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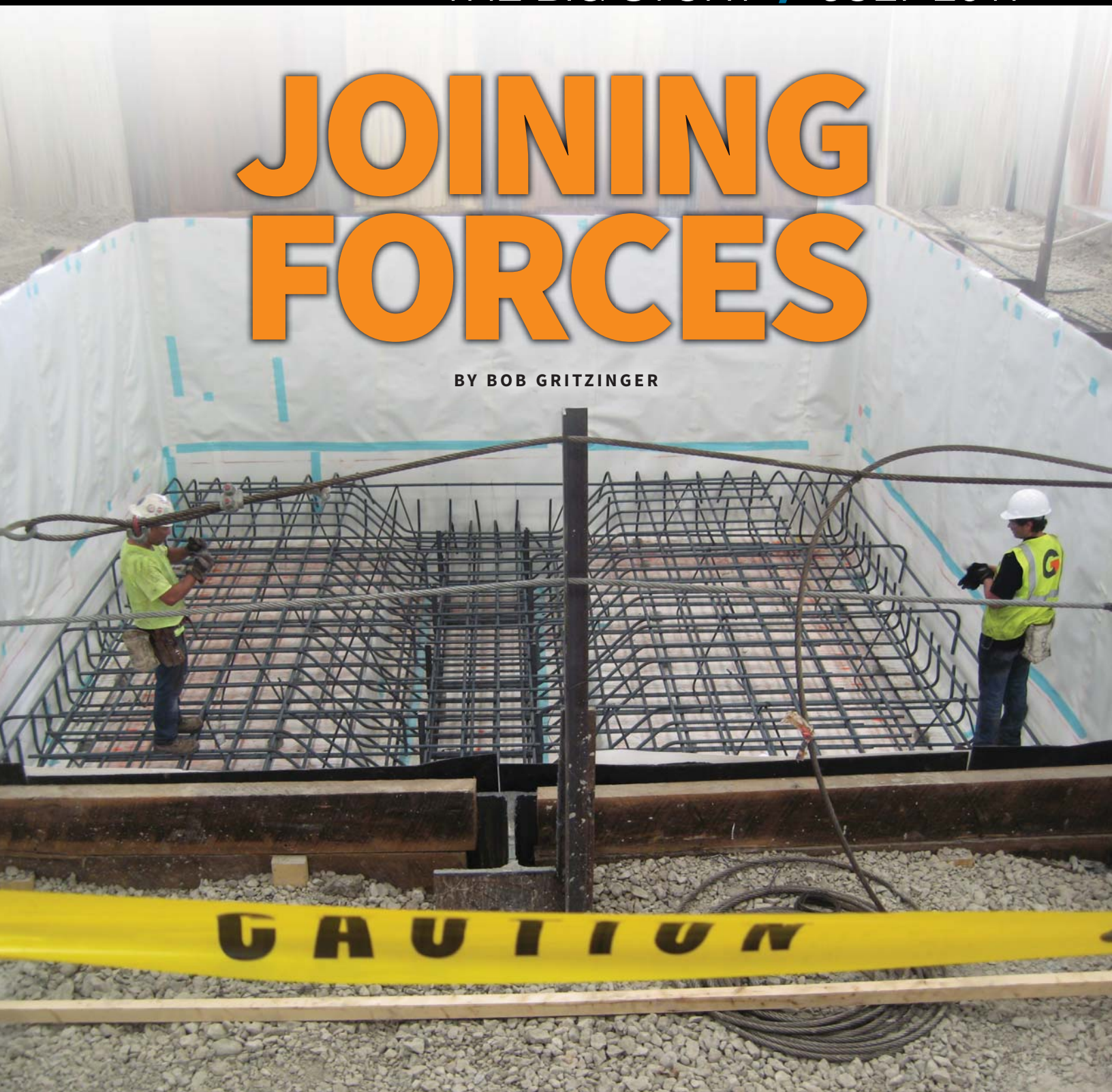
