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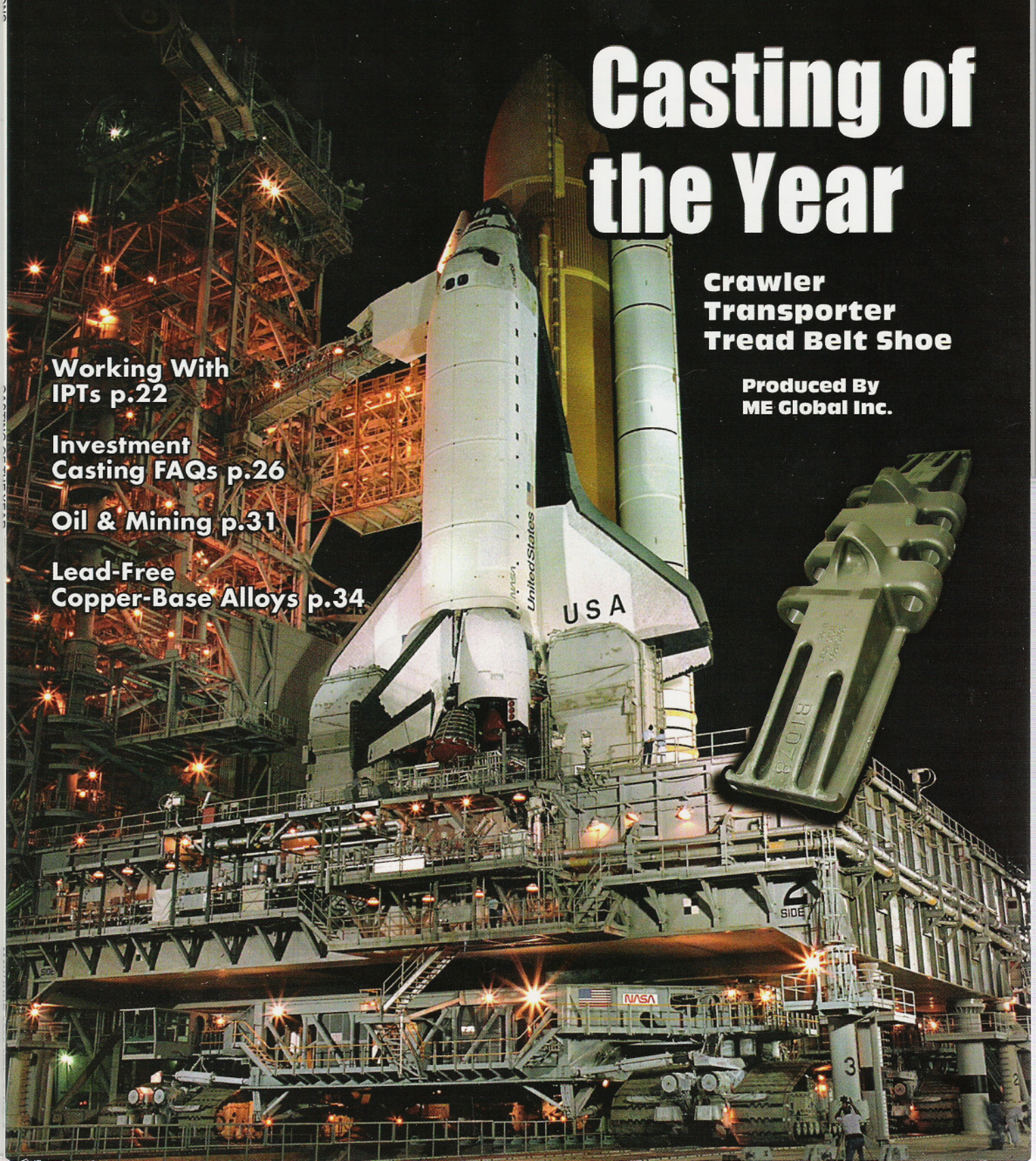
MAY 2005

Casting of the Year

Crawler Transporter Tread Belt Shoe

Produced By ME Global Inc.



2005 Casting Competition

From the delicate workings of a windshield wiper motor to the heavy, lumbering functionality of a tread shoe for a crawler transporter that carries NASA space shuttles to the launchpad, this year's casting competition winners illustrate the truly wide spectrum of casting capabilities.

