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TECHNICAL

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THE LATEST AND THE GREATEST

THE MOST RECENT TRAINING AND INFORMATION ON ADVANCED MATERIALS IS NEAR AT HAND FOR EVERY SHOP

TIM SRAMCIK // Contributing Editor

In the era of 24-hour news cycles, most news stories distill into a series of narrative for the audiences most affected. In the collision repair industry, the new, far stricter CAFE standards announced in 2015 have become a tale of the haves and the have-nots. The haves are those shops whose early investment in aluminum work gained them both an edge in competition and earning highly prized memberships in OEM repair certification programs.

The have-nots are everyone else — essentially most of the industry. With stronger, lightweight materials poised to take center stage in a design revolution aimed at carving away vehicle weight, the have-nots are on a tight schedule to get up to speed on new materials repair. Yet nearly two years into this transition, industry leaders like SCRS Executive Director Aaron Schulenberg say notable confusion remains among shops about what training and other resources are available and which direction repairers should take to enter this new generation of collision work.

Answers are readily on hand. A review of the current state of new materials repairs points to a number of training options, as well as the paths shops can take to remain competitive in a changing business climate well past 2016.

PHOTO: RELIABLE AUTOMOTIVE EQUIPMENT

REPAIRERS WILL NEED TRAINING to handle equipment like the XPress 800 rivet gun, capable of placing 10,000 ft.-lbs. of pressure on a 6mm rivet tip.

Available options

I-CAR continues to take steps to make new materials training available throughout the industry. Aluminum GMA (MIG) Welding (WCA03) remains a popular option for shops taking their initial steps in aluminum repair, particularly for the 2016 Ford F-150. Manufacturers such as Infiniti, Acura and Porsche require Gold Class shop designations and Platinum Individual recognition as prerequisites for their materials-focused repair certification networks. The organization continues to integrate its Jaguar and

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Land Rover training through the Jaguar Authorized Aluminum Repair Network.

I-CAR Industry Technical Support Manager Steve Marks notes two newer courses, he believes, provide significant benefits to shops looking to gain entry into aluminum and advanced materials work. The first, MIG Brazing Hands-On Skills Development (BRZ02), responds to the growing popularity of MIG brazing among OEMs who, Marks says, have become confident in the collision repair industry's ability to handle this procedure, which is suited for HSS and UHSS steels. MIG brazing provides bonds created with bronze and silicon wire while using substantially less heat than MIG welding — typically, a drop from 3,000 to 1,940 degrees F.

Damaging heat and loss of zinc corrosion protection are further reduced with the "stitch and "skip" brazing technique. Technicians braze with a series of quick welds followed by cooling stops with 50 percent overlapping.

Marks says brazing has become more important as newer steels are increasingly thinner (though stronger) and thus more prone to repair damage. MIG brazing drastically reduces damage potential through improved heat control and shrinking weld zones.

MIG brazing provides other advantages:

- Less welding spatter — Because material is transferred into the weld pool without any short-circuiting, the arc is almost entirely free of spatter.
- Reduced potential for burn through and panel warping from excessive heat
- Easier finishing of the welded joint
- Improved seal along the joint due to cathodic corrosion protection, which prevents rust "creep" between zinc and steel along cut edges of the panel

The second course recommended by Marks is Rivet Bonding Hands-On Skills Development (RVT01), an in-shop "intensive" session on solid steel, aluminum, self-piercing, blind and solid rivets. Students meet certification through a written test.

Marks says parts joining with rivets has moved to the forefront of collision repairs across vehicle brands with the increased production of mixed material vehicles — those utilizing combinations of UHSS, aluminum, carbon fiber and magnesium throughout their structures.

PHOTO: GM

THE NEW CADILLAC CT6 utilizes a mixed materials structure of steels and aluminum. This increasingly popular design replaces traditional welds with fasteners.

ROAD TO CERTIFICATION

Considering the busy schedules repairers face, navigating the requirements of OEM repair programs can be imposing. Throw in the high costs, and certification can seem nearly impossible. Assured Performance Network has partnered with a number of manufacturers, including Nissan, Infiniti, Ford, GM and Hyundai, to create a simplified program that puts advanced materials and evolving technology repairs within the reach of motivated shops everywhere.

Utilizing collective requirements and a uniform approach for documentation and inspection, Assured Performance helps repairers meet certification requirements for multiple OEMs at the same time.

"This joint-effort strategy was developed to reduce the redundancy of requirements and the duplication of cost for all sides of the equation," says CEO Scott Biggs. "The interested shop can literally become certified/recognized by several automakers for one set base price. This approach can save shops tens of thousands of dollars and reduces the complexity of certification significantly."

Additional benefits include: marketing tools, listings on the various OEM shop locators and smart apps, local area press releases and promotions, along with new OEM parts rebates that Biggs says can cover the cost of annual certification and shop upkeep.

To date, Biggs says Assured Performance has aided 2,000 shops in meeting some form of certification.

Verifacts VQ provides similar inspection, verification services for shops wanting Honda certification.

More information on both is available at www.AssuredPerformance.net and www.verifactsauto.com.

On the OEM side

Gregg Butts, Technical Trainer of Collision Repair for Mercedes-Benz, says his company has added new types of rivets while moving away from self-piercing versions it has replaced with free flows. The latter can reuse the holes created for the original rivets thereby avoiding what Butts calls the "Swiss cheesing" of parts.

Away from the joint area, OEMs have begun using Flow Drill Screws. The special fasteners are used in the Chevrolet Corvette, the new Ford F-150 and throughout Porsche's model lines. Mike Kukavica, Collision Repair Technology Instructor for Porsche Cars North America, says the screws provide a significant manufacturing advantage because they can be installed from one side of the assembly, making access to the opposite side no longer necessary. That not only makes automated assembly easier, Kukavica says, it also reduces production times.

At the same time, these fasteners can increase the complexity of collision repair. According to Dave Gruskos, owner of Reliable Automotive Equipment, these fasteners and others require substantial training and an understanding of installation tools. "Not knowing the proper way to handle rivets can be extremely dangerous," he explains. "You're talking about 10,000 ft.-lbs. of pressure being placed on a 6mm tip."

"The gun installing them must be 150 percent stronger to safely exert the pressure," he adds. Both the gun and the rivet also must be made of the same materials as the parts being connected. Further complicating matters, rivets come in a variety of sizes and compositions.

Gruskos's company manufacturers the Xpress 800 rivet gun (approved for Mercedes-Benz repairs), which comes with a set of adapters to accommodate the growing number of fasteners. Gruskos says some now feature a dot on top that undergoes a hardening process as the rivet is compressed.

Gruskos says auto manufacturers have become so concerned that rivets are installed correctly that some are taking steps simply to help shops identify the proper replacement rivet. Mercedes-Benz has begun incorporating its brand logo to ensure an approved part is used and not an aftermarket version that could fail. Gruskos believes manufacturers eventually will declare rivets proprietary parts to help eliminate the possibility of a sub-par version being used.

"Right now there's a tremendous amount of concern that the right rivet is being used," he says. "That's only going to increase."

Financial challenges

Before shops can make this concern their own, they must first leap some substantial financial hurdles. The XPress

800 costs between $11,000 and $14,000. Shops seeking manufacturer certification, which is currently a necessity for ordering many structural parts, can easily spend as much as $250,000 adding equipment, tools and other requirements such as an aluminum clean.

Even after making this investment, repairers face an equally imposing challenge, receiving sufficient return on their investment

Part of the problem lies with a relatively small number of vehicles requiring specialized material repairs on the road today. That will change soon enough over the next decade. Ron Reichen, SCRS Immediate Past Chairman and owner of Precision Body and Paint headquartered in Beaverton, Ore., sees another issue: low labor rates that can make investment in this work seem impossible.

"The industry needs to adjust pricing to compensate for the considerable cost of continuous training and equipment purchases," he says.

Reichen lays the blame here at the foot of insurers that he says have been suppressing labor rates. He believes insurers of luxury brands have started recognizing this issue, but most underwriting departments have yet to pay attention.

The struggles shops face in coming up to speed (due to costs and other reasons) is already showing up in the form of subpar and botched repair. Certified repairers report having to re-do work performed by shops that repaired aluminum and UHSS as though they were traditional steels and in the process damaged the vehicle further.

Kye Yeung, SCRS Vice Chairman and owner of European Motor Car Works in Santa Ana, Calif., points to another phenomena. He says some shops have taken on work they believed they could do only to later discover damage to structural aluminum or other advanced materials. These shops realize the vehicle has to be turned over to a certified shop. Before sending the vehicle elsewhere, they attempt to compensate for lost work by stripping down the vehicle as much as possible in order to bill insurers for labor hours.

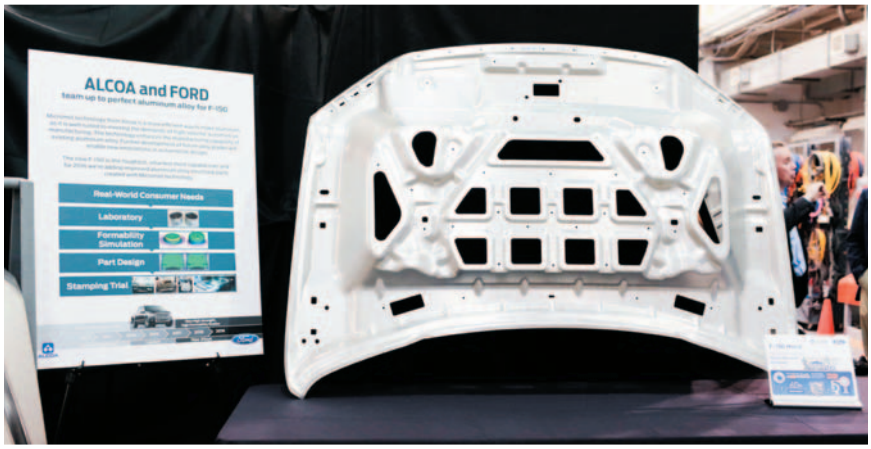

PHOTO: FORD

FORD WORKED WITH ALCOA to produce next-generation automotive aluminum alloys for the 2016 F-150. These alloys can differ significantly from those used in other vehicle brands, making OEM-specific repair procedures more important than ever in collision work.

