The 2015 Ford F-150 clearly requires specialized training. It is spot-welded in only two areas; the remainder of the attachments are made with structural adhesives and specially coated self-piercing rivets.

LIGHTWEIGHTING poses repair challenges

Mass-produced aluminum bodies and mixed-material structures present challenges for assembly and repair, as automakers increasingly pursue these lightweight strategies.

by Paul Weissler and Ryan Gehm

Aluminum panels for automotive application are nothing new. They've been used for hoods and decklids for many years, particularly when an automaker needed to shave a few pounds to fit a vehicle into a particular emissions class. And a number of luxury cars have had some models with bodies almost entirely of aluminum, such as **Jaguar**, **Range Rover**, **Aston Martin**, **Audi**, **Porsche**, and now **Tesla**. But **Ford**'s 2015 F-150, the best-selling vehicle in the U.S., with its all-aluminum body, is raising the issue of body repair to a level that can challenge America's mainstream auto body repair shops.

The F-150 retains a steel frame to go with its aluminum panels, but the amount of aluminum and the associated technology that enabled it will require new tools and techniques for the body shop. Wait, what about the aluminum body luxury cars? How have they been repaired?

The answer is that the premium car makers with all-aluminum models have been very selective. They've approved only "cream of the crop" shops that could afford the special equipment necessary. Because they were considered "craft shops," they could charge much higher rates. With just a handful of competitors in a large geographic area, they had enough volume to justify the necessary investments in equipment and technician training.

Servicing 40 Teslas a month

Kye Yeung is executive committee secretary of the **Society of Collision Repair Specialists** (SCRS), a trade association of body shops that exhibited at the recent **SEMA** Show (Specialty Equipment Market Association). He operates a recommended facility for Tesla, Aston Martin, Range Rover, and Jaguar, and told *Automotive Engineering* he has an investment of approximately $2 million in his shop. He said he pays premium wages to his employees and is able to command up to three times the labor rate of other body shops.

Yeung's operation, based in the southern part of Orange County, CA, with only one comparably approved competitor in a wide area, typically services 40 or more Teslas a month. He estimates that there are more than 7000 Tesla vehicles on the road in his market area. Yeung said his shop has a six-week backlog and is able to refuse to deal with insurance companies. He employs 14 technicians, five of whom (including himself) are certified to do structural repairs for all of the makes in which his shop is specializing.

The designated body shops are the only ones that can buy OE structural replacement parts for these high-end aluminum vehicles, Yeung said, which helps direct the customer traffic. Cosmetic parts are not under such restrictions, but in practical terms an owner would not know what was needed in most cases, and the training-and-special-tools factor is powerful.

LIGHTWEIGHTING
poses repair challenges

Technicians in an I-CAR class on aluminum-panel dent removal found that the work requires a learning curve

This Tesla chassis is all aluminum, and structural repair parts are restricted to approved shops. It was on display at the SEMA Show by SCRS.

The investment in F-150 aluminum body service is reportedly far lower than for the premium cars. Yeung estimated the amount would be in a range of $50,000-$70,000 and, he added, a shop would have to pay an annual fee for an independent agency to inspect and certify that it continues to meet Ford standards. Despite the lower overall cost, Yeung said he has no intention of servicing the new F-150, describing the service system as a "free for all" in comparison with the "craft"-oriented league in which his shop plays.

The 2015 F-150, however, clearly requires specialized training. It is spot-welded in only two areas, where the pickup bed floor attaches to crossmembers, as the welds have lower strength than the aluminum pieces that were joined. The remainder of the attachments are made with structural adhesives and specially coated self-piercing rivets. And where aluminum is joined to steel but the metals cannot be isolated with adhesive or coatings to prevent corrosion, plastic bushings are used.

Lightweighting focus for April webcast

The lightweight-materials fight taking place in the automotive industry is anything but lightweight—it's a heavyweight bout, with the steel and aluminum industries trading punches by making new technology and process announcements on a regular basis. And don't count out the other major contender—composite materials—which are steadily making inroads in new application areas within vehicles.

In reality, however, these materials are not mutually exclusive; they are selected to fulfill a particular purpose and exist side by side in vehicles to optimize automakers' lightweighting and safety initiatives. *Automotive Engineering* will host a special technical webcast in early April on the topic "Multi-Material Vehicles." During this free 60-min webcast, participants will hear representatives from steel, aluminum, and composites companies discuss the latest in materials advances, expectations of adoption between now and 2025, the challenges of multi-material vehicles, and where their respective materials fit in with this lightweighting strategy.

Webcast attendees will be invited to interact with the experts during a Q&A segment.

Visit www.sae.org/webcasts for more information and to register.

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Dent removal techniques

Knocking out aluminum dents, even where there is access, is an acquired technique. *Automotive Engineering* watched a room full of experienced auto body technicians in a SEMA Show I-CAR (**Inter-Industry Conference on Collision Auto Repair**) class try to remove the same test crease in an aluminum panel with hand tools. They clearly were at the very beginning of a learning curve.

