. The **Inventions and Innovation** program awards grants of up to \$200,000 to inventors of energy-efficient technologies. Grants are used to establish technical performance, conduct early development, and initiate commercialization activities. The second program, **NICE<sup>3</sup>** (National Industrial Competitiveness through Energy, Environment, and Economics), provides cost-shared grants of up to \$500,000 to industry-state partnerships for demonstrations of clean and energy-efficient technologies. Both Inventions and Innovation and NICE<sup>3</sup> award grants to such metal casting research projects as Filtering Molten Metal and Die Casting Copper Motor Rotors.

## State-Level Industries of the Future

Numerous key metal casting states are participating in OIT's State-Level Industries of the Future program, establishing partnerships and promoting the industry at the local level.

**For more information, please contact the  
OIT Clearinghouse at (800) 862-2086.**

## How to get involved

*Hundreds of metal casting companies are improving casting practices and boosting their competitiveness by participating in the Metal Casting Industry of the Future. In the process, they are saving energy and enhancing our nation's environmental quality.*

*To get involved:*

*Visit the Metal Casting Team Web site to learn more about Metal Casting Industry of the Future research accomplishments and partnerships:  
[www.oit.doe.gov/metalcast](http://www.oit.doe.gov/metalcast)*

*Team with other organizations and participate in cost-share research. Solicitations are published at [www.oit.doe.gov/news/solicitations.shtml](http://www.oit.doe.gov/news/solicitations.shtml)*

*Begin saving energy through technical assistance from BestPractices or the Industrial Assessment Centers program:  
[www.oit.doe.gov/bestpractices](http://www.oit.doe.gov/bestpractices)*

*Contact the OIT Clearinghouse at (800) 862-2086 and take advantage of OIT's other technical and information resources designed to help you save energy.*

[www.oit.doe.gov/metalcast](http://www.oit.doe.gov/metalcast)



For more information on the Metal Casting Industry of the Future,  
contact the OIT Clearinghouse at (800) 862-2086  
or visit [www.oit.doe.gov/metalcast](http://www.oit.doe.gov/metalcast)

Please send any comments, questions, or suggestions to [webmaster.oit@ee.doe.gov](mailto:webmaster.oit@ee.doe.gov)



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