AFS directly funds research projects from the allocation of a portion of annual dues paid by AFS Corporate Membership. In addition, AFS is involved in several research partnerships supported by government funding, industry contributions, and other means. Support of research is critical for North America to maintain a strong, vibrant, healthy, and continually advancing metalcasting industry. AFS participates in these projects by securing industry partners and providing technical management and oversight. AFS currently is active in two metalcasting research funding partnerships.

American Metalcasting Consortium/Defense Logistics Agency Funded Projects
AFS is a partner in the American Metalcasting Consortium (AMC). AMC is funded through the U.S. Department of Defense (DOD), Defense Logistics Agency (DLA). The American Metalcasting Consortium provides direct support to the DLA through new technology, improved processes, and technical expertise in the procurement of metal castings to ensure warfighter readiness. AFS is managing two projects under the current AMC program, Innovative Technology.

Casting Alloy Data Search (CADS)
AFS through AMC/DLA has developed a very effective web-based tool called Casting Alloy Data Search (CADS) for design engineers and ICME professionals, which has been used for over five years by the foundry industry and is accessible through the AFS website. CADS needs to further expand to accommodate more ICME relevant data generation for optimization and more accurate predictions of thermo-physical and thermo-mechanical properties for materials beyond casting alloys, such as molding media. The goal of this research project is to enhance the current CADS and create an additional module of CADS for the nonmetallics, such as molding and core materials, and populate it by generating and validating data useful to ICME professionals. CADS is developed in partnership with Product Development & Analysis (PDA).

Integration of ICME Tools in Casting Design and Process Optimization for Intelligent Manufacturing
The project will develop an effective and integrated ICME framework as an approach to make more efficient casting designs and improved manufacturing approaches. Current physics-based simulation tools are limited to simulate for a few, finite known process variables, but do not account for many more, including dimensional, compositional, and section thickness variability inherent to the metalcasting process. A comprehensive approach of physics-based simulation with probabilistic metamodeling using historic data is unique and will allow for rapid and more accurate predictions.

Current ACRC Funded Projects:

- **Al-Based High Entropy Alloys (ACRC)**
  This is an exploratory project to investigate the Al-based HEAs. The aim is to develop a new set of alloys with either high stiffness, both good ductility and strength, or excellent creep resistance at high temperatures (> 300 °C).

- **Big Data for Assessment and Enhancement of Casting Processes (ACRC)**
  Modern foundries have the capability to capture a vast amount of process data on a daily basis. However, the data from various sources throughout the operation are often kept in silos where their value might have limited utility. This is especially true when there are no significant quality issues arising to motivate a holistic interrogation of these data. It is a lost opportunity for the foundry if there is no way to compile, fuse, and analyse these data to better understand the process factors influencing the quality of castings.

- **Heat Treatment (ACRC)**
  The processes and designated alloys to be investigated in this project are listed below:
  - High pressure diecasting process for A360 and A380.
  - Permanent mold casting process for A356 and E357.
  - Cryogenic treatment process for A206, A355 and E357.

- **Castable High Strength Al–Mg–Zn Alloys Development (ACRC)**
Develop a castable, high strength, and high ductility aluminum alloy, which has:

- Good castability. Hot tearing and fluidity indices to be significantly better than A206 alloy.
- 40Ksi (276 MPa) yield strength at room temperature.
- 60 Ksi (414) ultimate tensile strength at room temperature.
- 10% elongation at room temperature.

**Multi-Material Metal Casting (ACRC)**
The scope of this project is to develop a ferrous insert that promotes the growth of a strong metallurgical bond with the aluminum during the casting process.

**Residual Stress in Al Castings (ACRC)**
The goal of this study is to measure and predict residual stresses in aluminum cast parts. It is important to understand the factors that affect the stresses in aluminum casting and to develop data that can be used in simulation technologies.