"They load fenders and other parts right into the expensive interiors and box up all the bolts together with no regard to what they're made of," says Yeung. "The result is a longer repair, additional labor and higher costs since more parts have to be replaced."

Reichen believes troubles like these could continue, and the industry will struggle mightily to upgrade unless insurers agree to higher labor compensation. "Eventually, we're all going to have to have this conversation." he says.

Yeung is a bit more optimistic. He says the industry went through a similar "re-set" when manufacturers shifted to unibody vehicles. Then too, shops had to invest in new training, repair practices and equipment.

Yeung says shops today also have a number of channels to explore when it comes to reducing re-set costs.

"Not every shop will need to spend $250,000. Shops can save a lot just by buying equipment that is approved by multiple manufacturers," he says.

Forecast

Repairers searching for similar tips and help can turn to several resources. Schulenberg says the first place shops should start when updating their operations is with manufacturers. He recommends shops survey their markets to determine what brands and models they should prepare for and then contact the OEMs who can best advise them on their next steps.

More guidance is available from shop associations and companies like Assured Performance Network and Verifacts VQ (see "Road to Certification" on page 6).

Regardless where they start, Schulenberg says shops need to recognize that new materials repair is becoming more brand-specific. "There's a big difference in metal alloys from one manufacturer to another, and the recommended repairs can be very different between OEMs," he says.

This makes training and sticking to manufacturer repair procedures more important than ever. That in itself might be the biggest adjustment the industry at large has to make. Kukavica says for years repairers looked at parts and often figured out on their own the best ways to repair or install them. Those days may have passed forever.

With so much on the line in terms of safety and drivability, there are no longer manufacturer recommendations," says Kukavica. "Those are orders."

It's now up to repairers to listen and act.

TIM SRAMCIK has written for *ABRN* and sister publications *Motor Age* and *Aftermarket Business World* for more than a decade.
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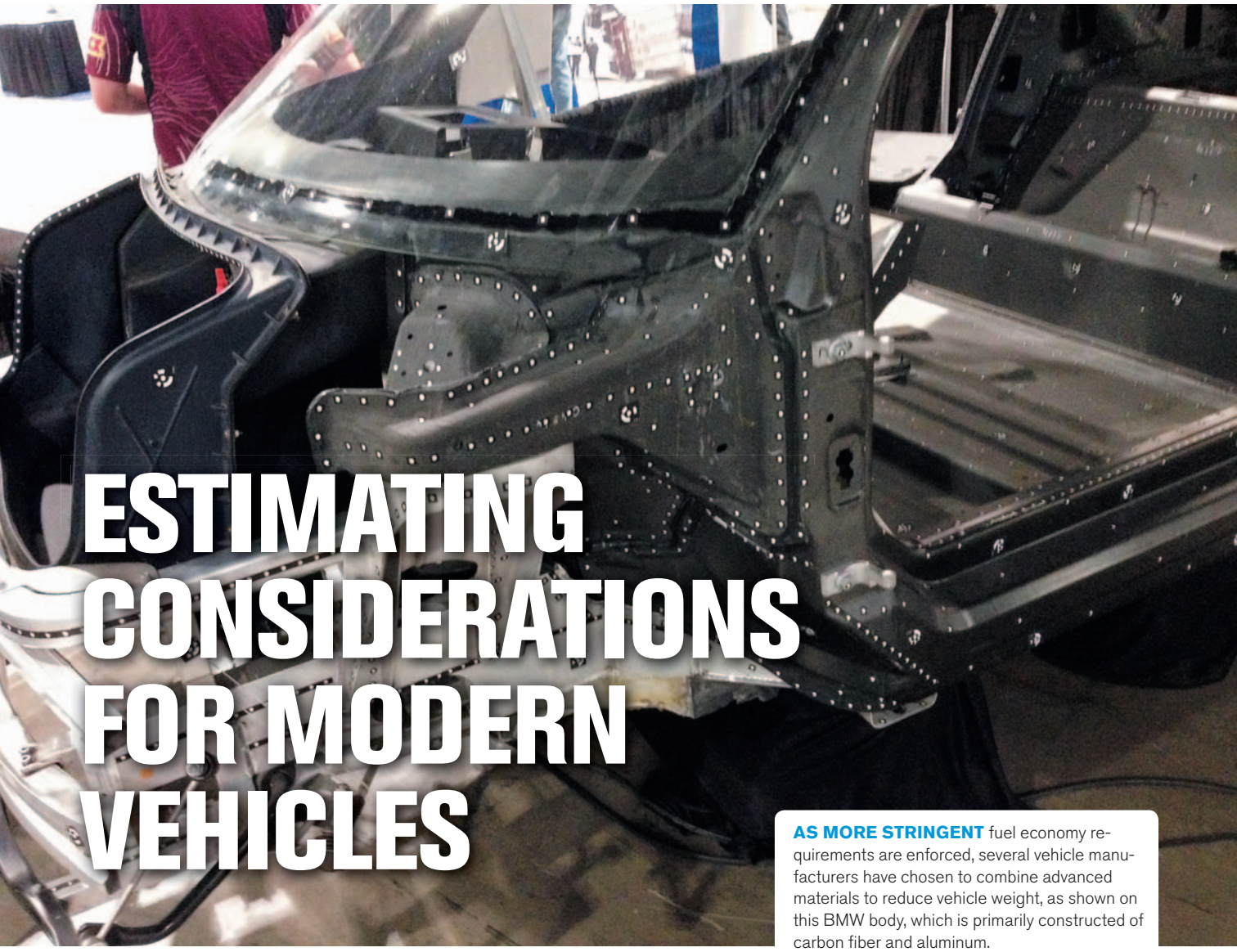

ESTIMATING CONSIDERATIONS FOR MODERN VEHICLES

AS MORE STRINGENT fuel economy requirements are enforced, several vehicle manufacturers have chosen to combine advanced materials to reduce vehicle weight, as shown on this BMW body, which is primarily constructed of carbon fiber and aluminum.

A LOOK AT THE CAUSE AND EFFECT OF RECENT CHANGES AND HOW THEY IMPACT ESTIMATING

MEL SCHAMPERS // Contributing Editor

Recently, I responded to a forum with an opening statement: "What the heck is going on? Cars haven't changed much, but lately I'm seeing all of these supplements." In my career, the past 10 years have offered far more changes at a faster pace than ever before in terms of vehicle structural design. While features such as electronics, connectivity, creature comforts and power have changed, the most alarming change is far less visual — it's structural. So how does this affect estimating and repair strategy? Let's take a look at the cause and effect of these changes and why estimate writing increasingly requires an in-depth knowledge of repair.

Remember the days of following general sectioning guidelines and procedures? Well that's pretty much history now. Over the course of my career, I've performed thousands of structural repairs and sectioned hundreds of frame rails by simply using a common sense approach

PHOTOS: JERRY GOODSON

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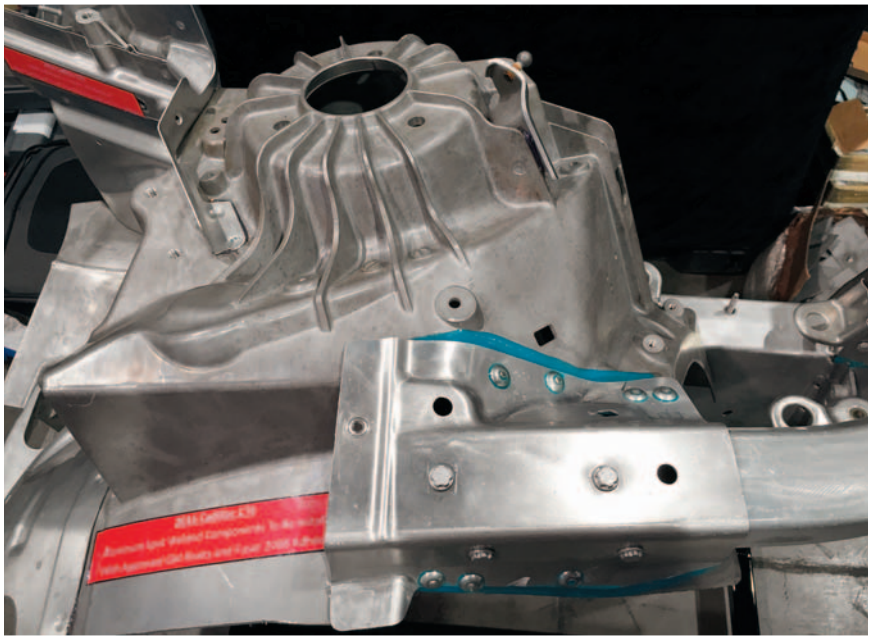
of following general sectioning guidelines, but not anymore. With today's vehicles, I will not consider a structural repair without a knowledge of metallurgy, OEM position statements and model-specific procedures from the vehicle manufacturer. So what happened? Advanced materials used in structures have progressed at an amazing rate, offering additional strength with less weight. Then there's the Ford F-150 with its all-aluminum body, so even more change.

Advanced high-strength steel

First, let's look at some of the properties of advanced high-strength steel materials. There are several ways that we can describe the varying strengths of steel, with the most common being tensile strength. Tensile strength is the maximum amount of force that can be applied before the material fails (fractures). We are accustomed to finding a tensile strength rating listed in pounds per square inch (psi), but it is much more common to see it listed in Megapascal (MPa), the metric equivalent, in most collision repair manuals or vehicle manufacturer publications. A comparison between the two measurements from psi to MPa is 1 MPa = 145.038 psi, while 1500MPa = 217,556psi.

