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MELTING POINT

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Unlocking the Universe's Secrets

Inside This Issue:

Why Metalcasting?... Metalcasting produces engineered metal components for use in all facets of our world, including what you drive, where you live, what you eat and how you work. The metalcasting industry maintains its traditions while embracing advanced manufacturing techniques. But the key to metalcasting is what is illustrated in ***Melting Point*** magazine—the diverse ways metalcasting helps propel society forward. If you are interested in joining this forward-thinking industry, look to the sections of the magazine dedicated to Metalcasting Universities & Scholarships and Career Opportunities on p. 20-23.

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DEPARTMENTS

LIGHTS. CAMERA. CASTING

Check out these cool videos online!
Visit **meltingpoint.afsinc.org**
to view these videos and more.

What is it like to work at a foundry? Employees at Charlotte Pipe and Co. share their stories in a video highlighting the company's culture and history.

Check out how a foundry in Indiana is using 3D printing to make castings. Read more about 3D printing in metalcasting on page 6.

Know you want to go to college for engineering or metallurgy? Consider attending a college affiliated with the Foundry Educational Foundation. Scholarships are available, and graduates are highly sought after by employers in the industry.

Young Pro Flourishing Early in Metalcasting Career

The Foundry Educational Foundation network of 33 world-class colleges and universities across North America equips and prepares students to enter the metalcasting industry immediately following graduation—providing not just book learning, but hands-on technical experiences in the school foundry, internships, and networking opportunities.

Emily Gerstein, a 2018 graduate of the University of Wisconsin-Milwaukee, first became interested in material engineering during high school after attending an ASM International camp at UWM. That camp introduced her to materials properties testing, microscopy, and even sand casting using foundry in a box.

Emily Gerstein, holding the pennant, parlayed involvement with FEF into a promising metalcasting career.

"After that, I knew that I really wanted to study materials, and I absolutely fell in love with metallurgy after I got involved with the UWM AFS/FEF Student Chapter," Gerstein said. "I use concepts that I learned in my heat treatment and metalcasting

Emily Gerstein graduated from the University of Wisconsin-Milwaukee, an FEF-certified school.

classes with things I'm doing at my work on a daily basis. Without the fundamentals that I picked up during my time at UWM, I wouldn't be able to problem-solve as effectively."

FEF's mission is to strengthen the metalcasting industry by supporting unique partnerships among students, educators and industry, helping today's students become tomorrow's leaders.

At the 2017 College Industry Conference held by FEF, Gerstein networked with industry professionals from around the country—some of whom she has worked with since.

"The CIC was a great opportunity to see what kind of jobs are available," she said. "I was able to connect with Waupaca Foundry and I ultimately ended up working at their Plant 1 facility following graduation."

Gerstein currently works as a metallurgist at Spuncast Inc. (Watertown, Wisconsin).

"I love that my job always keeps me on my toes," she said "I can always expect that there's going to be something different and exciting to work on whether it be in the lab or out on the floor.

"I can look back and see how my UWM education and my internship at MetalTek International helped prepare me for my jump into the metalcasting industry following graduation. A lot of what I learned was directly applicable to what I now do on a daily basis, so I was really able to hit the ground running when I started my first full-time job." MP

3D Printing in Metalcasting

3D printing has applications in many parts of the metalcasting industry and allows engineers to achieve creative designs that save money.

3D printing is an exciting way to create designs and make custom parts to order, and the equipment is getting better, faster, and more readily available. You might have even had the chance to use a 3D printer at your local library.

