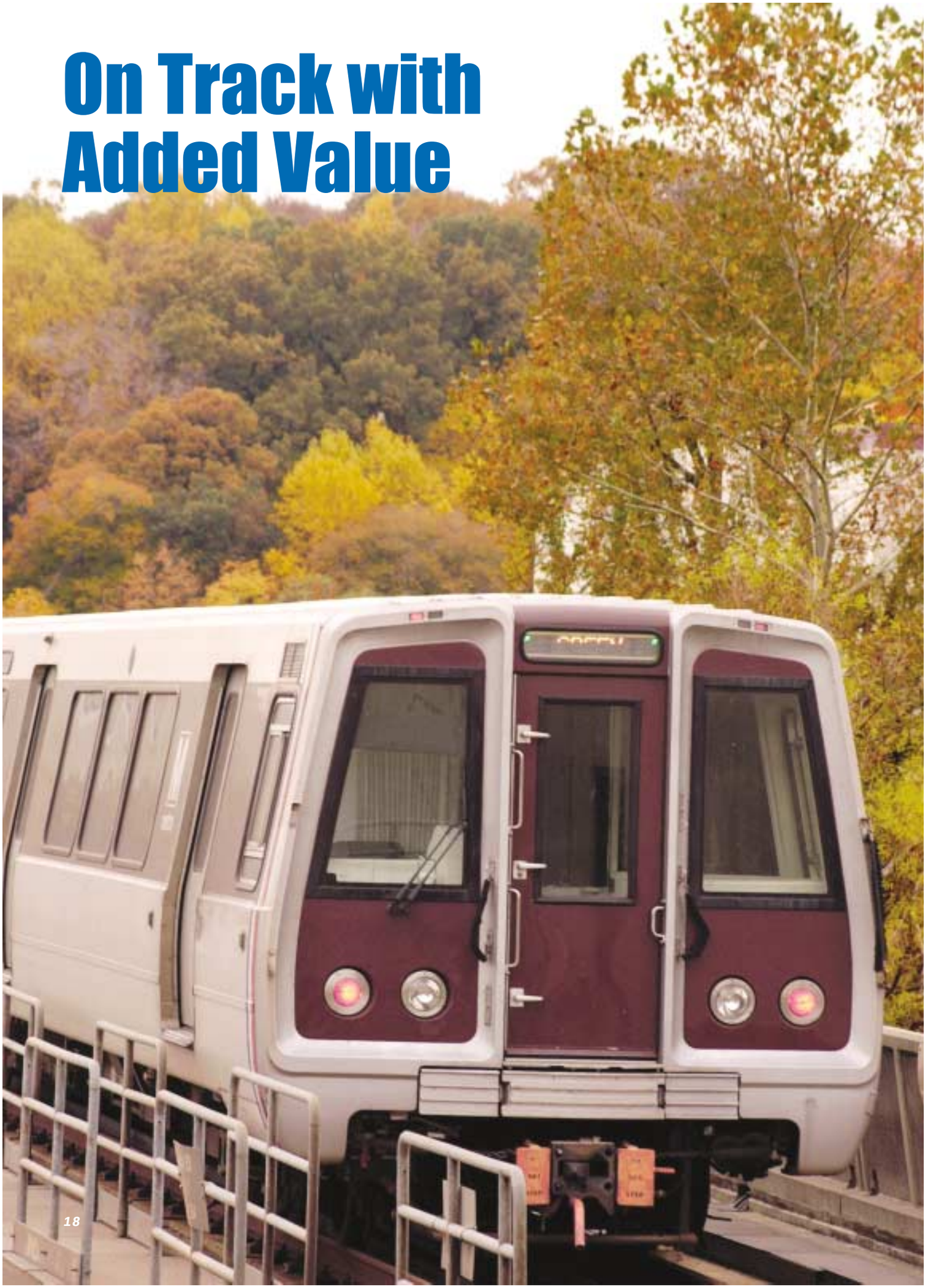
# On Track with Added Value



A metalcasting facility's responsibilities don't have to end after the final casting is poured. This article details how a truck assembly for a mass transit train was produced from engineered concept to finished assembly.