**Heat Transfer Coefficient Variation in Permanent Mold Casting**
This knowledge is a key input parameter for solidification modeling. With proper input parameters, the simulation/modeling results may be used as predictive tools as the fidelity between modeling and plant data will be more congruent.

**FEA Correlation of 3D Scanned Model of Cast Porosity**
The advancements in CT technology and software enable complete digital reconstruction of castings and mapping of the internal porosity. This allows for simulation of components with real porosity and more representative results for deflection and bending.

**Projects Leveraged With Funding From Federal Agencies and Industry**

- DOD Mobile Foundry: Agile Production (SERDP)
- Cold Spray R&D With UCI (ARL)
- Semi-Solid Metal Additive Manufacturing (ARL)
- In-Situ Manufacturing Techniques for Aluminum Matrix Nano-Composites (LIFT)
- Thin-Wall Aluminum Die Casting—Optimized Heat Treatment (LIFT)
- Rapid Creation of Tooling with Conformal Cooling (ATI)
- Knowledge Creation via Data Analytics in a High-Pressure Diecasting Operation (Mercury Marine)
- Numerical Modeling of Segregation and Shrinkage Porosity Formation in Multicomponent Alloys (Montupet)

**AFS Funded and Monitored Research**
AFS directly funds research projects from the allocation of a portion of annual dues paid by AFS Corporate Membership. Current AFS-funded research projects are described below.

**Determining the Effect of Boron in Gray Iron**

**Principal Investigators:** Dr. Laura Bartlett, Dr. Simon Lekakh, Missouri University of Science and Technology

The use of boron containing ultra-high strength steel parts has been ever increasing in Europe and North America since 2007. All of that steel is now making its way into the scrap supply with unintended quality control consequences to gray iron foundries. The other source of boron in gray iron melts can come from fresh furnace linings. Although boron is known to be a powerful carbide stabilizer, it may also counteract the effects of pearlite stabilizing elements like Cu and Mn, resulting in "soft" pearlitic castings. It is debated what is the "safe" level of boron in gray iron castings or what effect boron has on the microstructure and mechanical properties. Conflicting reports exist because the synergistic effects of boron and pearlite stabilizing elements such as Cu and Sn, and other minor elements, such as N and Ti, have not been considered.

The purpose of this project is to quantitively evaluate the effect of different boron additions in the range of 8 to 60ppm on the microstructure and mechanical properties of Class 30 and Class 40 gray iron. The synergistic effect of boron and other alloying elements such as Cu and Sn trace elements such as nitrogen will be evaluated.

The project is being monitored by the AFS Cast Iron Division. For more information about the project, contact AFS Senior Technical Associate Bo Wallace (bwallace@afsinc.org).

**Effect of Ceramic Sand on Cast Iron Mechanical Properties**

**Principal Investigators:** Dr. Scott Giese, University of Northern Iowa

Due to the OSHA Silica Rule under enforcement in the foundry industry today, many foundries are considering changing from silica sand to a ceramic sand/media to alleviate the issue. There are many questions associated with this
change, but one that is of primary importance is understanding the effect, if any, in microstructure and the associated mechanical properties that might accompany the use of the ceramic sand/media.

The purpose of this project is to evaluate the effect of ceramic sand/media on the mechanical properties for Class 30 iron and 80-55-06 ductile iron.

The project is being monitored by the AFS Cast Iron Division. For more information about the project, contact AFS Senior Technical Associate Bo Wallace (bwallace@afsinc.org).

**Turbulent Gating Effect on C89833**

**Principal Investigator:** Andy Shea, A.Y. McDonald Manufacturing Company

Brass foundries have seen an increase in “leaker” scrap when pressure testing brass castings since the switch to no-lead materials. This investigation will examine the impact of turbulent gating on pressure tightness and mechanical properties.

The purpose of this project is to help determine if turbulent gating has an impact on pressure tightness and mechanical properties of C89833 material.