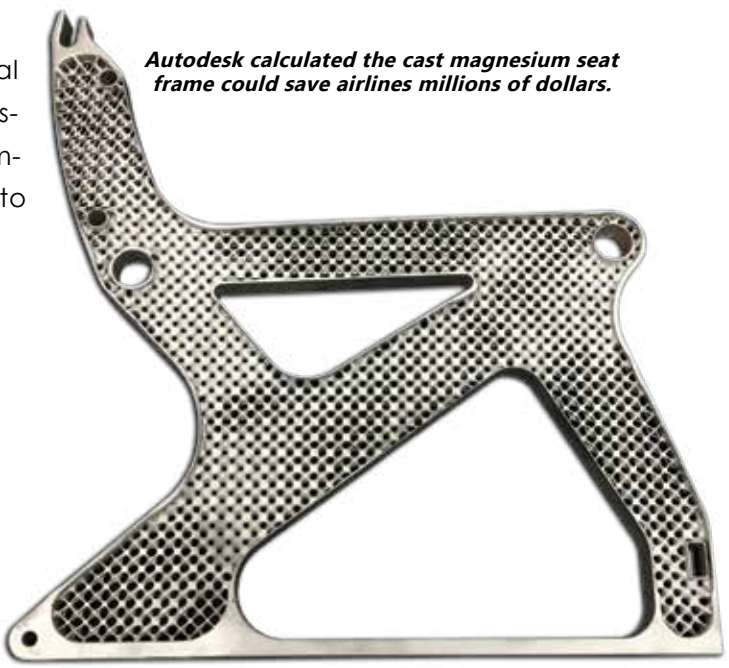
Layers of sand and binder are repeatedly laid down by the printer to gradually build up molds and cores.

3D printing is a growing part of metalcasting, too. While it is possible to print a part out of metal, it can be costly and these machines are limited in size and the type of metals that can be printed. Instead, metalcasters use 3D printing to make patterns and molds while still relying on the traditional process of pouring liquid metal into the mold

The 3D printing process does not require a pattern to create something, so each mold and core, like the ones here for a door hinge (also shown), can be unique.

to create the actual metal part.

Different types of molding material can be 3D printed, including wax, plastic, and sand. Check out these examples of how 3D printing is being used to produce real-world castings.



Autodesk calculated the cast magnesium seat frame could save airlines millions of dollars.

Plane Seat Frame

A passenger aircraft seat frame is a structural component uniquely designed for each aircraft configuration. Typically, they are machined into shape from a single piece of metal. But was there a better way to manufacture that could also reduce costs?

Autodesk, a leader in 3D design and engineering software, had been developing a different way of designing using

End-users of large castings like this gear part can get replacement parts quickly with 3D printed sand molds.

software that automates design options based on specific criteria, such as weight and strength, to perfect and speed up the design process.

Originally the thought was to use the software to 3D print the parts directly in metal. But metal printing is limited in size, and the team began considering how to use the model for other manufacturing methods. Metalcasting was a natural choice because 3D printing technology can be used to make the patterns and tooling in materials like wax and plastic on a larger scale than metal.

Autodesk sought to take out as much material as possible without affecting the strength requirements. The result was a much lighter seat frame with material located only were needed. The new shape was a lattice-like structure that was a perfect fit for investment casting.

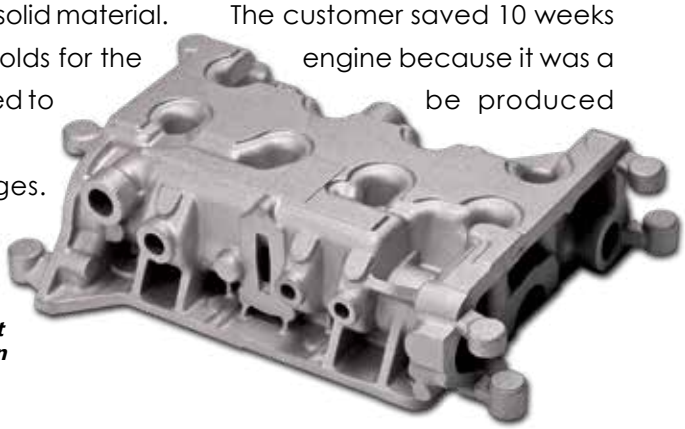
Autodesk contacted Aristo-Cast Inc., an investment caster with experience in prototyping and magnesium, to help carry out the design for an aerospace seat frame.

Through collaboration and sound casting principles, Aristo-Cast delivered final castings in four weeks that reduced weight by more than half compared to other lightweight frames on the market.