You may also recall in general sectioning guidelines that repairability of mild steel rated to mid-60,000 psi was excellent, and high-strength steel (HSS/HSSLA), which was defined as beginning at 70,000 psi, repairs were more tentative and varied with OEM statements. Ultra high strength steels (UHSS) beginning at 100,000 psi was considered non-repairable. It's hard to imagine 1,500 MPa strength, as compared to vehicles of the early century, but it's here, and we need awareness before repairs can begin.

Regarding specific advanced materials, it's relevant for us to consider that any advanced structural material will have specific characteristics, as well as repair and/or replace procedure considerations, along with all kinds of names and terminologies. The terminology is an important consideration. Most structural repair procedures or the vehicle manufacturer's repair/service information will contain an area that defines the steel type that is used on specific vehicles, as well as the repairability and limitations. Perhaps the first step when writing an estimate to perform a structural repair would be to obtain the vehicle manufacturer's procedures to identify the material type. When writing an estimate, the following should be considered:



STRUCTURAL ADHESIVE and GM-approved rivets are used to attach the upper frame extension and the cast strut tower on the 2016 Cadillac CT6.

Is repair an option, or is replacement necessary? Then, if replacement, can it be accomplished through a sectioning location or must it be installed in its entirety? Consider what happens to a repair plan when the B pillar reinforcement requires replacement. Often we end up cutting an access hole in the upper roof rail aperture to access the weld mount locations. Now we implicate damage to the roof panel when re-installing the window cut, not to mention the additional R&I operations.

Here are a few common vehicle examples. What does the 2015 Camry have for metallurgy? The front lower rail is 440MPa HSS, and inner rocker and upper B pillars are 440MPa HSS/980MPa UHSS/590MPa HSS. Examples of some mixed materials of aluminum and advanced steels can be found in the 2016 Cadillac CTS, where a cast aluminum front wheelhouse is rivet-bonded to the aluminum lower frame rail and tied into the Dual Phase (DP) A pillar extensions. The rocker panel reinforcement is not to be repaired or sectioned because it's UHSS, per a GM position statement.

Another popular vehicle example is Honda's use of 1500MPa steels in eight major structural areas in the ACE-designed Civic. Honda qualifies their repair with the following statement: "1500MPa steel parts must be replaced at factory seams using squeeze-type resistance spot welding (STRSW). Do not section these parts!"

Not only is there a variety of mixed materials for structural enhancements, but replacement procedures can vary widely depending on materials and OEM approaches. Before attaching a structural component, additional homework is required. Although the OEM attachment method may have been spot welds, the replacement call out can range from replacement spot welds, weld bonding, rivet bonding, plug welds, MIG brazed slots, double plug MIG brazed or some combination of any of the methods mentioned.

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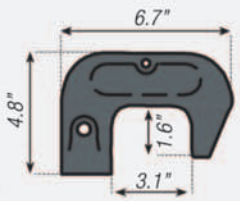
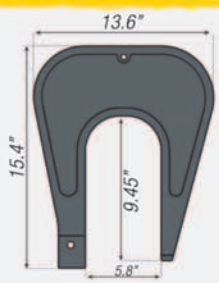


DF-SPRHR1S
Low Profile Arm



DF-SPRHR3
Large Arm

CUT HERE TO CREATE A FLYER

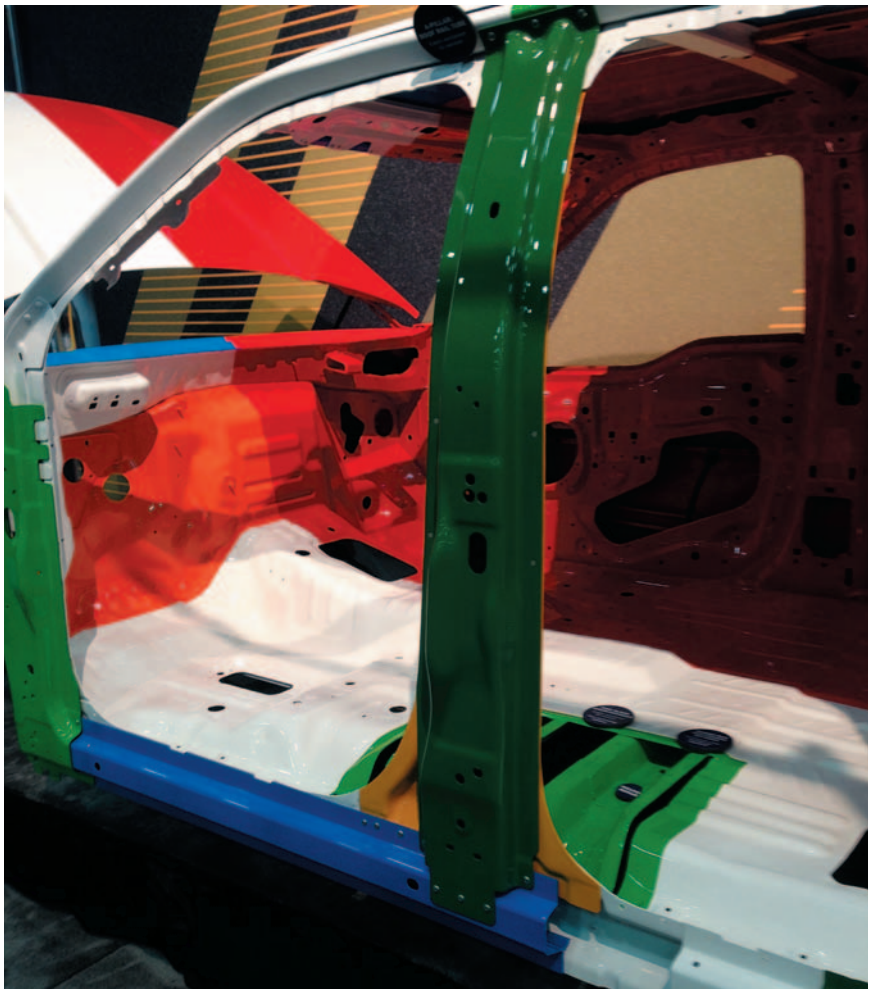
The effect

So what does this do to our estimating and repair plan? What was once considered a repairable panel may now require replacement, depending on OEM position statements of repairability. Is it possible to build a responsible repair strategy without doing the homework first? After all, an estimate could also be considered the repair strategy.

One of the first barriers is the fact that shops are pressured to generate an accurate estimate within hours of the damaged vehicle entering the collision repair facility. Is it plausible that if we only write for what we see, we'll be considerably far off the mark with our starting point? What about taking the vehicle apart, and then preparing the estimate? This is better, but we still need to do our homework before developing a true repair strategy. With an OEM position statement of "Do Not Repair" to an inner B pillar reinforcement, comprehensive measuring would also be needed to identify if it is in fact damaged. Utilizing comparative measurement points on hinge bolts to compare the damaged side to the undamaged side could determine if the inner reinforcement has moved.

Advanced materials have changed the process of how repairs are performed and what can or cannot be repaired. Don't forget that occasionally there will be scenarios where layered outer panels are on top of inner panels beyond the access locations needed for inner panel replacement. Will this require outer panel removal to replace a damaged inner panel? The answer is it depends: an inspection is required for layering and which adjacent panel is covering each other as this is generally not called out in most cases, causing an outer undamaged panel to be removed to access the inner layered panel.

So what's the estimating answer? Here are some observations: before a repair plan is developed, OEM position statements, vehicle repair procedures and damage information should be acquired and considered. Obtaining this information early in the repair process makes sense. Technicians will be following the repair instructions for correct installation anyway, so there is no need for a surprise later in the repair.



THE COMPLETE CABIN STRUCTURE on the 2015 Ford F-150 consists of various aluminum stampings and extrusions.

The blueprinting estimating approach can be an effective tool, but this process alone isn't quite enough to solve all of the problems that arise when estimating a vehicle with advanced construction materials. Having different technicians dismantle and assemble a damaged vehicle can be counter-productive. Can a rotational approach be implemented where the vehicle's primary repair technician is involved with the repair strategy early in the process by assisting the estimator during dismantling while the estimator obtains documentation to support the repair approach? This can create buy-in from the technician and fewer surprises without the frustrations about not understanding how things go back together when repairs near final assembly. This will create a valid "intelligent estimate" with few supplements.

Insurance companies need the supporting information to verify correct repair procedures are adhered to, so that's an upside to the early investment of time. If we think about it, isn't a well-planned repair going to have positives like reducing cycle time and lowered supplement ratios?

Aluminum

What about aluminum? It's been around for years, but only became a viable player in the materials market when the 2025 CAFÉ standard of "54.5 by 25" was intro-

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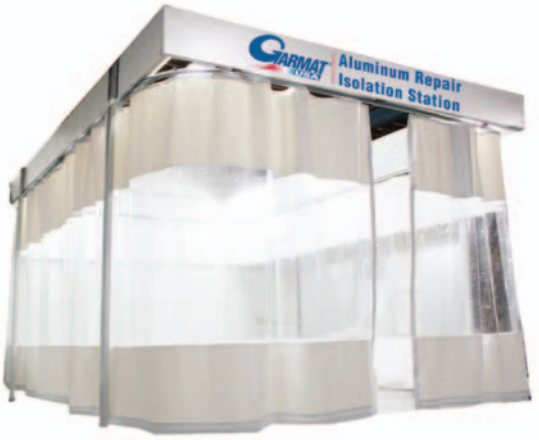
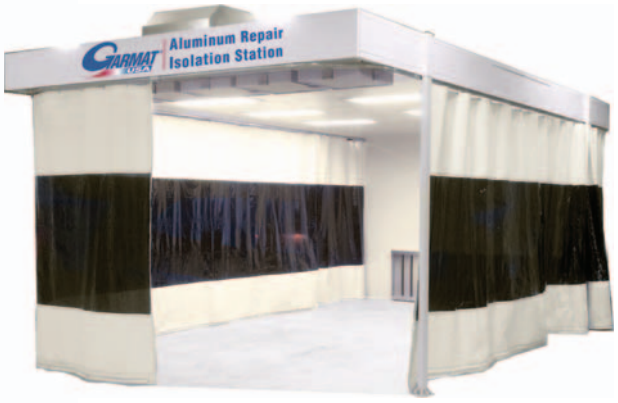


Garmat USA AlumaSAFE50-Plus Isolation Station with Light Ring,Column Supports and Clearview Curtains



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duced. It's lighter than steel and naturally resists corrosion, but how repairable is it?