The project is being monitored by the AFS Copper Division. For more information about the project, contact AFS Senior Technical Associate Bo Wallace (bwallace@afsinc.org).

**PVD Coatings to Aid Release for Permanent Mold Castings**

**Principal Investigators:** Dr. Stephen Midson, Colorado School of Mines

Aluminum often strongly solders to uncoated steel dies when cast in permanent metal molds. To address this problem, metalcasters use lubricants, which often need to be applied to the die prior to the production of each casting. For high-pressure diecasting, organic lubricants are sprayed onto the die, while for permanent mold casting, ceramic coatings, and graphite are used. Although the application is necessary, they cause various problems, such as reducing the quality of the castings and the creation of costly housekeeping issues. In addition, they are expensive and add to the cost of the casting.

The purpose of this project is to develop and utilize a laboratory test that can provide a quantitative measurement of the impact of different PVD coatings on the level of adhesion and force required to extract long cores from aluminum coatings.

The project is being monitored by the AFS Permanent Mold Committee. For more information about the project, contact AFS Senior Technical Associate Bo Wallace (bwallace@afsinc.org).

**LFC Molds Produced Using Additive Manufacturing**

**Principal Investigator:** Marshall Miller, Tesseract4D

Tooling constructed of T6061-T6 is considered expensive and requires special programming software and skilled programmers.

The purpose of this project is to determine the applicable metal additive manufacturing method and material for medium and high volume considering material durability, material costs, cycle time, equipment costs, and skill level required for production as compared to conventional methods.

The project is being monitored by the AFS Lost Foam Division and Additive Division. For more information about the project, contact AFS Senior Technical Associate Bo Wallace (bwallace@afsinc.org).

**LFC Molds Produced Using Polymer FDM & SLA Additive Manufacturing**

**Principal Investigator:** Marshall Miller, Tesseract4D

Tooling constructed of T6061-T6 is considered expensive and requires special programming software and skilled programmers.

The purpose of this project is to determine the applicable FDM (fused deposition modeling) polymer additive manufacturing and SLA (stereolithographic additive) method and material for low- and medium-volume considering material durability, material costs, cycle time, equipment costs, and skill level required for production as compared to conventional methods.

The project is being monitored by the AFS Lost Foam Division and Additive Division. For more information about the project, contact AFS Senior Technical Associate Bo Wallace (bwallace@afsinc.org).

**Casting of Aluminum Cerium Alloys Over Ferrous Inserts**

**Principal Investigator:** Paul Sanders, Michigan Technological University

Lightweighting vehicles can be enabled by multimaterial designs. Joining of aluminum castings to ferrous material will facilitate structural and material optimization of these metallic systems; however, current methods of forming metallurgical bonds between aluminum overcast on ferrous inserts are complicated and expensive with high process variation.
The purpose of this project is to identify a potential low-cost and robust process for multi-material joining of aluminum to ferrous materials; this work may enable utilization of more aluminum castings in the transportation industry.

The project is being monitored by the AFS Aluminum Light Metals Division. For more information about the project, contact AFS Senior Technical Associate Bo Wallace (bwallace@afsinc.org).

**Dimensional Tolerance Assessment Using 3D Printed Sand Casting Process**

**Principal Investigators:** Jiten Shah, Product Development; Tyler Nooyen, Waupaca Foundry, Inc.

The use of 3D printed sand (3DPS) casting process is growing in the production environment, and the initial feedback is comparable to the precise sand casting processes. The adoption of the 3DPS is seen mainly with the hybrid approach, where the mold is made with the conventional green sand process, and the complex core assembly is redesigned with a three-piece consolidated core using 3DPS. Very little is studied and known in the public domain about the dimensional tolerances achieved with this toolingless precision sand casting process, especially the potential of achieving much better true position and internal feature tolerances.

The purpose of this project is to identify and provide guidelines for improved dimensional tolerances with 3D printed sand iron castings to design engineers.