Engine Part for Racing

Choosing 3D printed sand molds for this engine casting meant not having to buy more expensive molds that are machined out of solid material. The customer saved 10 weeks and $60,000. It made sense to print the molds for the engine because it was a prototype, meaning not many parts needed to be produced and only a few molds were needed.

Using 3D printing had other advantages. One was the opportunity to make the



Choosing 3D printed sand molds for this crankcase casting avoided the need for traditional tooling, cut 10 weeks from the program, and avoided $60,000 in pattern and fixture costs.

complex interior passages with one core. A core is kind of like a mold that forms the inside geometry of a part, like holes or passageways.

An aluminum alloy called A206 was chosen for this component because it offers high mechanical properties. This alloy is known as a difficult alloy to cast, so extra care was taken into how to design the mold and how the molten metal would flow in what is called a gating system to create the final part. Computer-aided design (CAD) was used to model the gating system, and computer simulation was used to make sure the final part would meet quality standards.

Orders for the Fisher NPS 16 CL300 Vee-Ball valve body are now produced using 3D printed molds.

Control Valve for Oil Refineries

When traditional casting methods led to issues for a control valve body casting, Emerson contacted ExOne for equipment capable of making digital 3D printed molds.

To test this process, Emerson selected a control valve body casting with a known high probability for defects to three suppliers using traditional casting methods and compared the results with that of the 3D printed sand mold. The comparison led the company to produce new orders for the valve body in 3D printed molds because it eliminated design problems and improved the surface finish of the casting.

Engine Cylinder for Aerospace

By using additive manufacturing combined with standard rubber plaster molding (RPM), PreciseCast Prototypes & Engineering was able to 3D print a corebox in wax, which was used to produce a single plaster core. That replaced the five hand-assembled pieces and greatly reduced the variability and human error. The end result was a more repeatable, predictable part, thus reducing manufacturing time and cost.

PreciseCast Prototypes & Engineering was able to 3D print a wax corebox to produce a single plaster core.

Before incorporating 3D printing, the process to make these cylinders required producing five separate plaster core pieces that would be hand-assembled in the exterior mold. This caused a potential for error not only in mold-making but also in maintaining the proper port height and positioning of the part's features. MP

Casting a

Disney's theme parks are magic but they don't run on fairy dust. They run thanks to castings.

Spell

When you go to one of the Disney parks you'll have an enchanting experience. There are bright lights, cool buildings, fun toys and all of your favorites from childhood and, if you have kids, they'll create memories that will last forever.

You'll run into Mickey Mouse, Snow White, Mulan, Simba and so many others. But beyond that, the park still needs to function. And it does thanks in part to castings, which contribute to the unique vibe of the world-famous attractions. MP

The technology is modern but the look is vintage. The method of choice for production? Yep, casting. The exterior lamps and posts, like this one seen on the Disney Boardwalk in Orlando, Florida, are cast.

They're in the Magic Kingdom, but the cars at Disney parks still run thanks to cast components instead of pixie dust. Like the cars we all drive, the brakes and other vital systems rely on castings to work.

One of the subtly nice touches about Disney parks are the fences. The old-fashioned look immediately evokes a certain mood, and the fences are cast iron. An example (above) is the fencing in front of the Ferris wheel at Disneyland.

Disney World has actual mailboxes. Yes, the antique cast boxes look cool and add more flavor to the grounds, but they are functional and monitored daily like any mailbox you see around your neighborhood.

Walt Disney and Mickey Mouse will be linked for eternity. They stand hand-in-hand greeting you in front of Cinderella's Castle, as seen here.

A Winning Project

The home of the U.S. Open needed a roof. Castings made it happen.

The roof was completed in time for the 2016 U.S. Open.

The U.S. Open is one of the most exciting tennis tournaments of the year. Castings have made it even better.

For two weeks every year, Arthur Ashe Stadium is the center of the tennis world. Located in Queens, New York, it serves as the main arena for the Open, hosting the biggest matches in one of the planet's most important tournaments. Tens of thousands of ticket-buying spectators and millions more in a worldwide television audience see the stadium as it welcomes international stars like Serena Williams, Roger Federer, and Novak Djokovic.