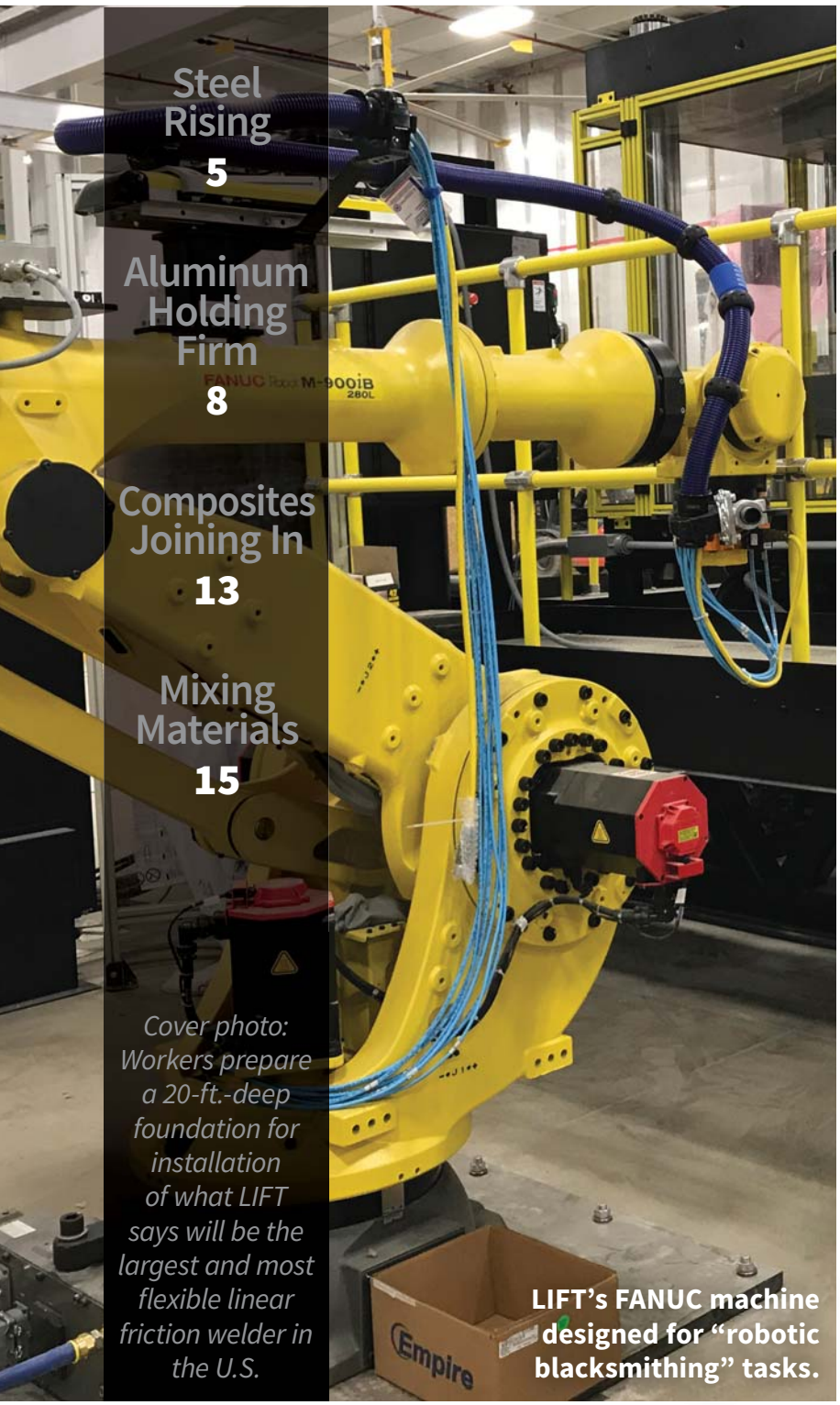
THE BIG STORY / JULY 2017