*An **ECS** Staff Report*

With ingenuity, progressive technology and vision, nine companies earned industry-wide recognition for their cast components honored in the 2005 American Foundry Society Casting Competition. The nine components reflect the metalcasting industry's place in today's world, showcasing the benefits of casting to the customer, the unique capabilities of the casting process and the contribution to growth and expansion of the casting market.

This year's competition drew entries from every metal type and casting process, and the wide variety of castings further cements metalcasting's place in present-day economics. Through benefits such as gains in speed to market, elimination or reduction of machining, cost reduction and part consolidation, these award-winning components stood out as industry leaders.

Along with the Casting of the Year, the competition recognized four Best-in-Class and four Honorable Mention winners this year. In the following pages you will find the details of the nine cast component design winners.

And the Winners Are:

Casting of the Year

NASA Crawler Transporter Tread Belt Shoe
ME Global Inc. (Elecmetal), Duluth, Minn.

The NASA crawler transporter tread belt shoe was made of modified 4320 steel using the V-process. Each shoe weighs 2,200 lbs. (998 kg) and measures 7.5 x 1.5 ft. (2.29 x 0.47 m).

Best-In-Class

Windshield Wiper Motor Components
Aristo Cast Inc., Almont, Mich.

Jam Nut
Burnstein von Seelen Precision Casting Corp., Abbeville, S.C.

Elevation Housing "Turtle"
Denison Industries, Denison, Texas

LS7 Dry Sump Engine Oil Tank
General Motors Powertrain USA Pontiac, Mich.

Honorable Mentions

Big Sky Laser Housing
A.L. Johnson, Camarillo, Calif.

Push Arm
Piad Precision Casting Corp. Greensburg, Pa.

Verado L6 Four-Stroke Cylinder Head
Mercury Marine, Fond du Lac, Wis.

Gooseneck Trailer Hitch Conversion Kit
The Dotson Co. Inc., Mankato, Minn.

Casting of the Year

This year's Casting of the Year reflects the forward thinking of a steel caster to see its challenges as opportunities and become a part of aerospace history in the process.

As the National Aeronautics and Space Administration (NASA) returns its space shuttles to flight this summer, it has been with the help of ME Global Inc. The steel sand casting company in Duluth, Minn., partnered with NASA and the United Space Alliance (USA) to develop new track shoes for the shuttle crawler transporters, which bring space shuttles from the Vehicle Assembly Building to the launch pad.

ME Global (a wholly owned business of Elecmetal, Santiago, Chile) came onto the space scene in the winter of 2002 when the company learned that the original track shoes on the transporters (dating back to the 1960s) and the inventory of spare shoes soon were to be refurbished. The steel caster proposed to NASA that it could cast entirely new sets of shoes at a similar price as refurbishing. But NASA declined because it had prior success with refurbishing the shoes (adding stock to existing roller paths and pin holes and then remachining them to fit the original design specifications).

However, several months later, NASA and USA took a second look into the idea of newly cast shoes. ME Global was asked to make a presentation in mid-2002 at Kennedy Space Center (KSC), Cape Canaveral, Fla., to show NASA exactly how this would be possible.

Late in 2003, ME Global's research helped prompt NASA to overturn the refurbishment program and charter USA (NASA's largest contractor, which is responsible for the shuttle ground transport systems including the transporters) to immediately start procurement processes to outfit both transporters with new shoes. NASA was obligated to leave the bidding open to other metalcasting companies, but in May 2004, ME Global was awarded the contract. Now it had to deliver more than 1,000 shoes in six months.

Ground Control

NASA has two crawler transporters, which carry the space shuttle assembly (the shuttle, two solid rocket boosters and the external fuel tank) and the mobile launch platform to one of two launch pads at KSC at a pace of 1 mph (1.6 km/h). Both transporters weigh 6 million lbs. (2.7 million kg) each, but that triples to 18 million lbs. (8.2 million kg) when carrying the mobile launch platform and the pre-launch shuttle. A professional-size baseball diamond could comfortably be placed on top of the transporter.