***Shannon Kruse,*** *Assistant Editor*

The Washington Metropolitan Area Transit Authority (WMATA), Washington, D.C., operates the second largest rail transit system in the U.S. Its rail cars gave riders a total of 190 million trips in 2004 alone on its 103-mile rail network. It services a metro area of 1,500 sq. mi. and utilizes 86 stations. Commuters and tourists alike depend on the rail to deliver them to their destinations in the U.S. Capitol. Below the riders' feet, zooming directly over the rails, are the steel truck assemblies that hold the working parts of the railcar together and faithfully support the cargo above. The assemblies are compact, complex structures that coordinate its sturdy weight-supporting frames with the electric motors, wheels and springs that make the cars move.

***Some metalcasting facilities offer several value-added services in order to be a complete scope supplier to its customers, including using CAM software for the machining of patterns.***

Working with the different part vendors and then finally pulling all the pieces together can be a headache for train car manufacturers, but many metalcasting facilities serve as one-stop shops that provide finished assemblies started from an engineered concept.

Alstom, Hornell, N.Y., is a global business active in the power and transport industry and a producer of cars for urban light rail and commuter trains, including trains for WMATA. The company utilized AmeriCast Technologies, a metal casting sourcing company that incorporates four casting facilities in the U.S. and one machine shop in Canada, to produce the train assemblies because the firm's design and engineering, cleaning and finishing, testing and assembly capabilities allowed it to perform complete scope supply of the WMATA undercarriages. AmeriCast's Atchison Steel Casting and Machining, Atchison, Kan., cast and assembled the truck undercarriages for the recent series of WMATA trains and will soon provide the same complete scope services for truck assemblies for the Triangle Transit Authority in North Carolina.

## Leaving the Station

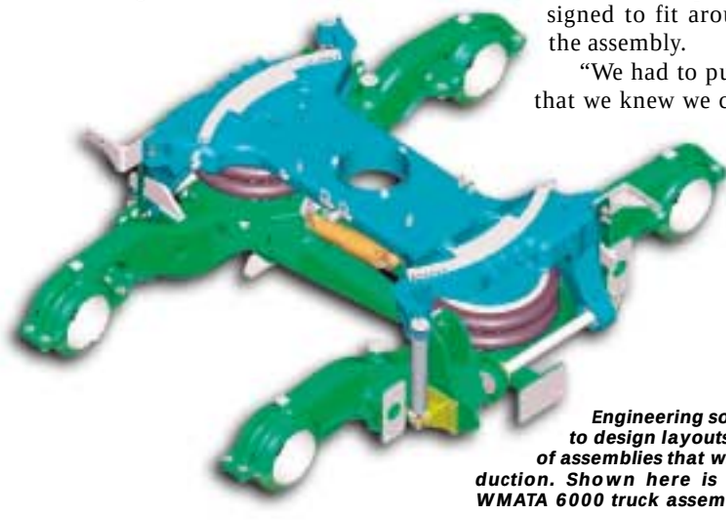
WMATA is on its sixth series of truck assemblies for its mass transit trains. The first series, WMATA 1000, was initially designed as a cast assembly in the 1970s, but subsequent series were produced as fabrications. Just under six years ago, it was decided to go back to the cast design, and Atchison was contracted to build the assemblies for the WMATA 5000 and 6000 series.

"We used the same basic design, but because it had been decades since it was last made, it was like starting with a new design," said Wolf Reimann, manager of design engineering at Atchison Steel Casting and Machining.