JOINING FORCES

BY BOB GRITZINGER





Cover photo: Workers prepare a 20-ft.-deep foundation for installation of what LIFT says will be the largest and most flexible linear friction welder in the U.S.

LIFT's FANUC machine designed for "robotic blacksmithing" tasks.

IN THE MIXED-USE DETROIT CORKTOWN NEIGHBORHOOD just a few blocks south of where fans cheered professional baseball for 87 years, LIFT – Lightweight Innovations For Tomorrow – is making some major-league noise.

"We're about reducing the weight of machines that move people and goods on land, sea and in the air," says Alan Taub, LIFT's chief technology officer, who retired in 2012 from his position as General Motors' head of global R&D. Taub also is an engineering professor at the University of Michigan in nearby Ann Arbor.

Although LIFT's lightweighting endeavors are wide-ranging, from military applications to aerospace, about two-thirds of its $150 million in projects relate to taking pounds out of cars, trucks

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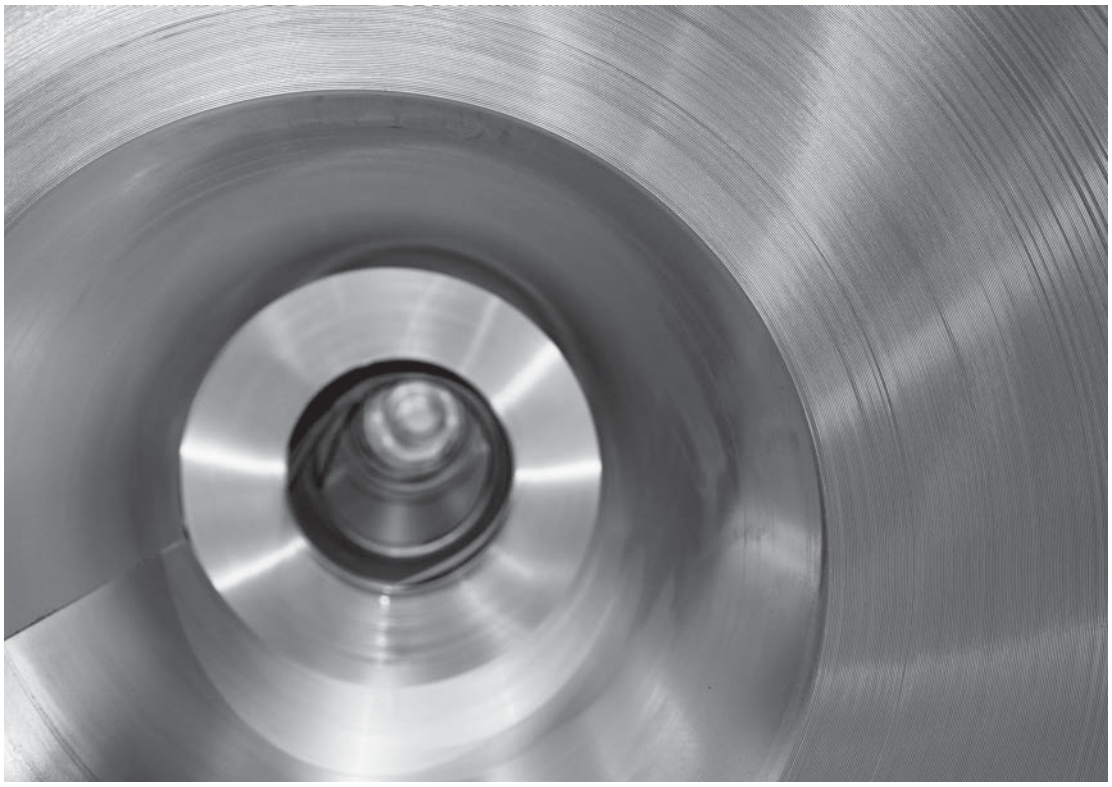
Sherkoh Abbas, director-Technology & Operations, is responsible for obtaining, installing and managing pilot-scale test equipment in the 114,000-sq.-ft. LIFT facility.

and SUVs. To do that, the not-for-profit technology incubator is installing pilot-scale equipment to study lightweighting solutions.

LIFT's projects include innovative methods for joining differing metals without causing corrosion, making robust thin-wall castings, friction-welding dissimilar metals and extruding aluminum tubing for use in lightweight vehicle frames.

In the bigger picture, however, LIFT's goal is to bridge the growing gap between laboratory research and practical industrial applications by creating a public-private partnership that brings together laboratories and industry to solve lightweighting problems.

At a time when the automotive industry is laser-focused on reducing weight as a key to meeting looming requirements for dramatically increased fuel efficiency and drastically lower greenhouse gas emissions, LIFT could be the kind of glue needed to bring it all together.