Although the all-aluminum Audi A8 was built in 1995, and 15 other aluminum-intensive vehicles were released before the 2015 Ford F-150, little was done as far as training the current workforce. The optimism of aluminum coming to market in high numbers was not enough to convince collision repair facility owners to make the investment in training and equipment. Since the release of the 2015 Ford F-150, this has changed. There has been an increase in awareness from the estimating side of things, as well as a degree of retooling to accommodate repairs to aluminum-intensive and aluminum/steel hybrid vehicles.

Aluminum panels vary by OEM in hardness and alloy mix, making some panels easier to repair than others. So how can the estimator predict hours of repair damage on aluminum panels? When compared to steel some additional time may be required for equal amounts of damage in appearance and as with all judgment times, it's someone's opinion. The good news is that with correct repair knowledge and tools, repairs are effective, productive and profitable for shops. As with all panel repairs, choosing repair is a business decision, but the math for aluminum panels favors repair since aluminum parts are typically more expensive than their steel counterparts.

Ford designed the F-150 with ample opportunity for collision repair options and offers access to procedures with PDFs hosted in a variety of locations at no charge to the public. For a repair facility, it means additional tool purchases, including rivet guns, dent removal tools, welding equipment and dust extraction. Self-Piercing Rivets (SPR) are widely used from the OEM, so replacement options include SPR installations combined with bonding. Depending on the repair procedure, a solid rivet installation may be an option in some areas. Ford is against all other aluminum repair procedures.

Since steel particles mixed into an aluminum panel is a recipe for failure due to galvanic corrosion, separating the repair area from steel repairs prevents cross-contamination. Ford allows curtains to temporarily segregate repair stalls, provided that the stalls are cleaned and tools are kept separated from steel repairs. A separate cabinet on wheels and/or tool packages on carts make that an easy task.

Repair planning is crucial when replacing a rivet-bonded panel. Installation must be completed while the adhesives are in the "open" stage. Plus, SPRs expand within the inner panel, so exact lengths of rivets must be installed in the correct locations.

Regarding the F-150, Ford requires that technicians attend I-CAR's "FOR06" prior to repairing the aluminum body truck, but estimators also need this information to properly prepare an estimate. Additionally, technicians need aluminum MIG welding training and certifications before attempting to weld on aluminum. One takeaway from FOR06 for estimating includes Ford's position regarding damage to cosmetic aluminum panels. Ford states the part may be repaired if it is cracked or torn. No different than steel, right?

As to structural: Ford's position is, "if any type of aluminum structural part is kinked, cracked or torn, the part requires replacement." This allows for repair depending on extent and location of damage. Most repairs to aluminum will require heat to the panel to temporarily soften the aluminum. When heating aluminum, Ford cautions not to exceed 425° F and to always monitor heat during repairs to prevent damaging the panel or destroying the adhesives between the panels.

Once trained and tooled up, technicians accustomed to repairing steel usually grasp aluminum repairs quickly and look at aluminum as an opportunity, not a barrier.

Estimating considerations for aluminum cosmetic panels isn't much different from steel when inspecting for damage. OEM statements still apply: For example Honda states "after aluminum dent repair, epoxy prime prior to body filler application." With that in mind, we know cycle time may be longer for repair versus replace, and it deserves consideration during estimating. Generally speaking, aluminum outer panels are considered cosmetic, which allows for repair if it is cost effective.

If a panel installation includes bonding, the required structural adhesives should be line itemed into the estimate for accurate compensation. Whether rivets are included with the panel or need to be purchased separately is another OEM-specific consideration. Specially coated SPRs specific to application are another consumable that should be added to the estimate.

Conclusion

Working with advanced structural materials has forced the collision repair industry to up our game another notch. We must ask this quesion: Is this a barrier or an opportunity? Not wrong, just different, right? There's no doubt these technologies require shops to tool-up and update technician and estimator training and expertise, require vehicle manufacturer's repair information and OEM-specific equipment. The investment in time and money will minimize frustration in dealing with new technology, allowing for a return on investment through proper repairs, lowered liability and a repaired vehicle that surpasses our customer's expectations.

The technology is already being used. Valid, accurate estimating turns into a seamless repair plan. Intelligent estimates result in reduced cycle time, less shop anxiety, improved insurance KPI numbers and satisfied customers to provide excellent CSI numbers and witness a repair that's truly professional.

MEL SCHAMPERS conducts Collision Damage Assessment Training (CDAT) and targeted contracted training throughout the country, with 28 years of industry experience before going into teaching.

UNDERSTANDING CARBON FIBER REPAIRS

WHILE STILL COMPLETED MOSTLY ON HIGH-END VEHICLES, FAMILIARIZE YOURSELF WITH THESE REPAIRS NOW TO PREPARE FOR THE FUTURE

NO SPECIAL TOOLS, equipment or products are needed for repairing structural damage to a carbon-fiber cosmetic part or panel.

DOUGLAS CRAIG // Contributing Editor

Carbon fiber material for car manufacture is popular due to its superior strength and light weight even though it is more costly than metals such as steel and aluminum and traditional composite materials. Carbon fiber is made of thin carbon filaments bound together with a plastic polymer resin to form a composite material. The material features a "woven" design that is exposed for use on exterior vehicle components such as door and roof panels, fenders and hoods. Carbon fiber can also be painted and used on exterior or interior surfaces.

While carbon fiber is becoming more prevalent as a substrate in car manufacturing, it is still pretty much relegated to high-end automobile models. The more complicated production techniques and molding requirements for manufacturing carbon fiber parts keep the costs high. Carbon fiber bodies and/or parts can be found on super-expensive race cars and sports cars, and more recently on "less-expensive" models from BMW, Chevrolet Corvette and Alfa Romeo. As advances in manufacturing technology bring down the costs of using carbon fiber, the material will find wider acceptance in more mainstream vehicles.

According to a report by Lux Research, "Scaling up Carbon Fiber: Roadmap to Automotive Adoption," carbon-fiber reinforced plastics (CFRPs) "will be poised to gain widespread adoption for automotive lightweighting by 2025, driven by a faster-than-expected pace of technology development." The report also notes that the adoption of CFRPs is dependent upon whether "they can become affordable enough for use in mainstream vehicles.

PHOTOS: LORD CORPORATION

Cosmetic vs. structural repairs

It is important to understand the difference between a cosmetic and a structural repair. Most of the repairs will be structural repairs to the cosmetic panels, such as mending a hole in a carbon-fiber panel. Although the cosmetic carbon-fiber panels add some strength to the car, they are not structural to the integrity of the whole vehicle. The majority of the carbon-fiber panels in use now are mechanically fastened to the car, although there are some panels, such as Tesla's, that are bonded to the base structure.

As for choosing the proper adhesive for making a repair, bonding will be done with a urethane or epoxy adhesive, while repair work is always done with an epoxy. The decision centers on the benefit the repair accomplishes for the life of the vehicle. If the damage to the vehicle requires a cosmetic repair to a structural element, then epoxy is the choice. Epoxies are not flexible and will form a solid attachment; urethanes are too flexible for this type of repair.

A repair is considered to be cosmetic when the carbon fiber is not damaged, such as a surface scratch or pitting to a panel. This basic type of repair involves hiding the imperfection and painting the repaired portion. An epoxy filler can be used to make this repair, since it is as rigid as the panel. When damage has been done directly through the carbon fiber part, such as a hole, the damaged fiber must be replaced with a suitable repair fiber and an epoxy.

Carbon fiber repairs

When the actual structure of the vehicle is composed of carbon fiber, repairing damage takes more skill and the repair process is defined by the OEM. Due to the configuration of the carbon fiber material, repair work must take into account how many layers of carbon fiber are involved, along with what type of carbon fiber cloth needs to be installed and at what orientation.

Carbon fiber cloth has a directional weave. The various layers of carbon fiber cloth are rotated — 30 degrees, 45 degrees, 90 degrees — because the cloth has more strength in one direction than another direction. The final part can have as many as 12 to 14 layers or more.

Taking the composition of the carbon fiber material into account, this type of repair is even more critical. To make a repair, you perform a process called "scarfing." In this process, the repair technician uses a tool to grind outwards to expose each layer of cloth and then begins to build the repair from the low center. Each layer of repair carbon fiber must be oriented to match the original structure.

As carbon fiber becomes more mainstream as a manufacturing material, it

will be used in more areas of car design. Since carbon fiber is strong and lightweight, OEMs are using it as reinforcement in A or B pillars, rocker panels and roof rails on vehicles. Carbon fiber is also being used as an alternative to "fiberglass" or sheet molded compound (SMC). As an example, the hood on a current production car is comprised of 50 individual pieces of carbon fiber. The carbon fiber is pre-impregnated (prepreg) with end resin. All the pieces are placed into a mold in a specific layering orientation. The mold is heated and the part is formed. With this procedure, the OEM obtains the moldability of SMC, and the strength and light weight of carbon fiber, in addition to a lowered cost suitable for high-volume operations.

The crucial question that has to be answered when deciding to repair or replace a carbon fiber part is: Will the repair be strong enough to survive the life of the vehicle? If a damaged carbon fiber part has a hole in its center, that repair will be strong since it is surrounded by support. If a carbon fiber part is missing a corner piece, such as a corner broken off of a hood, can that part be repaired or does a new hood have to be ordered? Because the repair area is hanging off the edge of the hood panel, will the repair be strong enough for the lifetime of the vehicle? The final decision rests on what the part to be repaired is going to be subjected to through its life, where it "lives" on the car and how detectable the repair will be.