There are four double-tracked, 10 x 41-ft. (3 x 12.5-m) crawler units (similar to a tank) on each vehicle, and each track has 57 shoes for a total of 456 shoes per transporter. Each vehicle has two 16-cylinder, 2,750-hp engines with a 5,000-gal. fuel capacity but only gets 42 ft. (12.8 m) per gallon.

Crawler Transporter Tread Belt Shoe

ME Global Inc. (Elecmetal), Duluth, Minnesota

Metal: Modified 4320 steel.
Process: V-Process.
Weight: 2,200 lbs. (998 kg).
Dimensions: 7.5 x 1.5 ft. (2.29 x 0.47 m).
Application: Tread shoe for transporter that carries space shuttles to launching pads.

Benefits of the Casting Design:

- Prototype shoes were developed to replace older shoes. The prototype overcame technical challenges, including alloy changes and a shoe design change to eliminate shrinkage porosity; alloy changes and precise treatment and quench regimens to meet reduced surface hardness requirements while maintaining high material strength; and shoe design refinements to enhance operational characteristics.
- The qualification process required pouring more than 40 castings to identify the alloy and manufacturing process that could repeatedly produce acceptable shoes.
- The first prototype shoes were completed one week behind the baseline schedule, despite alloy changes and two casting design changes. ME Global successfully delivered more than 1,000 shoes in less than six months.

To completely re-inventory USA with its track shoes, ME Global supplied a set of 456 shoes for each transporter, plus a set of spares for a total of 1,024 track shoes. Each shoe measures 90 in. (2.2 m) long, 25 in. (0.63) wide, 16.5 in. (0.41 m) tall and weighs 2,200 lbs. (998 kg).

Countdown

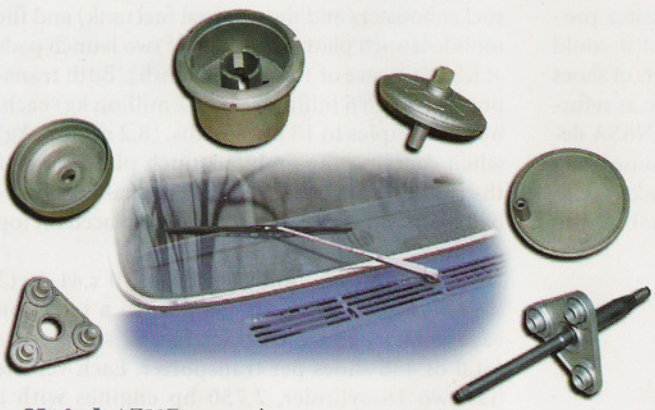
The shoe development was divided into three phases. Phase 1 was to produce a prototype that met all the requirements of USA and NASA and also confirm that the casting process is capable of producing more than 1,000 track shoes. Phase 2 was to outfit one transporter. Phase 3 was to outfit the other transporter. Based on the successful completion of Phase 1, ME Global was awarded Phases 2 and 3.

A significant challenge the company encountered in Phase 1 was trying to

Best-In-Class

Windshield Wiper Motor Components

Aristo Cast Inc., Almont, Michigan

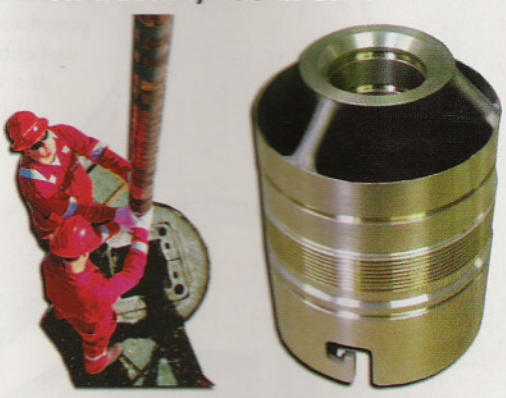


Metal: AZ91E magnesium.
Casting Process: Investment casting with rapidprototyping.
Weight: 3.67 lbs. (1.66 kg) with motor; 0.91 lb.(0.44 kg)without motor.
Dimensions: 4 x 6.5 in. (10.16 x 16.51 cm).
Application: Powers windshield wipers.
Customer: Trico Products.