Once Atchison Steel Casting and Machining received the specifications for the assembly from WMATA, its engineers began formulating the facility's plan of action for producing the assembly. The customer specified that each truck would be a four-wheel, inside frame, equalized, roller-bearing truck with a rubber primary suspension system and an air-spring secondary suspension system. Each truck would be equipped with two traction motors, which are geared to a single axle using a parallel drive and two disc brakes per axle. Achieving a low overall truck weight was a key design aim.

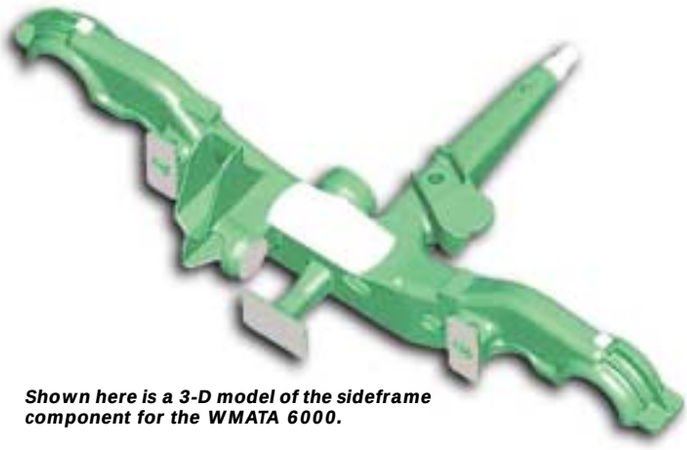
Because much of the assembly's design, such as the type of brakes, the dimensions of the wheel base and the diameter of the wheel, already were defined, the cast components were designed to fit around the rest of the assembly.

"We had to put all the things that we knew we couldn't change together and



***Engineering software was used to design layouts and 3-D models of assemblies that will soon be in production. Shown here is a model of the WMATA 6000 truck assembly.***

*Photo courtesy of Larry Levine, WMATA*



***Shown here is a 3-D model of the sideframe component for the WMATA 6000.***

***Casting inspection was performed on the sideframe component in-house using a 3-D coordinating measuring arm.***

connect it with the castings." Reimann said. "Because of that, the design is a really compact unit. It would probably be tougher to do this as a fabrication because there are so many complex changes in shape. It's a matter of putting the metal where you need it."

Atchison designed two cast steel side frames to run parallel to the tracks and a bolster to run across the two side frames, which would form the support structure for the truck assembly. 3-D models were then developed and assembled to provide a rough idea of the weight of the unit and indicate where there might be clearance issues.

After the initial design for the WMATA

## The Future of Commuter Rail Transit?

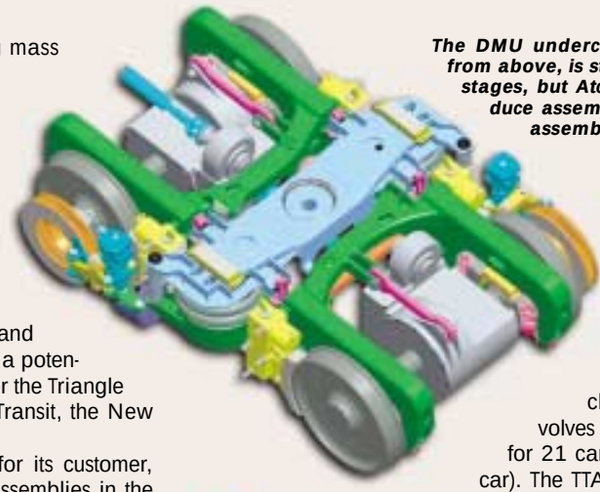
The majority of commuter rail cars serving mass transit authorities in the U.S. are push-pull cars, which depend on a separate locomotive to push or pull the cars along the tracks. However, a few cities are looking toward diesel multiple units (DMUs) for future replacements or expansions in their rail systems. DMUs differ from the push-pull cars because each unit has an engine and can run on its own.