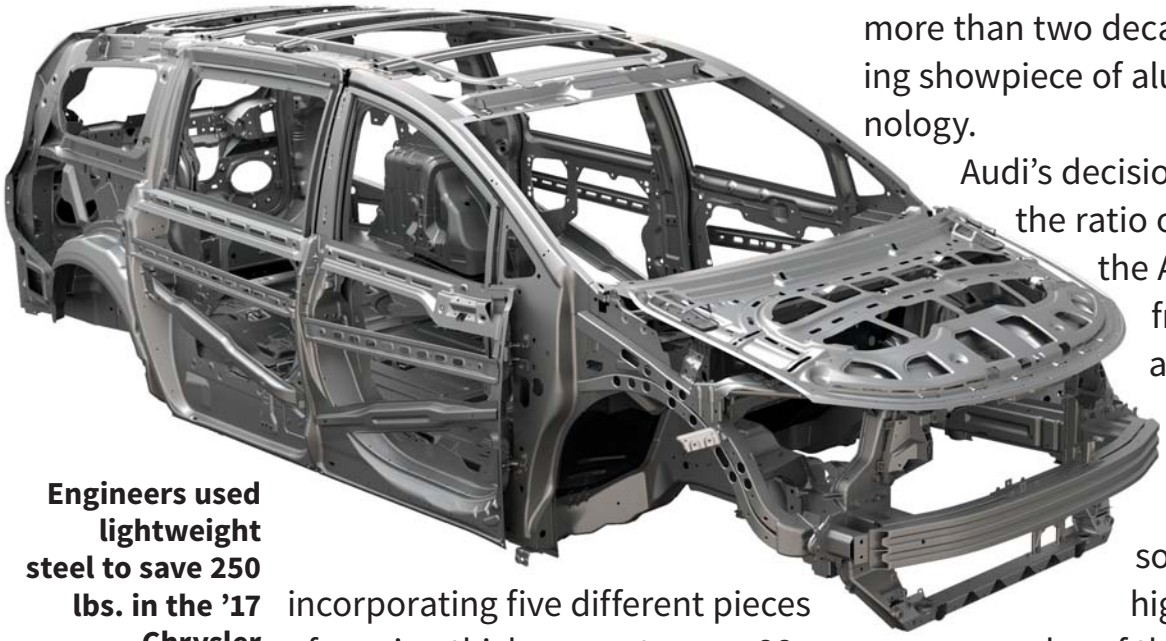


Steel Rising

Despite rumors of its decline, steel still makes up the lion's share of the material in most vehicles, with newly developed, lightweight, high-strength steel alloys gaining more and more favor among automakers.

When it came time to redesign Chrysler's bread-and-butter minivan, engineers working on the sixth-generation model that eventually debuted as the '17 Pacifica had a $2 billion development budget and an order from the boss, FCA CEO Sergio Marchionne, to create "the most technologically advanced minivan ever."

Using computer modeling and a plethora of mild and high-strength steels, body-in-white leader Jeff Tibbenham and James Truskin, technical fellow-Body Architecture, achieved a 250-lb. (113-kg) reduction in weight – 10% off the previous model – while also attaining top crash-protection ratings. The front door ring alone is a study in steel use,



Engineers used lightweight steel to save 250 lbs. in the '17 Chrysler Pacifica.

incorporating five different pieces of varying thicknesses to save 22 lbs. (10 kg) per vehicle.

Honda also found gold in steel when it developed its fifth-generation Odyssey minivan. Nic Goldsberry, senior body design engineer-Honda R&D Americas, says use of high-strength steel alloys for 58% of the body structure significantly increased rigidity and assured top safety ratings while cutting weight by 75 lbs. (34 kg).

Another prime example: the '18 Audi A8, returning to a steel body and structural parts after more than two decades as a rolling showpiece of aluminum technology.

Audi's decision to increase the ratio of steel in the A8 resulted from the automaker's understanding of how newer, more sophisticated high-strength grades of the metal could play a larger role at a lower cost, says Blake Zuidema, director-Automotive Product Applications for supplier ArcelorMittal.

"What they're finding is that steel, in the applications they've chosen, gives them the best performance, the best cost-to-weight ratio, the best strength-to-weight ratio of any material," Zuidema says.

"They could have used anything, but they chose steel because it provided them the best perfor-

Steel and aluminum come together in the '18 Audi A8.