A few years ago, Arthur Ashe Stadium underwent a major renovation that dramatically changed its look and feel. It's a renovation with massive and noticeable aspects, but also one made up of less-noticed but equally important phases.

Completed in 1997, the stadium was built without a roof. Because of this, matches

A connection is put into place outside Arthur Ashe Stadium.

were susceptible to the elements and the tournament schedule was often altered because of delays and cancellations. To fight the elements, the U.S. Tennis Association (USTA), the body that owns and operates the facility, announced in 2013 it was adding a retractable roof to the arena, following the lead of fellow major venues for Wimbledon and the Australian Open.

That roof, at a cost of a reported $150 million, is structurally independent from the stadium itself and was operational by the 2016 event, with the hulking steel frame in place for the 2015 tournament.

Of course, the project is much more complicated than simply slapping a roof structure over an existing arena. The new structure is supported by eight steel columns spaced around the perimeter of the stadium that are joined to ground-level concrete piers. Each base is a point where two diagonal braces are connected to a vertical steel column by cast steel connections. As fans walk into the arena, they stride right past the connections that are in place to help keep the roof up.

Around February 2014, Cast Connex, a supplier of castings and forgings with engineering and design capabilities, was contacted by steel fabricator Canam Group (Saint-Georges, Quebec, Canada). After a 2014 request from the New York City Design Commission, the USTA and the outside builders were tasked with creating the connections for the structure base that were strong and also attractive, since they are visible to spectators entering the arena.

Cast Connex was asked to deliver a custom-designed product, with the connections and braces in place by November 2014. The entire weight and lateral system of the roof goes through the connections, which are important from an architectural perspective. They had to be strong, but also aesthetically pleasing. Each of the connections weighs around 7,700 lbs. (3,492.7 kg) and connects to 30-in. (76.2 cm) diameter steel braces on one end. On the other, they're welded to the 40-in. (101.6 cm) diameter columns.

Cast Connex is not a casting facility. It designs the cast steel structural components for the construction of buildings and bridges, and partners with steel facilities for the manufacture of the components it designs.

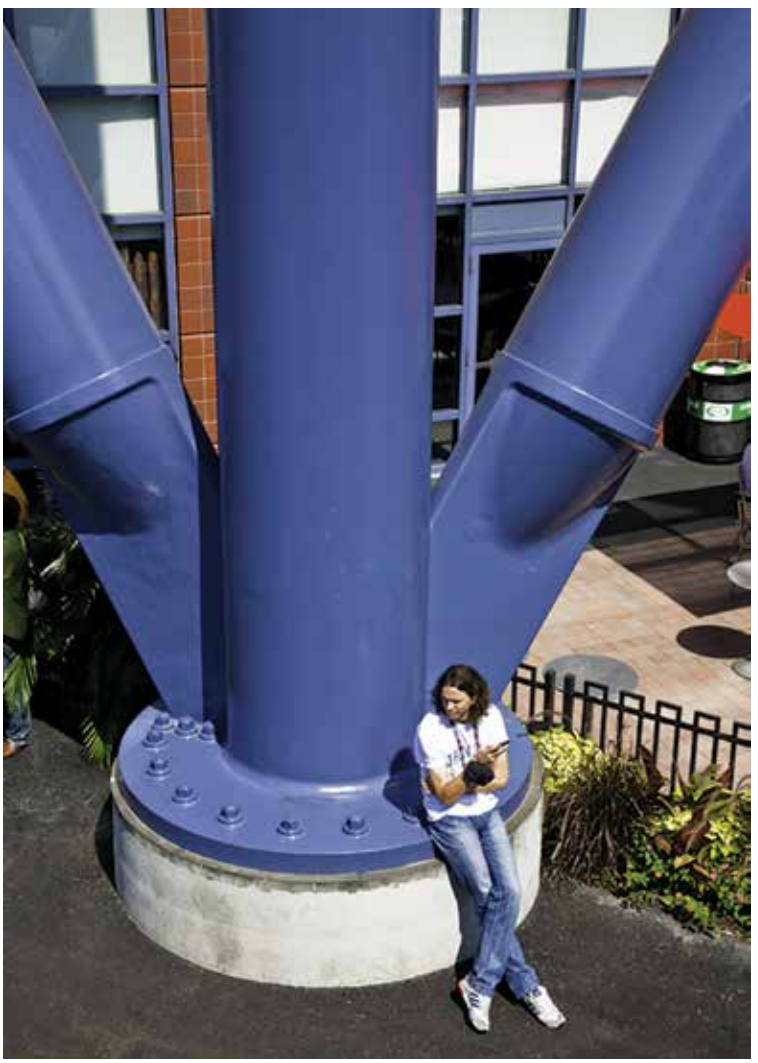
In the Ashe project, Cast Connex turned to Bradken and its Atchison, Kansas, facility for tooling, casting production, and machining. The two companies had worked together in the past, and based on their strong professional relationship and the size and complexity of the part, Bradken was the right facility for Cast Connex.