DMUs are just starting to make an appearance in the U.S., and Atchison Steel Casting and Machining is in the beginning design stages for a potential DMU contract to produce truck assemblies for the Triangle Transit Authority (TTA), Raleigh, N.C., and NJ Transit, the New Jersey Transit Authority.

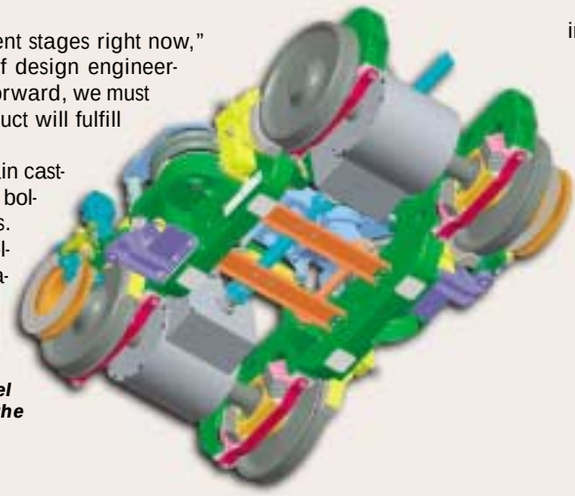
Atchison will produce the cast assemblies for its customer, Rotem, Seoul, Korea, which then will use the assemblies in the final construction of each car.

"We're just in the development stages right now," said Wolf Reimann, manager of design engineering at Atchison. "Before we go forward, we must show the customer that the product will fulfill the requirements."

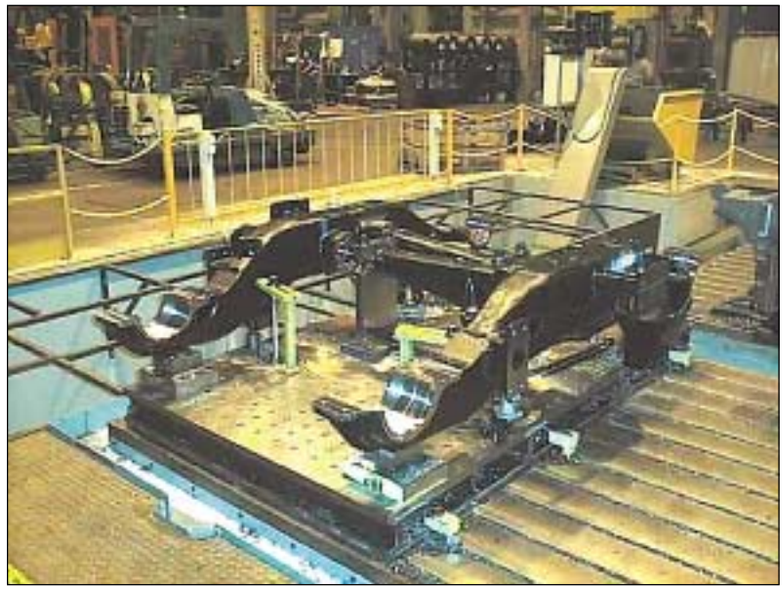
The assembly includes two main castings—the truck frame and the truck bolster. The frame weighs 4,000 lbs. (1,814 kg) machined, and the bolster weighs 2,000 lbs. (907 kg) machined. The assembly also includes 15 other cast components that range in weight from 14 lbs. (6.35 kg) to 150 lbs. (68 kg) machined. The order involves producing assemblies for 21 cars (two assemblies per car). The TTA will receive 14 cars, and NJ Transit will receive seven. This initial project could be the first of a wave of DMU contracts for Atchison. Transit authorities in Chicago and Portland, Ore., also have made plans to use DMUs in the near future. *ECS*



***The DMU undercarriage, shown here from above, is still in the development stages, but Atchison expects to produce assemblies for 21 cars (two assemblies per car).***



***Shown here is a 3-D model of the bottom side of the DMU truck assembly.***



*Shown is the machined sideframe and bolsters for the WMATA assembly. The assembly is designed to withstand a crush load of 34,800 lbs. (15,785 kg).*

order was set, Atchison solicited input from Alstom on the assembly layout and design. Once input and approval was received from the customer, Atchison went forward with finite element analysis (FEA) tests to make sure the castings met the specifications, which included a minimum tensile strength of 75,000 psi, a minimum yield strength of 48,000 psi, elongation not less than 25% in 2 in. (5.08 cm) and reduction of area not less than 50%.