You can use a generic carbon fiber cloth or repair cloth, which can be kept in stock, for performing structural repairs to a cosmetic panel (such as a small hole). When damage to the carbon fiber part is more severe, or damage to the vehicle structure is being repaired, specific carbon fiber material must be used. This type of material, especially pre-preg versions, cannot be kept in stock. Pre-preg carbon fiber cloth must be stored at -40 degrees. It is shipped on dry ice and has a very short life span once it is removed from the shipping container. The material cannot be stored; it must be cut to fit and installed as quickly as possible. These repairs are very manufacturer/vehicle-specific, so check with the OEM before attempting repairs on carbon fiber parts that display significant damage. Furthermore, additional repair equipment and training will probably be required.

Choosing a repair product

Basic repairs to carbon fiber parts are not difficult to execute. No special equipment, tools or products are needed for repairing structural damage to a cosmetic part or panel. Most repair shops should have an epoxy on-hand for small repairs to a cosmetic panel and urethane for

CARBON FIBER consists of thin carbon filaments bound together with a plastic polymer resin to form a composite material.

WITH STRONG, lightweight properties, pre-impregnated (pre-preg) carbon fiber is as an alternative to fiberglass and sheet molded compound (SMC).

bonding a carbon fiber panel to a vehicle. Repair technicians should be familiar with how to use these adhesives. There are no differences when repairing carbon fiber parts and SMC panels.

If a repair technician is not sure which adhesives to use, check with the OEM and the supplier. It is important that the repair technician understands the capabilities of the adhesive. Be sure that adhesives formulated for fiber-reinforced plastic and fiberglass repairs can also be used on carbon fiber material. Consult with the supplier for information on which adhesives are suitable for carbon fiber repairs.

When bonding a carbon fiber panel to a vehicle, rely on OEM information. You don't want to "overbond" a panel or make the attachment too rigid. Remember that the carbon fiber material is different from the vehicle's steel or aluminum structure; it is important to accommodate for the expansion, contraction and twisting nature of the carbon fiber part.

Carbon fiber education

Several training programs are available, such as Abaris Training and I-CAR Alliance courses, for those interested in learning more about carbon fiber repairs.

Abaris Training offers a variety of courses in advanced composite structures engineering, manufacturing and repair. The repair courses offer hands-on practice to provide students with the knowledge needed to conduct top-quality repairs in an efficient manner. Among the courses available are "Advanced Composite Structures: Fabrication and Damage Repair" and "Adhesive Bonding of Composites & Metals."

I-CAR (Inter-Industry Conference on Auto Collision Repair) Alliance programs bring together technical training providers to optimize educational efforts in the collision industry. As an example, the Fusor 003 Composite Repair & Bonding course provides instruction on making OEM-approved repairs using LORD products.

The course covers the techniques, procedures and safe use of adhesives and seam sealers; how to select the proper product for each type of repair; and surface preparation for the best repair results. Upon completion of the course and exam, the attendee can apply for I-CAR Alliance credits.

Repairing damage to carbon fiber cosmetic damage is similar to fixing damage to any composite panel — just make sure to use a fiber-rich adhesive to ensure the repair will be long-lasting with no read-thru. As more OEMs use more carbon fiber material in car manufacture, there will be more damaged carbon fiber vehicles needing repair, and a knowledgeable repair technician should be ready to make the repairs properly.

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JOINING METHODS FOR TODAY'S MATERIALS

KEEP IN MIND THAT WELDING IS NOT YOUR ONLY OPTION

JASON BARTANEN // Contributing Editor

An industry colleague once asserted, "Saying 'I believe I can repair anything' is no longer the case. Technicians need to be courageous enough to say 'I need training in order to repair this vehicle properly.'"

This quote applies not only to training, but also to actively researching OEM information to ensure that all collision repair technicians are following the vehicle-maker recommendations for repair. Today's vehicles are vastly different than those of just a few years ago. The use of new steels, aluminum, carbon fiber, and other materials require new repair methods and new tools and techniques for joining to achieve complete, safe and high-quality repairs.

As the use of different materials continues to grow, the collision repair industry will be faced with new challenges, not only for repairability but also for the joining technologies that will be required to replace parts on these vehicles. The vehicle makers continue to evolve their attachment methods, but many of the technologies they use today and will be using in the future cannot be duplicated during the collision repair process. Laser welds, friction stir welds and spot welding of aluminum and dissimilar metals all are techniques that are impossible today for repairers. These technologies will likely not make it to the collision repair industry anytime soon; perhaps never. This will require repair professionals to rely on OEM information more than ever.

GMA (MIG) welding

While GMA (MIG) welding has been the preferred welding method for the past 30 years, we've seen a significant change in recent years, and I expect we'll see a decline in the number of vehicles that require GMA (MIG) welding for part replacement. We also will expect to continue to see an increase in the number of vehicle makers that warn against using this process for repairs on vehicles that employ a high level of high- and ultra-high-strength steels (HSS and UHSS). This is due to the heat-effect that GMA (MIG) welding produces on HSS and UHSS. GMA

THIS PIECE OF EQUIPMENT not only allows for aluminum welding, but also MIG brazing and steel GMA (MIG) welding.

PHOTO: PRO SPOT

(MIG) welding heat damages the areas adjacent to the weld and can potentially produce an inferior repair. It's imperative to follow the vehicle makers' recommendations for when GMA (MIG) welding is acceptable.

In addition to determining if the vehicle maker has specifications for the welding equipment, it also important to identify the type of electrode wire the vehicle makers recommend. While conventional ER70S-6 remains the preferred electrode wire for many vehicle makers that allow GMA (MIG) welding, there are a handful of recommendations for ER70S-3 from some vehicle makers. With regard to Honda GMA (MIG) welding, where allowed, they have an additional consideration.

For steels up to 440 MPa, Honda allows conventional ER70S-6. For steels above that up to 990 MPa, Honda had previously required an electrode wire from Bosch: DS980J. That wire has now been replaced with new electrode wire, available from https://www.technicaltools.net/ (part number HWW-98008). Honda also requires an 80/20 mix of Ar/CO_2 (C20), not conventional 75/25 (C25) shielding gas. More information on Honda's welding requirements can be found at the I-CAR Repairability Technical Support (RTS) Portal (i-car.com/rts). Login information is required.

Squeeze-Type Resistance Spot Welding

Squeeze-Type Resistance Spot Welding (STRSW) has become the welding method of choice for many of today's steel vehicles, especially those with a significant use of HSS and UHSS. While each OEM may have welder specifications for spot welding equipment, STRSW is accepted — and more often than not preferred — for collision repairs on late-model vehicles. Additionally, some OEMs require STRSW for certain applications and warn explicitly against GMA (MIG) welding. Repairability guidelines from Ford Motor Company, General Motors, Fiat Chrysler and others outline which welding methods are acceptable and should always be adhered to. As mentioned earlier, Honda has published welding guidelines that are available to the collision repair inter-industry. Deviating from the vehicle maker recommendations may produce an inferior repair and may open the door for a potentially litigious situation.

MIG brazing

MIG brazing has started to gain popularity in recent years among some OEMs, and this momentum will continue to build over the next several years. MIG brazing is different from the oxy-acetylene brazing you may have learned years ago. While the principles of capillary action are similar, MIG brazing is done with much less heat. This limits the heat-affect on HSS and UHSS and leaves more of the corrosion resistant coatings intact.

Honda has been the biggest proponent of MIG brazing, beginning with the launch of the 2013 Accord and its 1,500 MPa A- and B-pillar reinforcements. The use of 1,500 MPa steels in Honda and Acura vehicles continues to grow and is now being leveraged for the rear rails on the 2016 Civic sedan. Honda requires MIG brazing for any 1,500 MPa steel that cannot be spot welded. There are several locations on each of the models that leverage this type of steel. If you repair late-model Honda and Acura vehicles, you must have equipment capable of MIG brazing in the pulse-synergic transfer mode. More information on HSS/UHSS repairs to Honda vehicles can found in the Honda & Acura High-Strength Steel Repair (HON11e) course, offered through I-CAR at i-car.com. Other vehicle makers that allow, or recommend, MIG brazing for repairs include GM, Ford, Jaguar and Land Rover.

If you are unfamiliar with MIG brazing, I-CAR now offers two courses on this subject. MIG Brazing Theory (BRZ01e) is a one (1) credit hour online course that covers the MIG brazing process, equipment options, techniques, and other pertinent information. The new I-CAR MIG Brazing Hands-On Skills Development (BRZ02) offering is an in-shop, instructor-led training program designed to teach technicians how to set up MIG brazing equipment and make common MIG brazing welds, including slot welds, open butt joints and Honda's double plug on lap welds.

The instructor and student(s) work with the repair facility's equipment to ensure the best possible learning environment. The course is a great primer for students enrolled in Jaguar/Land Rover's (JLR) network. JLR students, as part of JLR's Global Learner's Journey, are required to successfully pass a challenging hands-on welding assessment that includes numerous MIG brazing joints.

Adhesive bonding

When adhesive bonding first became popular for collision repairs, it was limited primarily to exterior panels such as door skins, roofs and quarter panels. Since then, much has changed and adhesives are becoming a requirement for many different repair procedures, usually in conjunction with welds (weld-bonding) or rivets (rivet-bonding).

Adhesive bonding technology has evolved over the past 10 years and is a common replacement requirement for a lot of unitized structure parts as well as exterior panels when used in conjunction with welds or rivets. Similar to all other attachment methods, the only way to determine if adhesives are required and which type of adhesive is to refer to the vehicle maker part replacement procedures. This has become even more critical with the arrival of some of the newer structural adhesives. These adhesives are different than panel replacement adhesives should be used where specified by the vehicle maker.