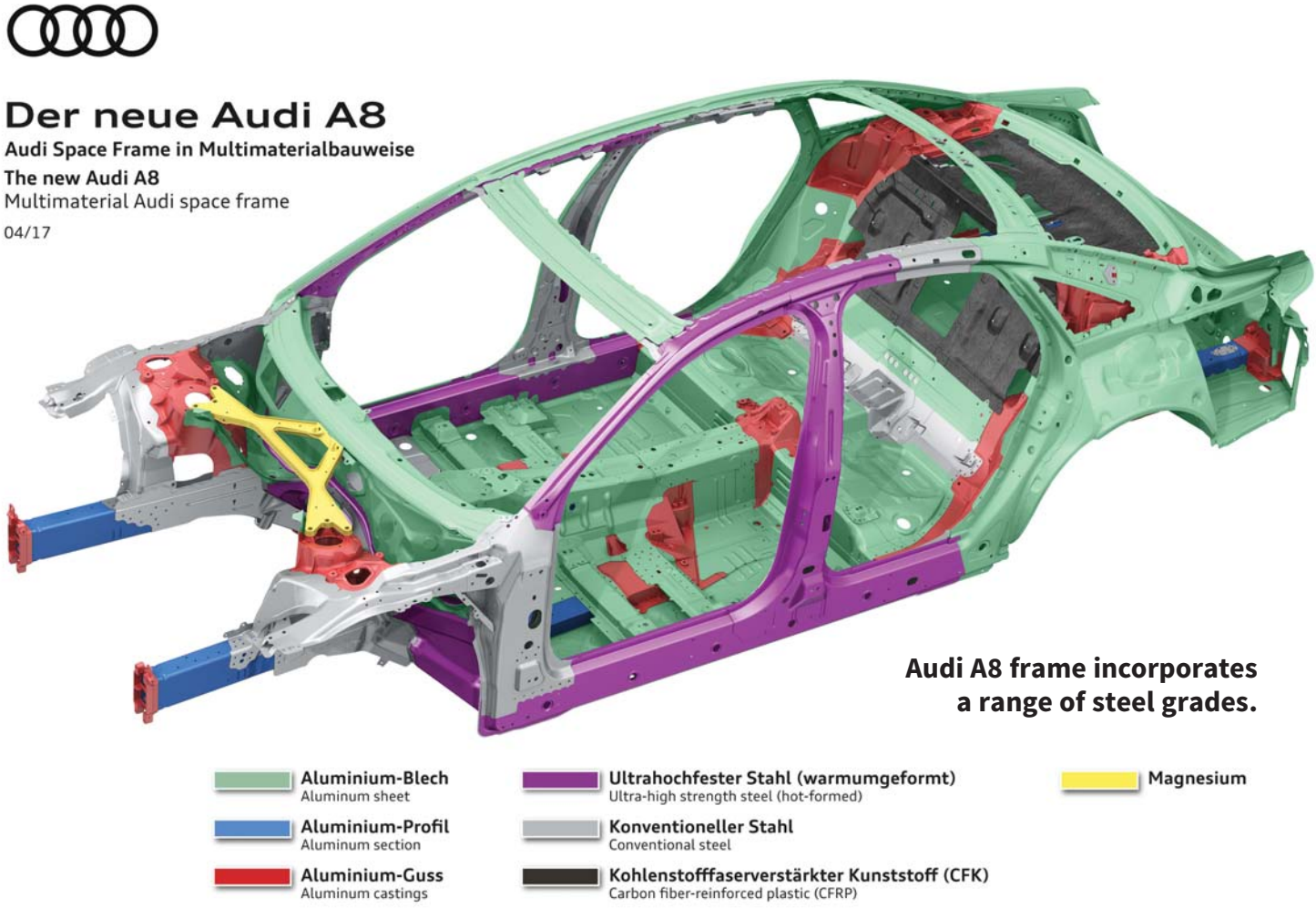
mance," he says. "It's the better material for the application."

ArcelorMittal's contribution to the A8 includes two classes of steel, a cold-stamped high-strength metal that can crumple and predictably absorb energy for front and rear body and frame parts, and a hot-stamped boron steel for roof rails, rocker panels, crossmembers and B-pillars to prevent intrusion into the passenger compartment.

"It shows you what we've been doing with steel," Zuidema adds. "The grades they've chosen actually provide better performance at a lower cost than the aluminum that they're replacing."

Zuidema notes that while work on new classes of steel has accelerated since more stringent fuel-economy standards were set in 2011, the trend began in the 1970s with the first round of vehicle lightweighting brought on by the oil crisis. Consumer demand for safer and lighter vehicles in the 1980s and 1990s drove a second wave of steel innovation.

Finally, Zuidema says, steel makes environmental sense because pound-for-pound it requires one-fifth of the energy required to make aluminum, regardless of the grade of steel.



Audi A8 frame incorporates a range of steel grades.

Aluminum Holding Firm

Aluminum enjoys its role as the automotive industry's leading lightweight material, the standard by which weight, strength and cost are measured when considering alternatives. But the industry isn't sitting idle waiting for others to catch up.

"We certainly need to do a lot to stay ahead as the industry moves toward more and more lightweighting solutions," says Ganesh Panneer, vice president and general manager-Novelis North American automotive business and vice chairman-Aluminum Transportation Group.