The specifications for the performance of the unit when the car is empty and when it is at maximum load also were defined for the assembly. FEA tests were run for static conditioning and for fatigue conditioning (bouncing up and down on the tracks) and endurance limits were set by the testing results.

When the FEA and drawings were approved, the 3-D models were given to process engineers, who then ran the models through casting process modeling software to determine the best design for the patterns. Once the proper results were found, Atchison began cutting the patterns and tooling. Because pattern and tooling operations were in-house, as well, an open relationship between the engineering department and the pattern shop was key to the success of the final product.

"A lot of times the pattern and tooling shop will take the drawings and models and do further work, such as add shrinkage and draft," Reimann said.

**"Making sure things fit when we cast it, machine it and put it together is a great benefit (of progressive supply). By the time we deliver (the assemblies) to our customer, we're confident that everything is in good order."**

***—Wolf Reimann, Atchison Steel Casting and Machining***

## Riding the Rails

As the cars travel over the rails in and out of the city, the trucks must respond to the dips, hills and curves of the tracks. An articulated design was needed in the WMATA assembly to negotiate the ups and downs. Rather than stand rigid, the assembly's four corners where the axles are mounted needed to move independently of each other.

To meet the requirements of this application, the truck's design consists of two steel-cast side frames, which run parallel to the tracks and are joined together with spherical bearings. These bearings allow the four corners of the assembly to move with the terrain of the track for a smoother ride.

The side frame castings weigh 1,100 lbs. (499 kg) each and were produced via nobake casting using ASTM A-27 Grade 65-35 steel alloy. Low carbon steel alloys are used in this type of application due to its good strength properties and good weldability, which allows the plant to correct imperfections to the castings before heat treatment.

Besides the two side frames, the assembly also includes castings in the truck's bolster, which lies across the two side frames. The bolster consists of two end castings—also cast via the nobake process—which are welded together with a fabricated center. The entire bolster, with castings and fabrication, weighs 1,000 lbs. (454 kg).

Atchison cast and assembled 394 trucks for the WMATA 5000 series. The initial order for the newer WMATA 6000 series asked for 124 trucks. After the first base order was delivered, Atchison was given another option order of 244 trucks, which is in production currently.

*The final WMATA assembly, shown here, measures 107 in. (271 cm) long, 75 in. (190.5 cm) wide and 33 in. (83.82 cm) tall.*

***Once production is complete, a total of 762 assembled trucks will have been delivered to the Washington Metropolitan Area Transit Authority for its 5000 and 6000 series of subway cars.***

## Completing the Circuit

Once the components are cast, they are cleaned and x-rayed at the facility in Atchison. Workers check the dimensions of each casting to ensure the proper specifications are met and then send the castings to Atchison's machining shop, where they are machined and painted. Once that's complete, they are ready to become part of its larger purpose—the WMATA truck assembly.

"Making sure things fit when we cast it, machine it and put it together is a great benefit (of progressive supply). By the time we deliver (the assemblies) to our customer, we're confident that everything is in good order," Reimann said.

As the sole source of the assembly to Alstom, AmeriCast purchased the necessary items that complete the unit, such as the rubber parts of the assembly. These additional items can require up to 26-week leadtimes, according to Reimann. It takes two workers two to three days to build one assembly.

Assembly at AmeriCast can include the basic steps of constructing the frame of the assembly with its varying cast components or can be as involved as installing wheels, axles and shock absorbers. The customers of the WMATA undercarriage specified basic assembly requirements that included building the frame and adding elements such as the shock absorbers and air springs, which allow the vehicle to come into the station platform and have the floor of the car be at the same height as the platform.