Adhesives offer benefits in addition to providing a strong bond between panels. Adhesives are often used to provide improved noise, vibration and harshness (NVH) prevention and offer a way to improve corrosion protection from panels that may otherwise be corrosion hotspots when factory e-coat and other coatings are removed. Adhesives also offer protection when joining dissimilar materials, such as aluminum and steel. This aids in the prevention of galvanic corrosion that can occur between dissimilar metals when exposed to moisture and air.

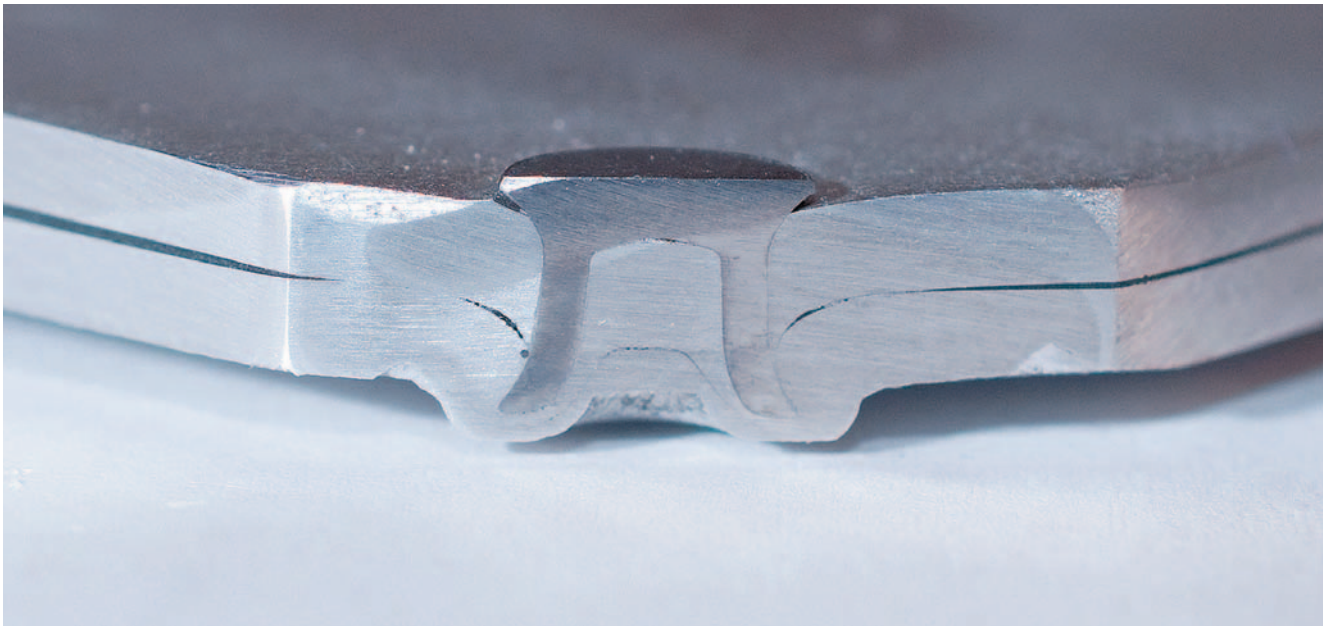
Rivets

Rivets have been used for several years on aluminum-intensive vehicles from Jaguar/Land Rover and Audi, but have gained significant popularity with the launch of America's most popular vehicle, the Ford F-150. Although welding is an option for some panel replacement procedures, rivets are the most common attachment method on the F-150.

There are a variety of rivet types that collision repairers will encounter from the vehicle maker and during the repair process. It's important to note that often the replacement rivet will be different from the vehicle maker installed rivet. It's important to not only identify which rivet is used by the vehicle maker (this will help determine the best removal process), but it's important to know which rivet(s) are required for part replacement procedures.

The most popular vehicle maker installed rivets are self-piercing rivets (SPRs). SPRs allow the vehicle maker to leverage rivets without the requirement of pre-drilled holes. SPRs do exactly as their name implies: they self-pierce the panels, creating their own bucktail when the SPR meets the die on the SPR gun. For repairs, SPRs are replaced with a new SPR (adjacent to the original SPR hole), blind rivets or welds. To determine if an SPR is allowed for replacement, refer to the vehicle maker repair procedures. This will also help identify the diameter and length of the SPR. When removing and installing SPRs, it's imperative that the technician uses the correct SPR to match the material and length of the rivet. If the SPR is slightly too long or too short for the application, the joint can fail. Using the correct dies is also very important. Incorrect dies can cause damage to the panels, rivets and rivet gun dies, and replacement of dies on a regular basis quickly will become a costly venture. SPRs require access to both sides of the panel for installation.

Blind rivets often are used when replacing panels that were installed with SPRs from the vehicle maker. When SPRs are removed, holes are left in the panels. Blind rivets allow for installation of replacement panels using the hole that remains on the vehicle. Similar to SPRs, it's important to install the correct diameter and length blind rivet. Blind rivets are also installed by the vehicle maker and may be replaced with a blind rivet or



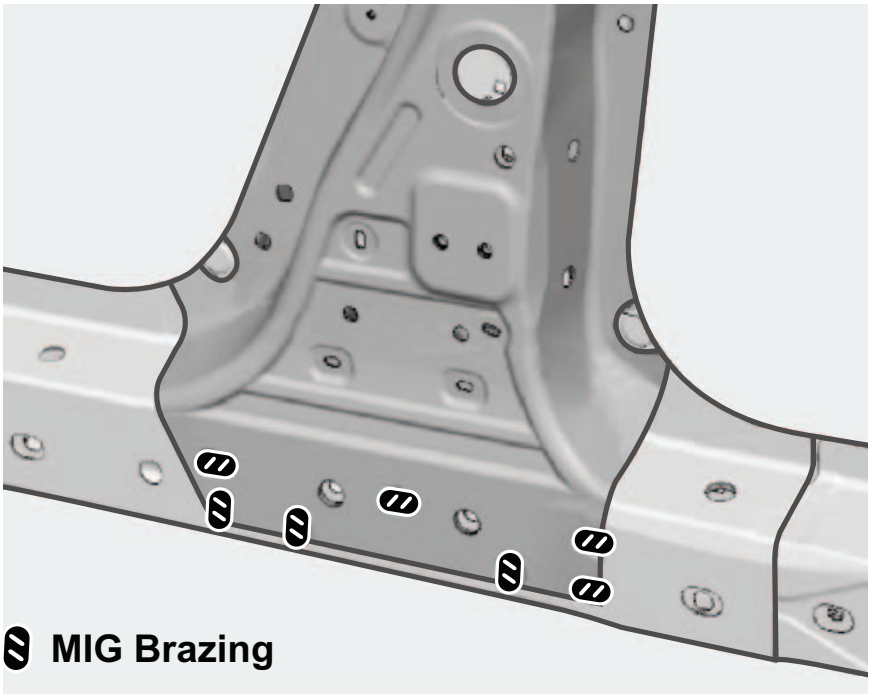
PHOTOS: I-CAR

THIS SELF-PIERCING RIVET (SPR) cutaway shows how the rivet holds the panels together.

sometimes by an aluminum weld. Blind rivets only require access to one side of the panel.

Solid rivets are another type of rivet that may be recommended by the vehicle maker. Ford, for example, has a number of locations on the F-150 where solid rivets can be used. Similar to blind rivets, a hole is required for installation of solid rivet, but it also requires access to the panel backside to allow for the use of a bucking bar to create the solid rivet bucktail.

If you've recently purchased a self-piercing rivet gun and are looking for expert training on its proper use, I-CAR now offers a Rivet Bonding Hands-On Skills Development (RVT01) course. Similar to the MIG brazing course, this course is delivered in-shop, with the repair facility's equipment.



THE BASE of the Accord B-Pillar reinforcement requires several MIG braze points.

Other mechanincal fasteners

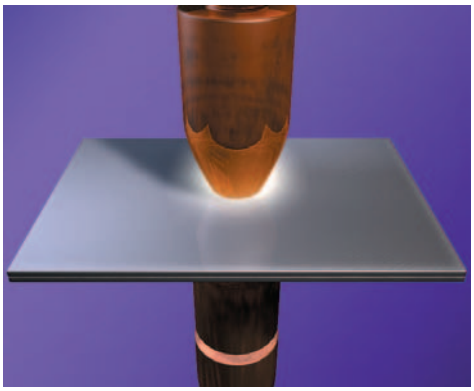
There are a couple of other mechanical fasteners that collision repair professionals may encounter on today's late model vehicles. Flow drill screws (FDS), such as EJOTs, may be used for some vehicle maker attachment methods when only one-sided access is available. FDS are similar in appearance to a sheet-metal screw and during vehicle manufacturing are rotated at a high rate of speed until the base material begins to soften. The FDS then pierces the material, creating its own threads to attach to. When the material cools and solidifies, a secure joint is created. Some vehicle makers allow FDSs to be reused if the threads aren't damaged. If the threads are damaged, FDSs are replaced with rivets. Some vehicle makers have oversized FDSs that can be used when the original threads are stripped.

Clinches are primarily used by the vehicle maker and don't often require any

type of replacement procedure other than on some door skins in the belt-line molding area. If clinches require replacement they are replaced with rivets.

Aluminum MIG welding

Aluminum MIG welding is allowed for a number of different repairs, and technicians should be familiar with the equipment requirements and differences in techniques between steel and aluminum welding. It's also important to be familiar with aluminum MIG welding for repair facilities considering getting involved with some of the OEM aluminum repair networks, such as JLR, Audi, Tesla, Mercedes-Benz and Ford. I-CAR offers an Aluminum Welding Training and Certification (WCA03) program to teach technicians how to set up their equipment and how to make some of the welds they may encounter when repairing aluminum vehicles. The course is also a great way to prepare technicians in advance of attending a multi-day OEM welding assessment, including the ISO 9606-2 certification.



SPOT WELDS are created as resistance builds, fusing two— or more —sheets of steel together.