"If we look out five to 10 years, we still expect the demand to continue to be strong. We expect

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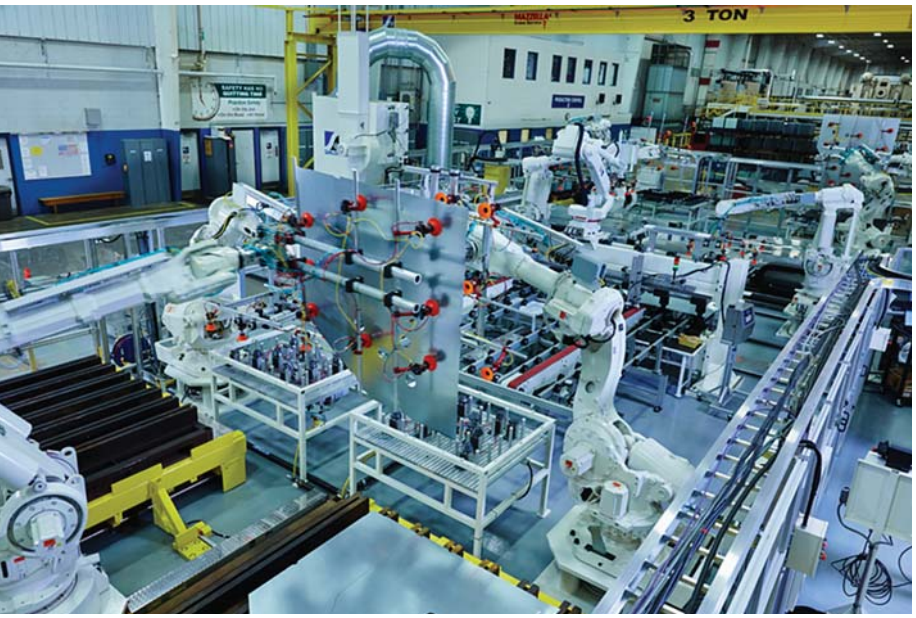


Shiloh's laser-welding process produces aluminum blanks for stamping.

the trend of lightweighting to continue and we want to be the primary metal of choice when it comes to our customers and designing lightweight vehicles."

Aluminum part supplier Shiloh Industries is borrowing from the steel sector in the development of one method to reduce weight and retain strength, says Jim Evangelista, executive director-engineering.

"We've developed a process to make laser-welded blanks for certain grades of aluminum," Evangelista says. "The trick is making a weld that can be stamped in a die and still hold its integrity," a process that is common with steel and now also possible with aluminum using Shiloh's process. Novelis is working on a similar process, Panneer says.

Shiloh also is working to make aluminum even lighter via a "squeeze casting" process that compresses the grain structure to make the metal stronger, yet thinner.

"It's in our vision statement: 'We make aluminum lighter,'" says Shiloh President & CEO Ramzi Hermiz. "There's not a vehicle we can't look at and take weight out – and we're talking significant weight."

As aluminum suppliers seek better and cost-effective solutions for strength and formability, all agree that joining technology holds the key to greater use of aluminum in combination with other materials in future vehicles.

Today, the Cadillac CT6 is a prime example, adding a mix of 13 different materials to its aluminum-intensive structure with the aim of increasing fuel efficiency, keeping the cabin quiet and not sacrificing performance. The CT6's mixed-material structure

builds on General Motors' earlier patented breakthrough in aluminum spot-welding that enabled more use of the lightweight metal in hoods, liftgates and doors.

Panneer also foresees increased application of high-strength 7000-grade alloy for B-pillars, roof rails and other protective structures in the next three to five years, along with greater use of high-strength 6000-grade aluminum.

"There is no one universal solution yet. It clearly comes down to customer needs and their capital investments," Panneer says. "It's been a mixed bag so far. We should be open to having multiple choices."

While aluminum can be more expensive, Panneer argues it doesn't add as much cost if the vehicle is properly designed with lightweighting in mind. By designing an overall lighter vehicle structure, smaller powertrains and other systems, such as brakes, can be employed while obtaining the same level of performance.

And when it comes to environmentally friendly materials, Panneer says it's hard to argue with the fact that Ford's closed-loop system builds 30,000 aluminum-bodied F-150 pickups per month – 350,000 annually – from recycled scrap metal.

Cadillac mixes 13 materials to build its aluminum-intensive CT6.

Composite structures cut weight of new Mercedes-Benz S-Class.

Composites Joining In

Reducing structural mass and thickness while damping cabin noise and retaining the kind of strength needed to meet increasingly stringent crash standards puts companies that make composite alternatives in the limelight.