- By using magnesium for the six main motor components, a 75% space savings was achieved, noise levels were lowered, and a 25% overall weight savings was achieved.
- Conversion to casting increased life expectancy of the component and reduced the product development cycle by a year.
- The final method of manufacture is planned to be thixomolding, but the investment cast prototypes had to duplicate as close as possible all of the characteristics of a production casting. As certain parts reached design completion, semi-production wax injection dies were constructed to more closely replicate the final thixomolded design concept.
- Due to the motor design, the casting wall thickness was as thin as 0.040 in. (0.101 cm) in order to maximize the weight reduction.
- The rapid prototyping of various concepts allowed the design for manufacture to run concurrently with the prototyping phase of the project.

Jam Nut

Bumstein von Seelen Precision Casting Corp. Abbeville, South Carolina

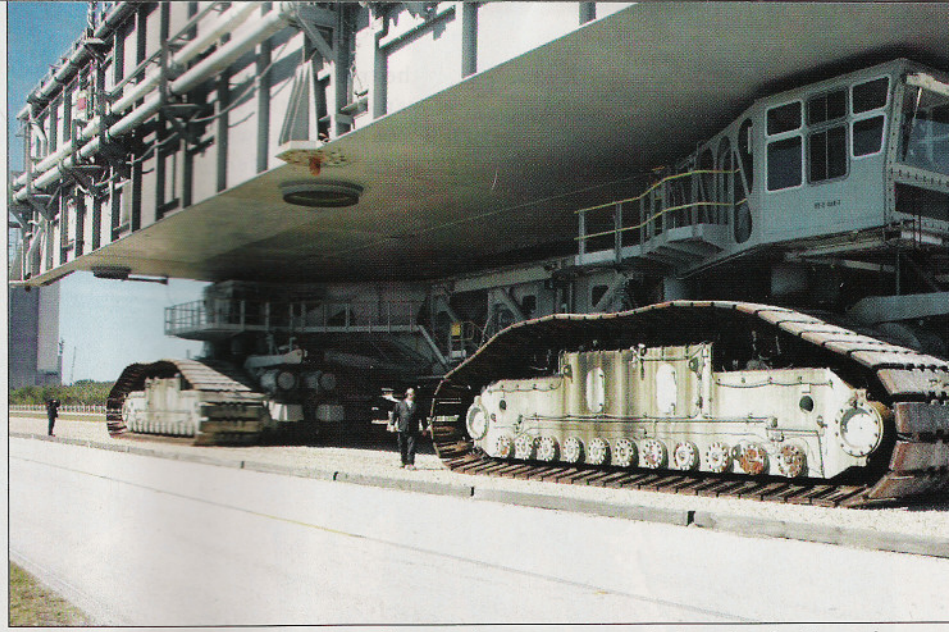


Metal: Modified CDA-955 aluminum-bronze.
Casting Process: Permanent mold.
Weight: 17 lbs. (7.71 kg).
Dimensions: 6.25 x 7.8 in. (15.875 x 20.3 cm).
Application: Contains electronic measurement devices used in seismic instrumentation located in the leading assembly of drilling apparatus.
Converted From: Machined billet.

- Significant cost savings were realized as a result of converting a 68-lb. (30.84-kg) solid billet to a 17-lb. (7.71-kg) machined permanent mold casting.
- The casting must withstand a pressure test of 25 ksi at 400F (204C) with no deformation while maintaining tolerances of ±0.002 in. (0.005 cm).
- The casting uses metal cores to achieve the inside configuration, including undercuts, eliminating machining.
- The casting supplier and customer worked together to engineer a modified CDA-955 aluminum-bronze alloy that exceeded conventional CDA-955 mechanical properties.
- The component must be 100% guaranteed due to significant down time costs associated with the deep hole oil and gas drilling industry. The casting has seen service down to 6 miles (9.65 km) below the earth's surface without failure.

obtain the desired mechanical properties with the given NASA shoe design and alloy. USA specified steel alloy 8640 for the project, but it was found to be impossible to manufacture on a large-scale basis as the prototype castings cracked during heat treatment. At the same time, NASA would not alter the shoe design, which forced ME Global to investigate different alloys. The company turned to the CKQ alloys of which the original shoes were made and also alloy 8630, but neither met NASA's specifications.