The project is being monitored by the AFS Additive Manufacturing Division. For more information about the project, contact AFS Senior Technical Associate Bo Wallace (bwallace@afsinc.org).

**Dynamic Testing and Analytics From Working Green Sand Systems**

**Principal Investigators:** Dr. Sam Ramrattan, Dr. Lee Wells, Western Michigan University

Green sand control is a conundrum because there exists a wide array of factors, such as water, clay, additives, sand grain surface, etc., that continuously fluctuate during a foundry’s day-to-day operations. Foundry engineers have long known that baseline standard green sand properties test provide limited information for green sand control.

The purpose of this project is to provide a statistical model demonstrating the ability of newly developed “dynamic” green sand control tools to augment standard tests and effectively detect near real-time process shifts affecting casting quality. The tests and strategy will reveal the influence of advanced oxidation bentonite treatment on green sand stability, scrap rate, energy signature, dimensional stability, and labor per shipped unit at a working green sand foundry.

The project is being monitored by the AFS Molding Division. For more information about the project, contact AFS Senior Technical Associate Bo Wallace (bwallace@afsinc.org).

**Iron Casting Life Cycle Analysis**

**Principal Investigators:** Dr. Greg Keoleian, Dr. Daniel Cooper, University of Michigan

There are limited life cycle inventory data available to characterize the energy and environmental performance of ductile iron cast products for the automotive and other industry sectors. The data are used by industry and other analysts to inform material selection and design decisions. Consequently, the ductile cast iron industry is missing the opportunity to compare the energy and environmental performance of their components against equivalents.

The purpose of this project is to develop a Life Cycle Analysis (LCA) model to characterize the energy consumption and greenhouse gas emissions for cast ductile iron parts and wrought steel equivalents.

The project is being monitored by the AFS Cast Iron Division. For more information about the project, contact AFS Senior Technical Associate Bo Wallace (bwallace@afsinc.org).
AFS Information Services

Casting Process and Alloy Assistance

The American Foundry Society website provides tools to assist casting design engineers in selecting the best casting process for a potential component and also provides casting alloy property data on many commonly used alloys. The goal is to give casting users, design engineers, and purchasers relevant and accurate information on casting capabilities and properties, providing easily accessible and retrievable information from a single site. The alloy property data can be quickly exported to a spreadsheet or FEA tools. The casting alloy & process selector, Casting Alloy Data Search (CADS), is located on the AFS website, www.afsinc.org under the ‘Designers & Buyers’ tab, or can be accessed directly at www.metalcastingvirtuallibrary.net/cads/cads.aspx. For more information, contact Steve Robison, AFS Chief Technical Services Officer, at 847-824-0181 ext. 227, or srobison@afsinc.org.

Casting Source Directory

Casting Source Directory is also available to the public on the AFS website. The site provides a directory of AFS Corporate Member metalcasters in a single source. Potential casting buyers can search by metal, alloy, casting process, casting size (weight), and U.S. state to locate a casting provider that meets their needs. The Casting Source Directory is located on the AFS website (www.afsinc.org) under the ‘Designers & Buyers’ tab, or can be accessed directly at www.castingsource.com/metalcaster-directory. For more information, contact Steve Robison, AFS Chief Technical Services Officer, at 847-824-0181 ext. 227, or srobison@afsinc.org.

CastingConnection

CastingConnection is a private, professional social network to connect, engage, and share critical industry information and best practices in real time. Through the open forum and sites devoted to our special interest groups, members gather to network via a comprehensive member directory, and participate in focused discussion groups. AFS members access and share useful, informative documents and media in all formats. Visit https://castingconnection.afsinc.org.
The AFS online library serves the needs of the metalcasting industry for current and historic information on metallurgy, casting processes, and material property data. The digital library is open to all AFS members. With a simple-to-use search, members have access to relevant technical and research articles and reports from all AFS published sources. Author and summary information is available for viewing, and full articles can be downloaded. All technical and management papers published in *AFS Transactions*, from the very first edition (published in 1896) to the present, are available, as well as technical articles from all AFS magazines. The library is located on the AFS website (www.afsinc.org) under the “Innovation & Management” tab. The library also includes summary information for technical articles published in the *International Journal of Metalcasting*. For more information, contact the AFS Senior Technical Associate at 847-824-0181 ext. 249, or bwallace@afsinc.org.