Future joining technologies

There are some additional joining techniques that have started to appear. Many in the collision industry have questioned what, if any effect, these new methods will have on the repair process. Processes such as friction stir welding, aluminum spot welding, and steel-to-aluminum spot welding are a few that have been noted recently. Fortunately for collision repair professionals, these vehicle maker attachment methods will have minimal impact on the repair process. If there are replacement procedures available for parts installed with these techniques, they will likely include one, or more, of the aforementioned collision repair attachment methods.

Conclusion

As vehicles continue to evolve and vehicle makers expand the use of HSS, UHSS, aluminum and mixed materials, the attachment methods used will continue to evolve. A few key takeaways to consider:

- Conventional steel GMA (MIG) welding will continue to decrease for part attachment; however, we'll continue to see it leveraged for sectioning and welding in areas where there is no backside access for spot welding.
- STRSW will continue to grow as the preferred attachment methods for steel-intensive vehicles.
- MIG brazing will be increasingly popular for vehicles that are primarily steel structured in areas where spot welding arms cannot access the weld zone.
- Adhesives, in conjunction with other attachment methods, will grow in popularity for both vehicle manufacturing and collision repairs.
- Rivets and flow drill screws will continue to grow in use for not only aluminum-intensive vehicles, but also many steel applications and for vehicles that use a mixed-material architecture.

Today's and tomorrow's vehicles are different than the vehicles we've been repairing in the past and each new model year will present the industry with new challenges. The only way to ensure complete, safe and quality repairs is through adoption of new tools and equipment, training, and access to vehicle maker technical information.

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YOU ALREADY ARE SEEING THE FUTURE

RIVET and bolt bond procedure

A LOOK AT ADVANCED MATERIALS, METALLURGY AND ESTIMATING

LARRY MONTANEZ // Technical Advisor

Welcome to the future and what the future holds for the collision repair industry. Today's vehicles are constructed out of materials found on the space shuttle and more computers and electronics than the spacecraft used in the first 30 years of space exploration. Today's collision repair damage assessors (estimators) need to lead by example and set the bar higher.

Too many times we see that many are just data entry people with no real knowledge of vehicle construction, design, technology or repair protocols. I cannot tell you how many times I have spoken to a group and asked, "How many estimators are here by a show of hands?" and most of the class raised their hands. I then ask, "How many of you have I-CAR training?" and still most of the hands stay up. But when I ask how many are ASE certified, I wind up with only a few hands left.

Then I ask how many are on a certified OEM program from a European OE or Tesla, and that is when I realize why the hands of those few are still up. The European OEMs and Tesla are forcing their program shops to excel and train. Cadillac seems to be doing the same thing with the CT-6 program. But this is not the masses; it is the minority that is excelling and making the effort. The masses need to change their way of thinking and get on board with training and education or be left behind.

Metallurgy and advanced substrates

Metallurgy is the study of the structure and properties of metals; their extraction from the ground; the procedures for refining, alloying and the forming of components from them, such as full frames, monocoque stampings, structural parts and body panels for automotive use. This includes both steel and aluminum of various grades of strength. Damage assessors (estimators) need

PHOTOS: LARRY MONTANEZ

to understand these scientific principles and vehicle design to better determine the full extent of sustained damage. Additionally, damage assessors will also need to understand what the strengths of these materials are to determine repair vs. replace decisions, what may or may not be sectionable and what requires full component replacement.

Classifications for steel are different between the USA/Asian and the European vehicle makers for the same materials. Let's look at the comparison:

USA and Asia/Europe

• Low Strength (Mild Steel)/Standard Steel

• High-Strength Steel/High-Strength Steel, Higher-Strength Steel, Ultra-High-Strength Steel

• Ultra-High-Strength Steel/Highest-Strength Steel, Maximum-Strength Steel, Ultimate-Strength Steel

Although the classification names might differ, if we look at the material strengths, pounds per square inch (psi) of MegaPascal (MPa) we have a better understanding of the material we are working with.

• Low Strength/Standard Steels are steels that are 270MPa/39,160psi

• High-Strength Steel are steels that are between 271MPa/39,305psi to 700MPa/101,526psi for the USA and Asia.

The Europeans also use the 271MPa to 700MPa range, but split this classification into three different sub-categories. The low grade is called High-Strength and ranges from 271MPa to 400MPa/58,015psi; the next is the medium grade High-Strength called Higher-Strength, which ranges from 401MPa/58,160psi to 550MPa/79,770psi; and the top level in this category is the Ulta-High-Strength Steel, which ranges from 551MPa/79,915psi to 700MPa.

USA and Asia	Europe
Low Strength (Mild Steel)	Standard Steel
High-Strength Steel	High-Strength Steel, Higher-Strength Steel, Ultra-High-Strength Steel
Ultra-High-Strength Steel	Highest-Strength Steel, Maximum-Strength Steel, Ultimate-Strength Steel

Ultra-High-Strength Steel in the USA, Asia and Europe is any material stronger in strength then 700MPa. Once again, this category is broken into three sub-categories. The lower grade Ultra-High Strength Steel, Highest Strength Steel ranges from 701MPa/101,671psi to 900MPa/130,534psi; the medium range Maximum-Strength Steel ranges from 901MPa/130,679psi to 1500MPa/217,556psi; and the highest category is the Ultimate-Strength Steel, which is 1501MPa/217,701 and higher. This category is also referred to as Advanced-High-Strength Steels.

Information analysis

The OEM repair information is paramount to writing a proper and accurate damage report (estimate). The damage assessor must check in the construction materials section of the OEM repair information to know what type of substrate it is and the strength of the component. Additionally, the assessor must check the repair procedures to know if sectioning or full components replacement is required, along with the required materials and additional labor. Today's damage assessor needs to know how to properly repair vehicles and have the documentation to prove it; assuming is not the answer.

In the coming years, OEMs will be producing not only hybrid construction vehicles, such as the Mercedes-Benz C and S-Classes, Audi TT and Q7, Cadillac CT-6, Porsche Panamera and 911 to name a few, but mixed-material vehicles (steel, aluminum, composites) such as the Audi R8 and BMW 7 Series, which a constructed from various grades of steel, aluminum and carbon fiber reinforced plastic (CFRP). Training for the technicians, the damage assessors and insurance personnel will be required. For Model Year (MY) 2016, Honda released a newer version of their Advanced Compatibility Engineering (ACE) body structure, which has specific areas that will crumple intelligently in a collision event and direct the collision impact forces away from the occupants. Additionally, Honda introduced their 3-Bone Platform Structure, which improves impact load management around the passenger compartment while reducing overall weight. The floor pans contain additional reinforcements strategically placed to direct the collision pulse through the floor pan. After a collision, these reinforcements will require inspection, and if damaged, must be replaced. The new 3-Bone floor pans are Advanced

MERCEDES-BENZ quarter panel replacement

High-Strength Steel (590MPa-780MPa).

BMW introduced the new redesigned 7 Series for MY2016, and it is constructed with Advanced High-Strength Steels, aluminum and carbon fiber. Carbon fiber is used for inner structural reinforcements. BMW has stated that this design will be utilized on the 5/6 Series and X5/X6 SAVs in MY2017. Repairing aluminum has been a major issue for most of the shops that are not involved in the European aluminum OEM programs, and carbon fiber will be just as difficult for the masses as we see mixed-material vehicles on the economical vehicles.

Estimating

A big misconception in the industry is the reparability of some of the materials, such as the Advanced HSS and aluminum. Structural aluminum for the most part cannot be repaired. Some OEMs allow movement of only +/- 3mm to be repaired on aluminum structural components. Fractures (rips/tears), cracks, stress markings, significant bends or kinks to aluminum cannot be repaired and must be replaced. Aluminum outer cosmetic panels in some cases may be repaired, but the technician must be proficient with metal shaping and not sculpting with body filler. B-Pillars on almost every vehicle made in the past five years have a reinforcement that is constructed from Martinsite (Hot-Stamped) or Boron alloyed steel. Any displacement and/or deformation of the reinforcement requires replacement of the reinforcement. Always check with the OEM procedures prior to attempting any repair.

Adding to this issue of advanced material is all of the electronics and safety features in vehicles. Today's electronically advanced vehicles are driven by multiple computers all communicating with each other. For years OEMs have required scanning to relearn or reset systems, but this information was buried in the mechanical information, and too many collision repairers were too lazy or uneducated to look at the mechanical procedures. For this reason we are seeing OE after OE issue position statements about pre- and post-scanning.

Another thing this industry needs to understand — both repairs and insurers — is that many of the outside-view mirrors are now equipped with not only blind-spot warning sensors and LEDs, and lane departure radar/sensors, but now many OEMs are installing the side-view camera for the all-around camera system. Thus, replacing a side-view mirror assembly on the door will now require the alignment and re-initializing of the camera to the system and the aiming of the camera if necessary. Because of the back-up cameras, this procedure many times will require a four-wheel align-

ment. Additionally, vehicles with autonomous features also require four-wheel alignments when cameras are moved or replaced.

Any shop's SOPs must include the following:

• Complete description of the event, who was in the car, weather conditions, road conditions, what was impacted, any issues observed now, day or night, etc…

• Pre-wash vehicle to better view the damage and to ensure all dirt, grime, grease, debris and waxes are removed prior to repairs.

• Walk around the vehicle and start your analysis in the opposite corner of the impact.

• Take photos overall and drill in close-ups.

• Take notes.

• Pre-scan the vehicle.

• Check with the OEM repair information for procedures and inspections required after a collision.

• Pre-measure the vehicle mechanically with quicks checks. If any deviations are discovered, pre-measure the vehicle with 3D electronic measuring equipment and also measure the suspension components (EME 54® Theory).

• Write the damage report, and check with the repair procedures for operations and required materials (foams, rivets, adhesives, FDS, etc). While you are doing this, have the vehicle disassembled for more analysis.