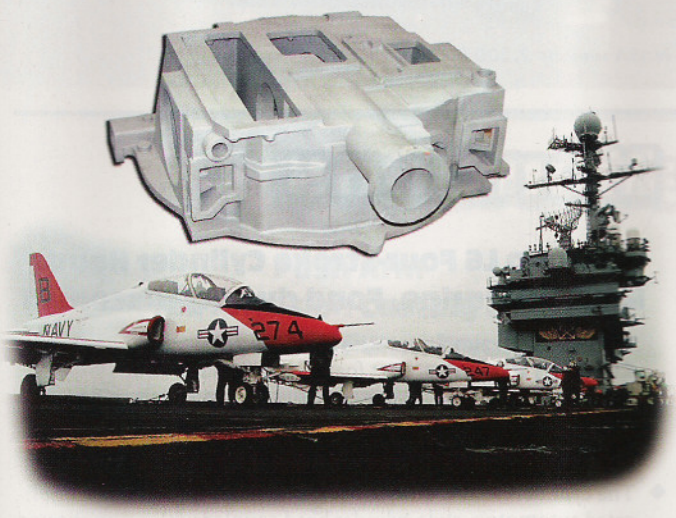
ME Global then looked to alloy M4320 (which it recently used successfully in another project), and it achieved the requirements needed for the shoes. A low-carbon alloy, M4320 was determined to be the proper casting material in August, but this left ME Global with



NASA gave the crawler transporter and its new shoes a test run to the launchpad at Kennedy Space Center in January.

Best-In-Class

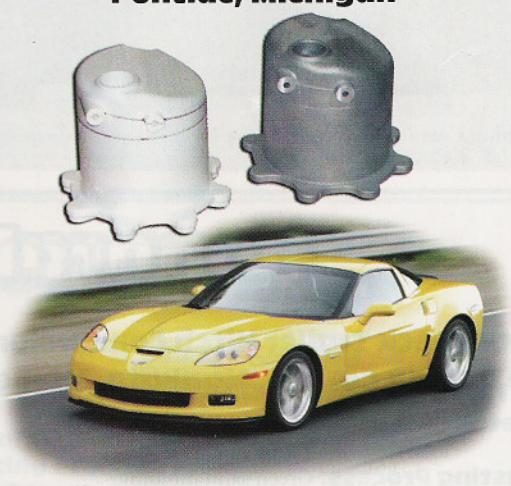
Elevation Housing "Turtle"
Denison Industries
Denison, Texas



Metal: A356 aluminum.
Casting Process: Nobake molding.
Weight: 330 lbs. (149.7 kg).
Dimensions: 55 x 50 x 17 in. (139.7 x 127 x 43.18 cm).
Application: Used in a mechanism that allows radar to maneuver on U.S. Navy vessels and track activity as it locates potential threats, such as incoming aircraft or missiles.
Converted From: Machined welded fabrication.

- The casting supplier converted the component from a labor-intensive, high-cost fabrication process.
- The original process has been improved from the machining and welding of 90 individual components to an improved casting process requiring only three cast assemblies.

LS7 Dry Sump Oil Tank
General Motors Powertrain USA
Pontiac, Michigan



Metal: A356 aluminum.
Casting Process: Lost foam.
Weight: 5.5 lbs. (2.49 kg).
Dimensions: 7.9 x 7.9 x 6.1 in. (20.07 x 20.07 x 15.49 cm).
Application: Dry sump oil system for 2006 Chevrolet Corvette.

- The component is manufactured using three molded polystyrene foam slices. The component is a first-of-its-kind design for commercial automotive production, and significant cost savings were realized at full production.
- Improved lubrication during high G-force maneuvers resulted in improved engine design. The integration of several typically assembled components into the casting, including de-aeration baffle, fill cap bore, mating flanges, dipstick tube bore and mounting brackets, resulted in cost and leadtime savings.
- The component design maximizes oil volume in limited packaging space, resulting in superior lubrication performance of the engine.
- Design eliminated several internal leak paths that reduced oil carryover and oil consumption. The PCV connections and air/oil separation chamber enabled the casting supplier to meet evaporative hydrocarbon emissions standards and oil economy requirements.