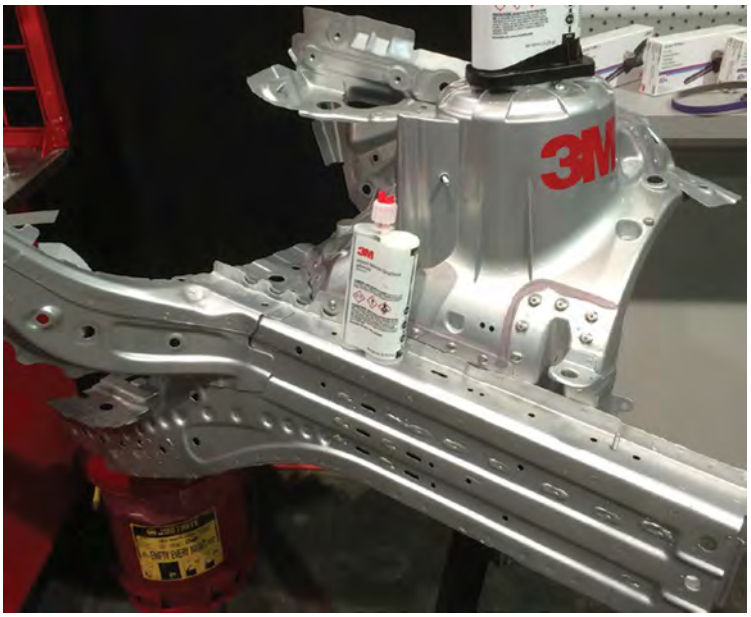
Where an F-150 panel is dented but there is access just to the exterior side, the shop also can weld on aluminum pulling studs to pull it out. However, care must be exercised in the placement of grounding clamps, because of the electrical conductivity of aluminum. This was just one of the special cautions noted by David Solmes, instructor in aluminum body panel repair. He spoke at a training session by I-CAR, which is a nonprofit training organization. It was one of several such sessions at the recent SEMA tradeshow.

Solmes also cautioned that although aluminum panel dents may be removed by shrinking the metal with heat, the technician has to be careful to stay below the 425°F (218°C) limit of the typical alloy. When the temperature applied is too high, he said, the aluminum is annealed and loses strength.

"At 570°F [almost 300°C]," he added, "a Ford F-150 panel becomes aluminum foil."

Even where the heat can be useful, he noted, the technician has to keep it away from structural adhesive, which typically softens at 400°F (204°C). To avoid this issue, the technician should take a protective step. One would be to position a wet rag close to the joint. Some technicians apply thermal paint or crayon, which melts and runs when the threshold temperature is reached.

Infrared thermometers also can be used, but as Solmes pointed out, a reflective aluminum panel surface will produce a significantly incorrect reading. A strip of nonreflective tape should be applied to the panel to provide a suitable target for the infrared beam. By contrast, low-carbon steel does not anneal until about 1650°F (almost 900°C).



The Cadillac ATS and CTS cast-aluminum strut tower attached to a high-strength-steel frame rail—on display at the 3M booth during the recent SEMA Show—is the perfect application for 3M's new aftermarket structural adhesive. (Ryan Gehm)

Bonding multi-material structures

According to Dan Wittek, Technical Service Supervisor at **3M**, aluminum vehicle bodies are not all that complicated to repair, reminding that "trucks have been made out of aluminum for a really long time."

The company's product lineup such as adhesives, body fillers, and abrasives all apply not just to steel, but aluminum-intensive vehicles as well.

"We're not starting from scratch with aluminum repair; it's not a whole new lineup of products," Wittek said. "It's just technique and how you use them is slightly different." For example, repair shops need to be mindful of "cross-contamination"—i.e., galvanic corrosion—that can occur by using the same set of tools on aluminum and steel vehicles.

3M's standard 08115 panel bonding adhesive, which has been on the market since the late 1990s—has already been approved by Ford for use on the new F-150 pickup truck, according to Wittek. "This is our standard product for steel, and it's going to be standard for aluminum—but [only] for outer body, nonstructural sheet metal."

The real challenge, according to Wittek, comes from repairing multi-material structural applications. The **Cadillac** ATS and CTS cast-aluminum strut tower attached to a high-strength-steel frame rail—on display at 3M's booth during the SEMA Show—is the perfect example of such a challenge.

"You can't weld them together; it has to be mechanical or with adhesives, so **General Motors** came to us [for a solution] to meet this spec," Wittek explained to *Automotive Engineering*. 3M and GM worked collaboratively on a new structural adhesive that is expected to be commercially available in February.

"There hasn't been anything like it before. We already have GM's stamp of approval for their vehicles, and we're working to add other OEMs to that as we go," Wittek said.

As a result of vehicle lightweighting and the use of thinner-yet-stronger materials, OEMs are using adhesives and under-coatings more often to reduce NVH, improve ride quality, and enhance the feeling of quality, particularly in luxury vehicles such as those in the Cadillac lineup.

3M's new structural adhesive is expected to be commercially available in February. (Ryan Gehm)

"General Motors [in some cases] is bonding almost the whole car *and* welding it. Even if it's all steel, they're using a structural adhesive…because there's still some flex," Wittek said. "So that's where this [new product] is going to be deployed for the aftermarket because today there isn't something for that aftermarket repair in structural applications."

Carbon fiber is a "different animal," according to Wittek, because of its unique layup construction.

"There's a big difference in carbon fiber between a cosmetic outer body panel and a structural inner panel," he explained. "If it's a structural inner panel and it's damaged, today OEMs like **BMW** with their i3 structural carbon fiber just replace it. Things can change as technology advances, but today because of the weave and the way that it's designed and engineered…it's going to be a weak spot."

Carbon-fiber outer body panels, however, are repairable with current adhesives.

"We have solutions today, but we're still working on *perfect* solutions," Wittek said. "Our panel bonding adhesive actually works really well for carbon fiber; the challenge with it is that it's slow-drying, it's a 4-h cure. It's designed that way so you have enough time to get a body panel onto the car, but if you're just doing a small crack in a [carbon fiber] fender, you don't want to wait 4 h. So when I say we're working to improve that, it's not that we can't do it, it's just there isn't a system designed for carbon fiber…We're getting there." ■