**Foundry e-Learning**

AFS offers industry-specific training, information, and education for metalcasters in a web-based format for a single access fee. The AFS Foundry e-Learning program gives subscribing organizations full access to online modules for formal staff training on a wide variety of metalcasting topics. Individual e-Learning modules also are available a la carte. More information and a video demonstration are available at www.afsinc.org/e-learning.

**AFS Technology Transfer**

**AFS CastExpo 2022: Back Together Again**

North America’s largest metalcasting trade show and congress will return April 23–26, 2022, in Columbus, Ohio. Thousands of decision-makers from across the metalcasting supply chain will participate, innovative new technologies will be unveiled, and millions of dollars in purchases will be initiated and finalized, making it the most important appointment on your 2022 business calendar.

**Conferences and Workshops**

AFS offers members and industry personnel an extensive program of professional development and learning opportunities on a wide variety of topics covering all aspects of metalcasting, including casting alloys and technologies, as well as events targeting EHS, management, and marketing professionals. In addition, AFS is sponsoring several workshops and conferences focused on best practices and the latest metalcasting technical developments, metallurgy, production, and safety.

- **Molten Aluminum Cleanliness Virtual Workshop (July 20–23, 2021, online):** All aluminum casting operations struggle with two major impurity issues: inclusions and hydrogen gas-caused porosity, which limit aluminum alloy castings from achieving their full, consistent capability casting after casting. In this workshop, aluminum industry expert Rafael Gallo will provide a comprehensive discussion on molten quality, molten cleanliness assessment, and inclusions in castings.

- **2021 Foundry Leadership Summit (September 12–14, 2021, Scottsdale, AZ):** Every September, leaders from all corners of the metalcasting industry meet for the finest in highly rated speakers, thought-provoking discussions, and rich networking opportunities. At the 2021 Foundry Leadership Summit, metalcasting leaders will discuss the profound changes sweeping the worlds of manufacturing, technology, economics, trade, and politics. Summit attendees will emerge refreshed, recharged, and ready to embrace the future.

- **2021 Casting Copper Alloys Workshop (September 14–15, 2021, Schaumburg, IL):** The Casting Copper Alloys Workshop will provide details on commonly poured alloys and metallurgy, with emphasis on best practices for melt cleanliness, pouring, and casting process control. Presentations include information on melting and pouring non-leaded alloys, new alloy developments, and the latest research and developments relevant to copper alloy casting. The seminar is geared toward foundry management, supervisors and operators to further their knowledge of copper-based alloy casting processes and help with finding solutions for the foundry.

- **2021 Environmental, Health, and Safety Conference (October 5–7, 2021, Birmingham, AL):** The annual AFS Environmental, Health & Safety Conference is the singular event for foundry industry EHS professionals to network, benchmark, and learn from each other. Attendees will share case studies of successful EHS projects, hear about cutting-edge issues from EHS and regulatory experts, and meet with vendors of EHS equipment and services. Join EHS peers in Birmingham, Alabama, for the 35th AFS Environmental, Health & Safety Conference.
2022 Foundry Industry 4.0 Conference (July 25–27, 2022, Itasca, IL): What do metalcasting owners, CEOs, COOs and foundry managers need to know about Industry 4.0 to make smart investments and gain a lasting business advantage for their foundries? Industry 4.0 is no longer just about the future. Smart, proactive manufacturers are using technology today to improve productivity, profitability, and worker safety. Evaluating and implementing technology today is the key to remaining competitive and sustainable tomorrow. Join us at the Eaglewood Resort in Itasca, Illinois, convenient to O’Hare Airport, for an array of expert speakers and superb business networking.