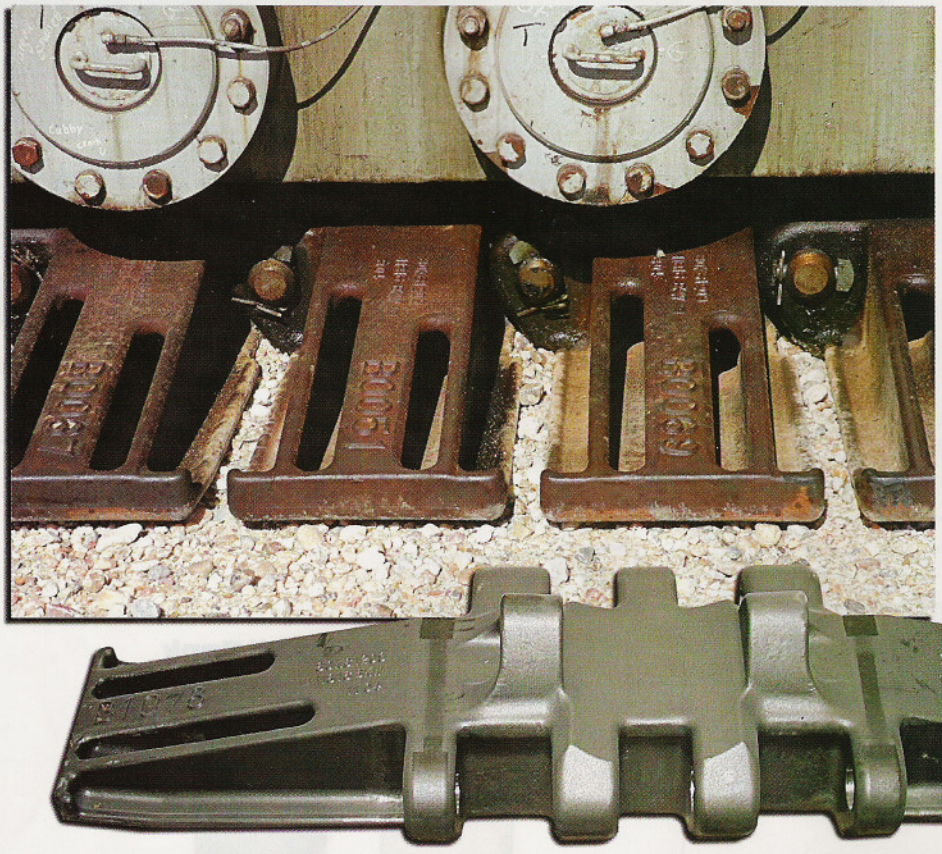
only four months to complete the project on time.

With the assistance of 20 extra employees the company hired to work on the track shoe project, ME Global began casting the shoes through V-process molding, which uses unbonded silica sand under one atmosphere of pressure to form and maintain the shape of the mold.

As the castings were completed, they were sent to Remmele Engineering, Big Lake, Minn., for machining. USA sent several quality assurance inspectors to Remmele, and ME Global had one of its principal metallurgists work full time on-site at Remmele to keep the project at pace. Once the track shoes were approved, they were sent from Remmele to KSC and installed on the crawler transporters.

We Have Liftoff

With the newly cast track shoes, NASA initiated a trial run of the crawler transporters carrying a mobile launch platform to one of the launch pads in January. Then, in April, ME Global's castings were used to bring the entire space shuttle Discovery assembly to launch pad 39B, where it rests until its ascension into space this summer. **ECS**



ME Global's casting of a tread shoe for a crawler transporter used by NASA weighs 2,200 lbs. (998 kg) and measures 7.5 x 1.5 ft. (2.29 x 0.54 m).