The two companies used a collaborative relationship to produce the connections. There was feedback, give-and-take, input, and evidence of a strong professional relationship.

"Not everybody can do this because there are a lot of technical and quality back-and-forth between the two because of the importance of these components, not only the structural integrity but also the expectation visually," said Wayne Braun, Bradken's director of business development – industrial products.

Other manufacturing processes theoretically could have been used to create this component. Casting, however, brought many distinct advantages. Beyond the aesthetics, it holds an ability to handle a bigger range of challenges, not to mention the absence of weld joints, leading to more capability to handle stresses.

"One of the advantages is the ability to make shapes that are aesthetically pleasing to an architect," Braun said. "If you combine those with the various grades and strengths that steel offers in addition to its weldability, it really gives you a number of options that allow you to cast shapes that are extraordinarily difficult or almost impossible to fabricate." MP



A person sits near one of the eight connections around Arthur Ashe Stadium.

Unlocking the Universe's Secrets

Particle physics investigates the tiniest detectable particles to figure out how the universe works. It is used in the treatment of cancer, cleaning dirty water, and making better tires, along with discovering the building blocks of matter.

Fermi National Accelerator Laboratory (Batavia, Illinois) operates the second largest particle accelerator complex in the world. Recently, it needed a support mount inside a crucial structure for accelerating particles, called a cavity. A copper casting was the answer.

Previously, the structure was milled from solid copper blocks and welded together. But the Fermilab team is pursuing new, cost-saving manufacturing methods.

The laboratory contracted a foundry to test a new way of creating the component. RoMan Manufacturing (Wyoming, Michigan) used a 3D-printed sand mold of the part and then poured copper into it to make the prototype.

"Traditional casting techniques for a single piece often require special tooling and machining, and a structure of this size is labor-intensive," said Fermilab engineer Matt Slabaugh.

Producing the part with a 3D-printed sand mold costs

Fermilab researchers work on experiments across a number of fields, including quantum science, dark energy, and neutrinos.

This accelerating cavity support mount was made using a 3D-printed sand mold.

roughly one-fifth the price of the milling method, and production time goes from many months to a few weeks.

"This was quite a feat. It's not easy to fashion copper into a shape like this, let alone to the precise specifications we needed," said Fermilab engineer Bill Pellico. "So the method is promising, especially since copper is such a common component in accelerating cavities."

The award-winning combination of old and new design techniques may become a solution for cutting-edge science.

"Copper casting is one of the oldest known metal forming techniques," Slabaugh said. "Enhanced with modern 3D printing technology, it shows potential as a unique solution for our accelerator." MP

PSU Behrend Students Learning Value of Internships

What is the value of an internship program at a metalcasting facility? What does an intern do? Who benefits from an internship program? The value is immeasurable, interns help complete projects that may have been put aside because no one has had the extra time to invest in them, and internships benefit all parties involved.

One of the goals of students pursuing a career in metalcasting is putting into practice what they are learning in class or taking on a project completely out of their comfort zone.

It's one thing to read about a process and maybe even to be able to test it out in the school foundry, but it's another thing to see it in a real world situation.

Students from FEF-affiliated Penn State Behrend have learned that firsthand.