The assembly's shipping weight comes in at 5,000 lbs. (2,268 kg). The assembly measures 107 in. (271 cm) long, 75 in. (190.5 cm) wide and 33 in. (83.82 cm) tall. It is built to withstand a crush load of 34,800 lbs. (15,785 kg) and endure speeds up to 80 mph.

Metalcasting facilities that offer full manufacturing services, provide customers the convenience of one-stop shopping and add to the overall ease of production for the casting facility.

"It makes it possible to do things like move a rib that might help the cleaning process," Reimann said. "It gives us the opportunity to make changes along the way." *ECS*

### For More Information

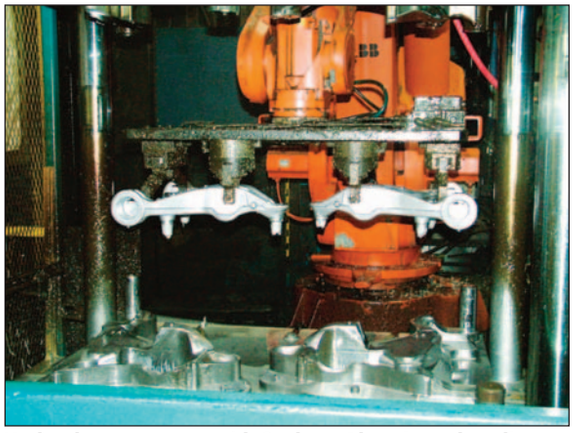
***"Value-Added Services Offer Benefits, Opportunities to Casting,"*** *Engineered Casting Solutions, An ECS Staff Report, Winter 2000, p. 30-33.*

***"Industry Focus: Railroad Equipment,"*** *M. J. Lessiter, Engineered Casting Solutions, Fall 2001, p. 45-47.*

## Alcoa Forms Alliance with Seohan for VRC/PRC

Alcoa Inc., Pittsburgh, and Korea-based Seohan Industries Co. Ltd. signed a letter of intent in September forming an alliance to produce cast aluminum chassis and suspension components and modules for the automotive industry in South Korea, Japan, China and Australia.

Under the agreement, Alcoa intends to license its vacuum riserless casting/pressure riserless casting (VRC/PRC) technology and sell related production assets. Seohan, which manufactures automotive parts, will establish an aluminum castings plant in South Korea to supply OEMs in Australia and Eastern Asia with cast structural parts via VRC/PRC methods. The letter of intent provides the framework for both companies to identify, develop and launch programs. According to Alcoa officials, when operational, the Seohan plant will complement and expand Alcoa's current VRC/PRC aluminum casting capabilities in the U. S. and Europe.



***Under the agreement with Seohan, Alcoa intends to license its VRC/PRC technology in Asia and Australia.***

"With ever-increasing demand on safety and fuel economy and consumers desiring superior driving performance, we project a significant increase in the use of aluminum castings in the critical chassis and suspension areas of the vehicle," stated Allen Zwierzchowski, president of Alcoa Automotive Castings. "We are excited to be working with a proven supplier like Seohan in order to establish the VRC/PRC technology in Asia." ***ECS***

## Ryobi Earns Governor's Awards For Environmental Excellence

In honor of its exceptional environmentally aware operations, Ryobi Die Casting USA Inc., Shelbyville, Ind., received two Indiana Governor's Awards for Environmental Excellence.

Ryobi earned the awards for: recycling/reuse, in which the company saved $227,000 last year by recycling metal for production purposes, and energy/renewable resources, recognizing the company's natural gas usage reduction of 27% and significant prevention of excess aluminum dross.

The awards honor Indiana firms who have implemented outstanding environmental practices into their operations to reduce waste, save money and contribute to the state's environmental protection efforts. ***ECS***