Honorable Mentions

Gooseneck Trailer Hitch Conversion Kit
The Dotson Co. Inc., Mankato, Minnesota

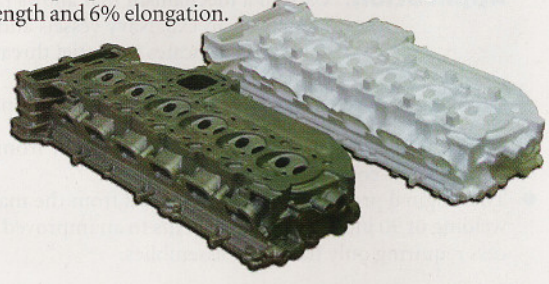
Metal: C5G body—100-70-03 ductile iron; lock ring—80-55-06 ductile iron.
Casting Process: Green sand molding.
Weight: C5G body—33 lbs. (15 kg); king pin collar—4 lbs. (1.81 kg); lock ring—1.6 lbs. (0.73 kg).
Dimensions: C5G body—14 x 10 x 10 in. (35.56 x 25.4 x 25.4 cm); king pin collar—3 x 4 x 4 in. (7.62 x 10.16 x 10.16 cm); lock ring—1 x 4.25 x 4.25 in. (2.54 x 10.8 x 10.8 cm).
Application: Connects existing gooseneck hitch to a fifth wheel hitch.
Converted From: Steel weldment and machined parts.

- Each component was designed to minimize any machining operations. With the exception of a few bolt holes, the customer still is using the part as it is delivered to its facility.
- The new casting assembly is stronger than the original weldment/machined assembly and exceeds SAE J-684 towing guideline.
- The new design simplifies the manufacturing process by eliminating almost all machining and welding. With the cost savings, tooling payback was realized in less than one year.

Verado L6 Four-Stroke Cylinder Head
Mercury Marine, Fond du Lac, Wisconsin

Metal: A356 aluminum with T6 heat treatment.
Casting Process: Lost foam with pressure.
Weight: 37 lbs. (16.78 kg).
Dimensions: 4.75 x 11 x 27 in. (12.07 x 27.94 x 68.58 cm).
Application: Cylinder head for Verado L6 outboard engine.

- The cylinder head is unique because it is comprised of a complicated automotive-style cylinder head coupled with a complicated double-water jacketed exhaust manifold. Traditionally, the two are cast separately.
- The design and manufacture was achieved by a concurrent and proactive interface between technical personnel in engineering and manufacturing.
- Mechanical properties are 37 ksi tensile strength, 26 ksi yield strength and 6% elongation.



The NASA Space Shuttle Discovery made its journey to the launch pad in April on top of the crawler transporter, which sported newly cast tread shoes produced by ME Global.

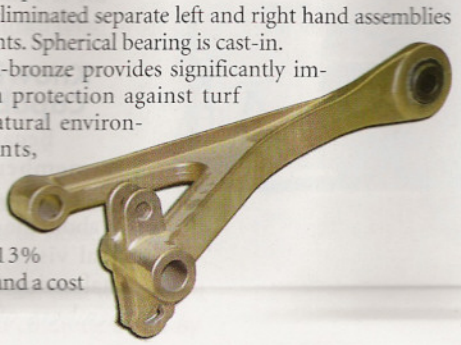
Honorable Mentions

Push Arm

Piad Precision Casting Corp. Greensburg, Pennsylvania

Metal: Nickel-aluminum-bronze.
Casting Process: Permanent mold.
Weight: 5.12 lbs. (2.32 kg).
Application: Lifts and supports the front mower deck on a "0" turning radius.

- The redesign to casting provided a one-piece, near-net-shape component that required only one machining operation while the nickel-aluminum-bronze alloy provided higher strength than the original cold rolled steel components.
- Universal design eliminated separate left and right hand assemblies as well as weld joints. Spherical bearing is cast-in.
- Nickel-aluminum-bronze provides significantly improved corrosion protection against turf chemicals and natural environmental elements, eliminating the need for painting.
- The new design resulted in a 13% weight reduction and a cost savings of 30%.



Laser Housing

A.L. Johnson Co., Camarillo, California

Metal: A356 aluminum with T51 heat treatment.
Casting Process: Rubber plaster molding.
Weight: 4 lbs. (1.81 kg).
Application: Houses electronics and cooling system for lasers used in the industrial, medical and scientific markets.
Converted From: Sheet metal fabrication.

- Customer manufactures lasers for industrial, medical, military and scientific markets and wanted to create a new look for products with new options/capabilities for users and a better interface.
- Using a casting allowed the customer to equal the cost of a sheet metal fabrication but dress up the appearance.
- The functionality is the same, but the customer believes the casting will set the product apart from its competitors.