"You don't usually think of a plastic or polymer-type material as being stronger than steel," says Leslie Wolschleger, vice president-R&D at Sika Automotive. "But you can if you have the right design and the right material and you put it in the right location in the vehicle. You are able to replace the steel."

Sika's alternatives typically result in an average 30% weight savings compared with a similar steel part, she says.

An example, says Sika research scientist Christian Eyholzer, is

the current Mercedes S-Class that employs a trademarked Sika Reinforcer system. The 16-part system saves 22 lbs. (10 kg) in the flagship sedan.

As automakers seek to design thinner, more aesthetically pleasing roof rails and pillars, high-strength bonding with composite reinforcements will offer significant advantages in design flexibility, Wolschleger says.

"Roof crush requirements can be difficult to meet, and that's where this structural adhesive comes in," Wolschleger says. "I say it's more bang for your buck – it's not a technical term – but essentially what it means is, it can absorb more energy in a quicker amount of time. By placing that strategically in a vehicle you can get better crash performance."

She says the use of the structural inserts started small but now is growing to the point Sika and its customers are "looking at all areas of the vehicle to remove mass, from frame to the roof" using the system.

Diagram details use of Sika Reinforcer structural composites in S-Class.

Audi uses 18 different joining technologies to build its all-new A8 sedan.

Right: A8's magnesium strut brace.

Mixing Materials

On the surface, Audi's decision to revert to steel in its flagship A8 sport sedan illustrates advancements in steel as a lightweight material. But it's the German automaker's ability to combine a wide range of materials, using 18 different joining technologies, that is the real harbinger of future developments on the lightweighting front.

Mario Greco, an automotive aluminum materials expert and director-Ground Transportation at aluminum supplier Arconic, says the A8 represents the state of the art in multi-material technology, combining new lightweight steel and aluminum alloys.

"If you consider the natural evolution of materials, steel has made progress as well as aluminum alloys, (but) the joining technologies have made substantial progress because the concept of multi-material joining went from being a research project to commercial viability," Greco says.

"What you're seeing in the A8 is just a natural progression of the fact that multi-material joining technologies weren't where they needed to be at the time (in 1994) to truly do a multi-material or highly optimized structure.

"I see it much less as any sort of

indication of a step backwards of any one particular material.

"It's not about the materials, it's about the fact that the OEMs have developed technologies and have naturally progressed to where they can finally achieve very optimized body structures," Greco says.

Jay Baron, president of the Ann Arbor, MI-based Center for Automotive Research, agrees:

"In the next 10 years the trend toward mixed materials will continue to escalate" with adhesive joining, long a subject of research, now on the cutting edge.

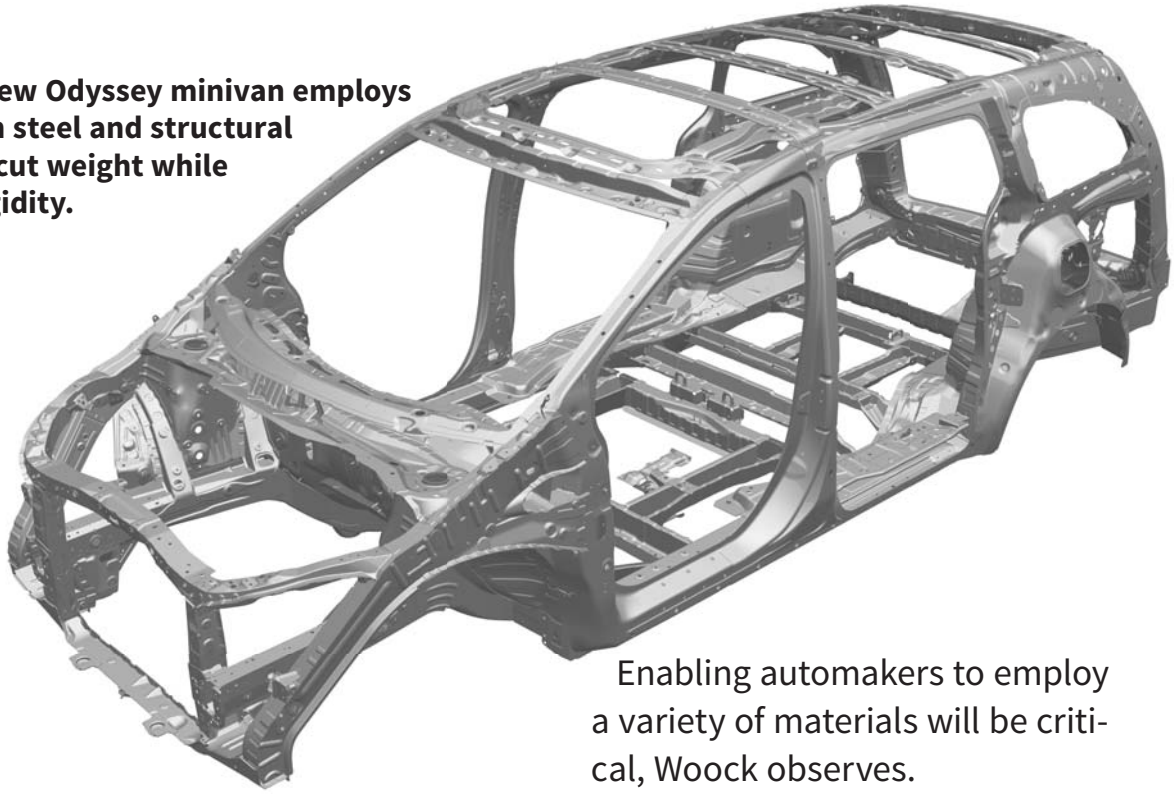
"Gluing cars together gives you a stiffer car, one that doesn't rattle, (provides) better performance and helps you down-gauge the materials," Baron says. "We call it a lightweighting enabling solution, regardless of the material."