Have you wondered about how cool driverless vehicles can be? Chris Lashway spent his internship developing a proposal that included a recommended supplier, project cost estimate and a revised department layout to accommodate automatic guided vehicles (AGV) at the foundry. This project not only filled a need for the company, but he

Kylan Bartok worked on creating an automated system that will transfer alloys from the alloy hopper to each furnace.

also learned a lot about emerging technologies. Lashway was offered a full-time job from his internship company, which he accepted.

Or maybe you are curious about automation and engineering. Kylan Bartok's assignment for his internship was to work on an automated system that will transfer metal to each furnace, instead of using a bucket system.

"I gained knowledge of working in a facility that can't be taught through books," said Bartok, who is on his second internship with this same company.

The main objective of Amber Nolf's internship project was to investigate how to develop both minimum hardness and tensile strength values in a cast stainless steel alloy.

"It was an experience that I'll forever be grateful for and it has prepared me to take on my full-time position (with this company)," Nolf said.

Branson Elliott worked on a project that measured the silica exposure levels in a machining department which taught him about environmental controls for facilities and solutions to limit exposure to silica dust. In addition to working on several individual projects, Austin Hankey worked on a group project to create an automatic shakeout machine to help the quality team.

The majority of FEF students participate in at least one internship prior to graduation. FEF professors have connections to many companies so they can guide a student in their choice of internship opportunities.

Not only do FEF students enjoy their internships but they are then better prepared for their first industry job following graduation. MP

Find a College to Study Metalcasting

Ready to launch your metalcasting career? Want to know where to get started? These colleges are optimal institutions to consider if you are interested in metalcasting as a career.

Arizona State University
Tempe, AZ

California Polytechnic State University
Pomona, CA

California State Polytechnic University
San Luis Obispo, CA

California State University—Chico
Chico, CA

Central Washington University
Ellensburg, WA

Eastern Michigan University
Ypsilanti, MI

Georgia Southern University
Statesboro, GA

Instituto Tecnologico De Saltillo
Saltillo, Coah, Mexico

Kent State University
Kent, OH

Michigan Technological University
Houghton, MI

Milwaukee School of Engineering
Milwaukee, WI

Missouri University of Science & Tech
Rolla, MO

Mohawk College
Hamilton, ON, Canada

Penn State Erie—The Behrend College
Erie, PA

Pennsylvania State University
University Park, PA

Pittsburg State University
Pittsburg, KS

Purdue University
West Lafayette, IN

Saginaw Valley State University
University Center, MI

Tennessee Tech University
Cookeville, TN

Texas State University—San Marcos
San Marcos, TX

The Ohio State University
Columbus, OH

Trine University
Angola, IN

University of Alabama—Birmingham
Birmingham, AL

University of Alabama—Tuscaloosa
Tuscaloosa, AL

University of Michigan
Ann Arbor, MI

University of Northern Iowa
Cedar Falls, IA

University of Wisconsin—Madison
Madison, WI

College Scholarships Available... YES!

Visit
American Foundry Society
Chapters at:
www.afsinc.org/chapters

Visit the Foundry
Educational Foundation at:
www.fefinc.org

University of Wisconsin—Milwaukee
Milwaukee, WI

University of Wisconsin—Platteville
Platteville, WI

Virginia Tech
Blacksburg, VA

Western Michigan University
Kalamazoo, MI

Worcester Polytechnic Institute
Worcester, MA

Youngstown State
Youngstown, OH

CAREER OPPORTUNITIES

Do You Like:

- Science?
- Building things?
- Designing things?
- Being creative?
- Working with people?
- Solving problems?

Consider Metalcasting. We Need:

- Business Managers
- Chemical Engineers
- Computer Engineers
- Electrical Engineers
- Human Resources
- Safety Managers
- Accountants
- Quality Control Technicians
- Marketing & Salespeople
- Mechanical Engineers
- Metallurgists
- Skilled Trade

Careers: Post High School

- Molder, Machine Operator, Pourer, Crane Operator
- Lab technician, Quality Assurance, Welder, Furnace Operator
- Patternmaker, Maintenance Mechanic
- Electrician:

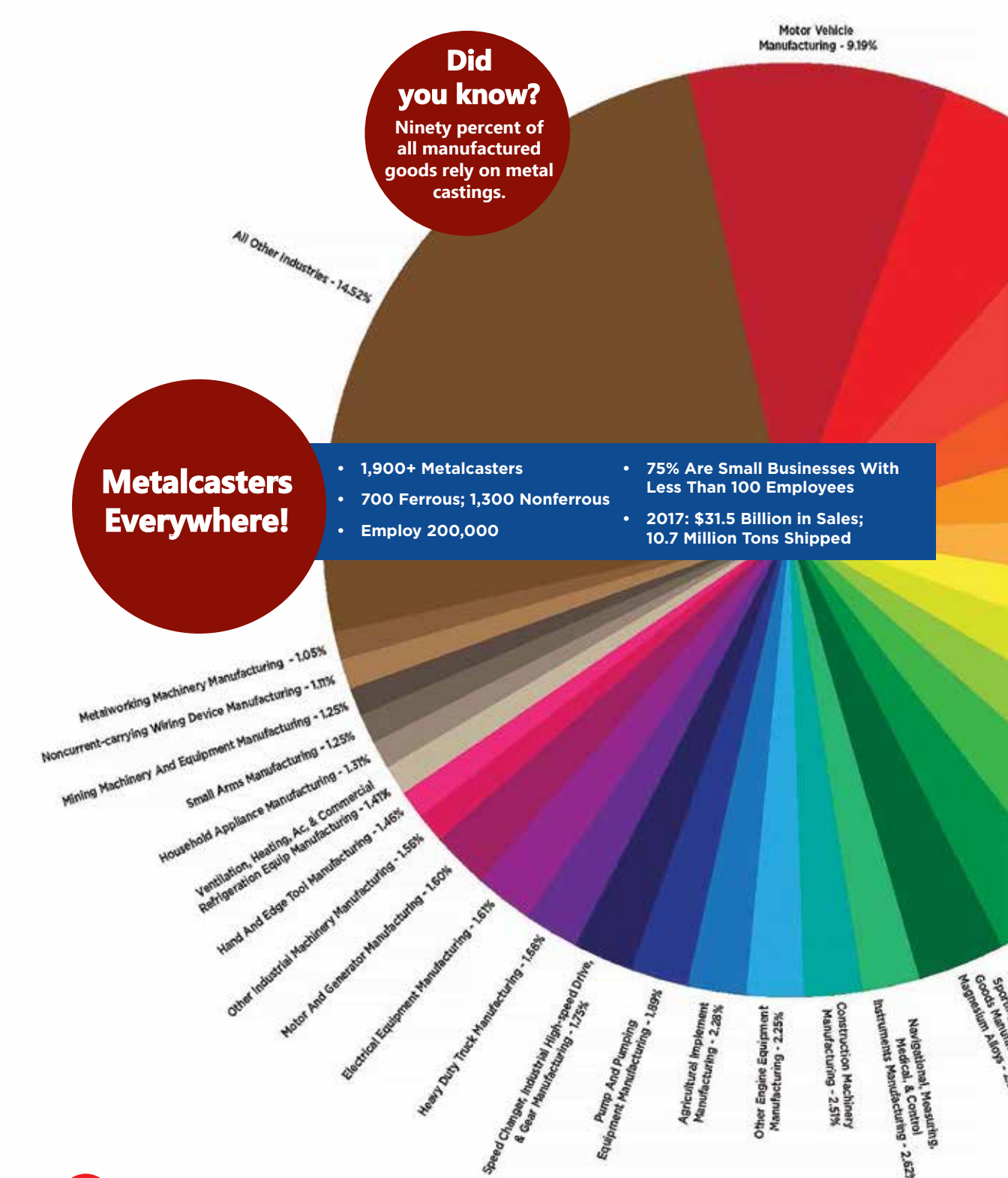
Careers: Post College

- Molding, Melt Superintendent
- Metallurgist, Quality Assurance Manager, Facilities Manager
- Engineering Manager, Plant Manager, HR Manager, Controller
- Sales Manager, Technical Director
- VP, President

Benefits

- 98% of U.S. foundries offer health benefits
- 90% offer retirement plans
- 83% pay bonuses

WHERE DO CASTINGS GO?