Web-Based Events

AFS also offers a series of technical webinars. Open to all industry personnel (offered at no cost to AFS members), web-based seminars provide relevant information presented by industry experts on a wide variety of metalcasting subjects. An archive of past webinars is also available. For a full listing of upcoming and past webinars, visit the “Events” tab on the AFS website at www.afsinc.org.

Information and Registration

AFS educational events provide relevant and practical information to improve casting quality, productivity, and profitability for metalcasting facilities and provide expertise in marketing and management issues. For more information, contact AFS Technical Assistant Kim Perna at 847-824-0181 ext. 246 or technicalassistant@afsinc.org, or Chief Technical Services Officer Steve Robison at 800-537-4237 ext. 227 or steve@afsinc.org. For a full listing of AFS educational opportunities, visit the “Events” tab on the AFS website at www.afsinc.org.
IJMC-FEF Student Research Competition

Make your mark in the industry’s original casting research scholarship competition.
The IJMC-FEF Student Research Competition empowers undergraduate college students to showcase their metalcasting research projects at CastExpo 2022. Winners will earn scholarships and be published in the International Journal of Metalcasting, a valuable step in students’ careers!

All eligible submissions will be judged by a leading panel comprised of the AFS Research Board and officers of the AFS Technical Council. Up to $4000 in total scholarships from AFS will be awarded.

Qualifications

The IJMC-FEF Student Research Competition is open to North American citizens who are undergraduate students currently enrolled in metalcasting-related programs at FEF-certified and affiliated schools. Students must be registered with FEF, have a current student membership with AFS, and be enrolled in the current academic year. The project must represent current or recent undergraduate-level work performed by the student(s) in metalcasting technology or molten metal processing. Each student may enter only one submission.

All presenting students receive free registration to CastExpo 2022, April 23–26, 2022, in Columbus, Ohio.

Participation and Presentation Guidelines

Deadlines and presentation instructions will be announced soon.

| Judging criteria                        | Points |
|----------------------------------------|--------|
| Technical Content—completeness of work, interpretation of work, and results, analysis, discussion, references/bibliography. Sufficiency of data to validate conclusions | 40     |
| Relevance—relevance and applicability of the research to the metalcasting industry | 25     |
| Innovation—originality of ideas, concepts, or approach | 25     |
| Presentation—overall style is effective. Information is concise and logically organized | 10     |
| Total                                  | 100    |

QUESTIONS? Contact: Bo Wallace, Senior Technical Associate, American Foundry Society at bwallace@afsinc.org.
The American Foundry Society has issued a call for papers and presentations for the 126th Metalcasting Congress and CastExpo, April 23-26, 2022, in Columbus, Ohio.

Produced by AFS, Metalcasting Congress is one of the foundry industry’s leading forums for knowledge-sharing and the presentation of new research and innovations. AFS is seeking proposals related to all areas of metalcasting, including technical and management subjects.

Technical papers and presentations covering all issues related to metalcasting, diecasting, and foundry operations will be considered. Technical topics of particular interest include, but are not limited to:

- Melting and molten metal treatment
- Gating and pouring
- Casting process innovations
- Additive manufacturing
- Quality
- Automation
- Foundry/Industry 4.0
- Finishing
- Energy efficiency
- Environmental health and safety

Technical papers and presentations are subject to peer review before receiving final approval.

Topics of particular interest for management papers and presentations include, but are not limited to:

- Supply chains
- Casting design
- Management
- Diversity and inclusion
- Human resources
- Succession planning
- Education
- Social media
- Professional development
- Student engagement pertaining to the metalcasting industry

Papers and presentations about the effect of COVID-19 on metalcasting operations are also desired. Submissions will be accepted beginning July 1, 2021. Abstracts are due Aug. 15, 2021. For an author’s guide, templates, and other guidelines and information, click here.