Baron downplays the decades involved in perfecting adhesive joining in automobiles, noting mixed-materials cars are much more complex than monolithic-material vehicles when it comes to the joining technology, automation involved, timing issues and development of a supply chain to support the process.

Kevin Woock, global market segment manager-Automotive Group at Henkel, confirms Baron's observation, noting his company's automotive investments often take 10 to 15 years to pay off as automakers put their chemicals, coatings and adhesives into production.

But lightweighting, Woock says, is a sure bet as the industry strives to meet 2025 and 2030 fuel-efficiency and emissions targets without sacrificing the

Audi's '18 A8 uses more steel, less aluminum.



Honda's all-new Odyssey minivan employs high-strength steel and structural adhesives to cut weight while increasing rigidity.

performance consumers now demand in their vehicles.

"Lightweighting is not only not dead but is going to accelerate over the next 10 years," Woock predicts. "As of 2017, automakers have gone about as far as they can with efficiency of the internal-combustion engine, so lightweighting is the key to better performance.

"Short of electrification, there's not a whole lot more they can do to improve the overall efficiency within the internal-combustion engine and lightweighting is going to be in much, much bigger demand."

Enabling automakers to employ a variety of materials will be critical, Woock observes.

"It's exciting because you're constantly being challenged by these new opportunities that are coming up because the OEMs want to use these lightweight materials, these dissimilar materials, that they want to join together."

Woock points to the new Honda Odyssey, as well as the Japanese automaker's Ridgeline pickup, as examples of how using adhesives to replace welds reduces weight. The Odyssey cut weld mass by 50%, Woock says.

Honda didn't use Henkel adhesives in those vehicles, but in the bigger picture, Woock sees the

automaker's use of the new bonding technology as a sign of future growth. The company already is seeing demand for adhesives at double or triple the rate of market growth, he says.

"Japanese OEMs tend to be a little bit more conservative in taking on new materials and new process technologies, so when you see Honda or Toyota starting to use a significant amount of bond-line adhesives you say to yourself this is really mainstream now," Woock says.

Sika Automotive's Eyholzer says different multi-material bonding techniques hold huge promise for making vehicles lighter as automakers combine steel, aluminum, composites and carbon fiber in the exact locations they are needed for strength and stiffness.

Sika's Mixed Bonding Excellence system, which is carefully designed to handle expansion and contraction that occurs in high-temperature paint curing, allowed BMW to save 309 lbs. (140 kg) in its latest 7-Series, he says.

Going forward, the industry is bound to see more use of aluminum, high-strength steel and other materials, along with the coatings and adhesives that allow them to join in harmony, CAR's Baron observes.

"Those technologies all exist – we're not inventing a lot, but we're validating, improving and scaling it" to aid an industry that is seeking lightweighting solutions, he says.

"The regulations are clearly stressing the industry. It's not coming easy," Baron says. "Any supplier of these advanced technologies has an open door to demonstrate their cost competitiveness and what weight they can get out of the car." **WA**

This story was written by Associate Editor Bob Gritzinger, a longtime journalist and industry observer who covers automotive product, technology and business news.