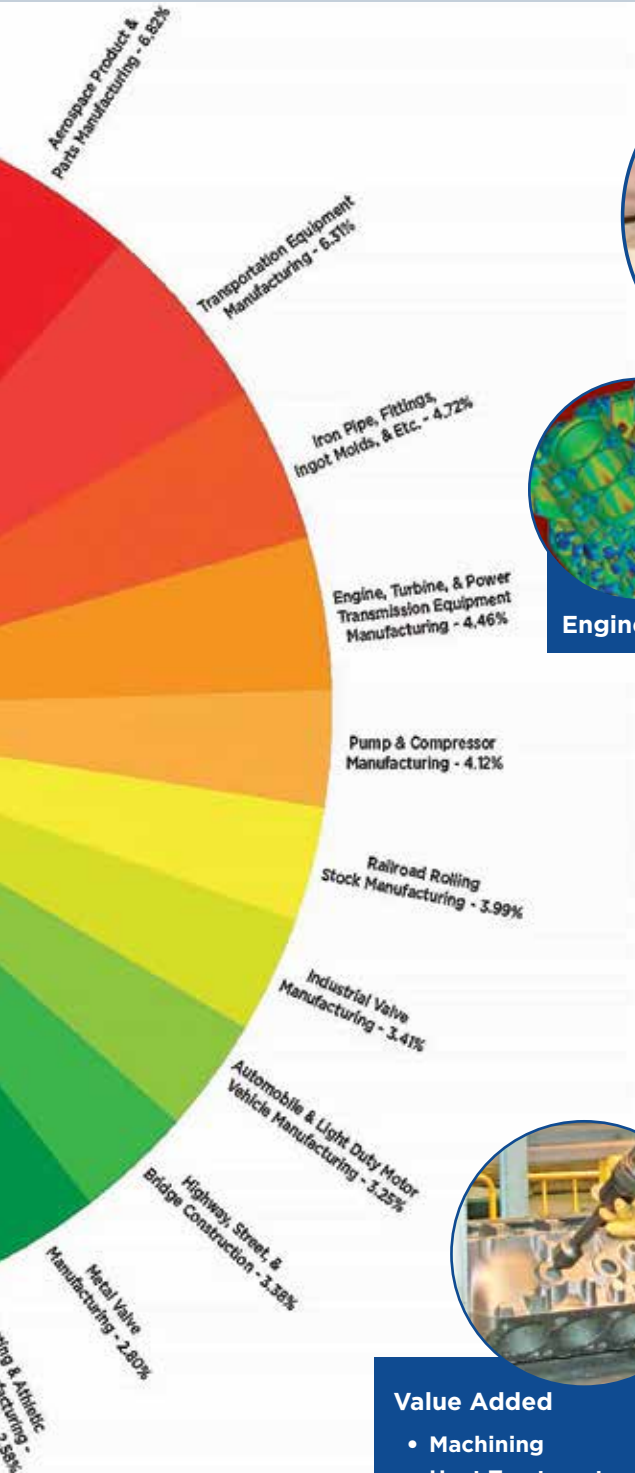
Did you know?

Ninety percent of all manufactured goods rely on metal castings.

Metalcasters Everywhere!

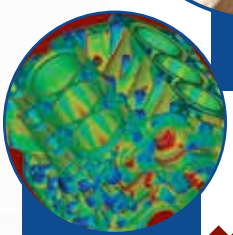
- 1,900+ Metalcasters
- 700 Ferrous; 1,300 Nonferrous
- Employ 200,000
- 75% Are Small Businesses With Less Than 100 Employees
- 2017: $31.5 Billion in Sales; 10.7 Million Tons Shipped

METAL CASTING SUPPLY CHAIN



Pattern & Tooling

Raw Materials & Equipment



Engineering

Metalcasting Facility

Value Added

- Machining
- Heat Treatment
- Parts Assembly

End Users of Castings

1695 N. Penny Lane • Schaumburg, IL 60173
Tel: 847-824-0181 • Fax: 847-824-7848
www.afsinc.org
http://meltingpoint.afsinc.org