• Review the damage report after the vehicle is disassembled and make any additions or corrections.

• Check all parts prices from the OEM.

• Print a final copy and work order, and conduct a meeting with the foreman, technician and parts manager.

• Place the vehicle in the waiting area for all parts to arrive.

• Wrap and store all reusable components.

By adhering to these SOPs you will ensure the following:

1. Damaged components and procedures were all addressed and no hidden or unknown damage will be discovered (supplement).

2. This is basically your final invoice, except for the dealer services (wheel alignment, scanning, resets, etc.). Changes in judgement labor times are either additions or subtractions.

3. There will be little to no delays in the repair, as the vehicle was fully examined and diagnosed, and there wil be no surprises.

4. There will be no wasted time on supplements, because all the damage was viewed up front.

5. There will be better utilization of equipment and man power, as vehicles will move smoothly through each department and not be delayed waiting for parts due to unseen damage.

Due to the complexity of today's vehicle designs and substrates, damage assessors need to understand what it takes to structurally repair a vehicle and how it must be affixed to the structural realignment apparatus or bench (frame machine). Two hours has never been a standard, and it has never been a body labor operation. There are some vehicles that will take 2.0 hrs and others can be 7.0 hrs for the set up and removal and storage of anchors. Damage assessors must be fully educated in what the operations and tasks are and how to calculate them. The amount of time required to affix the vehicle to the bench would be dependent on what type bench system you are using. Some examples would be:

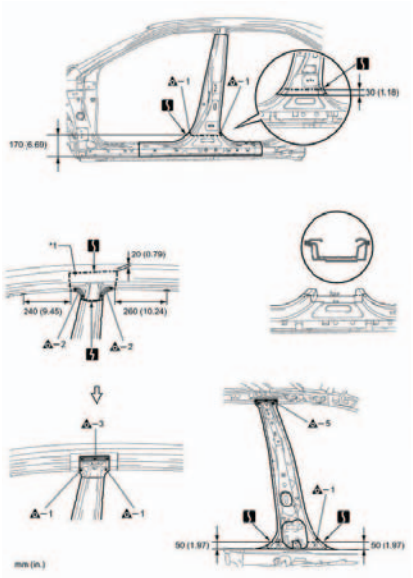
• Affixing the vehicle to a Celette Bench, which requires renting dedicated fixture jigs

• Affixing it to a CarBench/Global Jig, which would require building the universal jigs for the specific vehicle.

• Affixing it to a Car-O-Liner, which would require building the EVO jigs for each vehicle application

• Or does the vehicle maker allow standard pinch weld anchoring to a standard bench, like Chief or another universal machine like Spanesi?

Damage assessors need to acquire the knowledge of the required operations and tasks, as the times for the procedures for these different apparatuses vary greatly. Today's vehicles require very little structural realignment time (pull time) and much more time to anchor them to the bench. You must also consider the additional — not included, but required — operations that damage assessors must address, calculate and charge for.



2015 TOYOTA CAMRY sectioning center body pillar

To sum it up, today's damage assessors, technicians and insurance adjusters must think differently and make attempts to go to training and learn more about the industry. People's lives are at stake and many seem concerned with profits and loss statements and alphabet acronyms like KPI, GP, NP, CSI, DRP, etc., but not with proper repairs following the OEM procedures. Today's vehicles are so far advanced that we can no longer assume and make business decisions, as doing so could expose not only the shop to a lawsuit but the damage assessor and technician, too.

LARRY MONTANEZ is co-owner of P&L Consultants, which works with collision shops on estimating, production and proper repair procedures. He is also a certified technician for multiple OEM collision repair programs.
info@PnLEstimology.com

GROWTH IN ELECTRIC VEHICLES

THE TESLA Model S

PHOTO: TESLA

WHILE THEIR NUMBERS DO NOT REPRESENT A LARGE PORTION OF VEHICLES ON THE ROAD, THESE CARS AND SUVS ARE GROWING. HERE'S HOW TO BE READY TO REPAIR THEM.

BRIAN ALBRIGHT // Contributing Editor

Electric vehicles (EVs) are just a tiny minority of vehicles currently on the road, but the category is poised for significant growth over the next 10 years. That means collision shops will see more and more of these vehicles in their bays, and they need to be ready for them. EVs pose unique repair challenges that will require shops that service them to invest in training, equipment and safety gear that will be necessary to handle these cars' dangerous high-voltage batteries.

Right now, EVs are less than 1 percent of light duty vehicle sales. Research from Bloomberg New Energy Finance suggests that EVs could be 35 percent of new light duty vehicle sales by 2040, almost 90 times the figure in 2015. Just last year, EV sales of 462,000 represented a 60 percent increase over 2014.

Tesla, Chevy and Nissan all plan to sell long-range electric cars in the $30,000 price range, which should boost market penetration even more. The Tesla Model 3, for example, will cost around $35,000 when it is released in 2017. Anticipated demand for that vehicle may very well push Tesla over the 500,000 annual production mark by 2018.

By the end of Bloomberg's forecast period, there will be EVs available that cost less and perform better than their gas-powered equivalents.

The number and variety of hybrid electric vehicles and EVs continues to increase, making it more and more likely that your collision shop will encounter them. These new EVs require special handling when they've been in a collision to ensure the repairs are completed correctly and so that technicians can avoid injuring themselves.

There are two general categories of EVs. Some, like the Nissan Leaf, rely entirely on their batteries for power. There are also hybrid electric vehicles (the Chevy Volt leads this category) that have a gas engine as a backup/range extender. In either case, shops working on these vehicles will need to have the proper train-

THE CHEVY VOLT includes a manual service disconnect (MSD) used to interrupt the high-voltage circuit within the drive motor battery.

EV BATTERIES should be recharged before returing a vehicle to its owner; the batteries can discharge on their own if the vehicle sits too long.

PHOTOS: GENERAL MOTORS

ing and equipment on hand to complete a safe repair.

Unique requirements

Tesla is unique among the OEMs in that it doesn't have a traditional dealer network outfitted with service centers. Thus, Tesla has established a certification program for collision shops that can work on its cars. Rife's Autobody in Columbus, Ohio, is one of the few shops in the Midwest that Tesla asked to join its shop program. According to manager Mike Troxel, Tesla approached them because of their existing certification to work on other high-end and foreign vehicles. "They were looking for someone in this region, and we thought it was a fairly prestigious opportunity," Troxel says.

Rife's technicians went to California for training, which included a week-long exam on the aluminum welding procedures, a week of structural repair and a week of learning about the mechanical and computer systems. The shop also had to purchase welders, rivet guns, hand tools, a battery table and other equipment. Tesla also requires that the vehicles be repaired in a specified area of the shop (since the vehicle is aluminum, this is necessary anyway.)

"It's electric and aluminum, so you can't pull it, or you'll risk totaling the car," Troxel says. "If you don't know how the car is put together, you are going to create more damage. You need to make sure you have the power disconnected, and make sure you know what parts you are dealing with."

Each EV requires its own specific training and equipment, and each poses different challenges from a collision repair perspective. For example, while the Tesla is made of aluminum, the Chevy Volt contains a lot of high-strength steel.

There are common considerations across most models, however. The high-voltage batteries, if not handled properly, could provide potentially lethal shocks to technicians and other staff. The regenerative braking systems can produce enough of a shock to injure someone. Heat can also damage the batteries, which means that technicians should follow manufacturer procedures if the vehicle has to bake in the booth.

Battery considerations

Repair procedures for most EVs are going to be similar to gasoline vehicles made of the same materials. The critical difference in working on these vehicles are the safety considerations related to handling the battery — an issue that many shops have already faced when working on existing hybrid vehicles like the Prius.

"In a way, EVs are very similar to hybrid vehicles in that they have high-voltage battery packs and high-voltage wiring," says Eric Pruden, automotive technology

RIFE'S AUTO BODY in Columbus, Ohio, is one of the few shops in the Midwest that have been certified by Tesla to repair its vehicles.

EACH ELECTRIC VEHICLE requires specific training and equipment to ensure that proper repairs are made.

ONE BIG CHALLENGE with repairing EVs is that you have to know which components can be repaired and which components have to be replaced.

PHOTOS: RIFE AUTOBODY

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Shops will need to invest in high-voltage personal protective equipment (PPE). The PPE should include eye protection and sets of rubber-insulated lineman's gloves that are rated at 1,000V AC (Class 0). These gloves must be inspected carefully before and after each use. If the gloves are damaged, they can allow electricity to leak through, injuring or killing the wearer. To test the gloves, roll the cuffs and inflate them to test for leaks. You can also wear a second pair of leather work gloves over the lineman's gloves in order to prevent damaging them when working around sharp metal or glass.

"We highly recommend to our students that they have leather gloves over the rubber gloves, because it will protect the gloves that protect the wearer," Pruden says. "You always check them before and after they are used."

Lineman's gloves also have an expiration date. "Even if you don't use them, you have to change them out after that date," says Kye Yeung, owner of European Motor Car Works in Santa Ana, Calif., another Tesla-certified shop. "We test them with a machine that fills them up with air to check for leaks. That high voltage could go through a pinhole and into a person."

When working with high-voltage vehicles, employees should also have access to a safety hook to safely pull a technician away from the vehicle in an emergency.

Each type of EV or hybrid has different procedures for disarming the high-voltage battery. Generally, you should check for any warning lights, remove the key and access the high-voltage disconnect switch. In the case of the Volt, there is a manual service disconnect (MSD) that is removed to interrupt the high-voltage circuit within the drive motor battery.

Double check that the system is disarmed using a high-voltage meter to ensure the system is actually safe before performing any work. If the area where the switch is found is damaged, there are usually alternative methods for disarming the system (such as removing a fuse). High voltage wires (which should be clearly marked) will also need checked for damage and replacement.

"You may need to remove the battery pack completely, depending on where the vehicle is damaged," Pruden says. "You have to isolate the power at the battery, and be able to power down or discharge the capacitors in the vehicles so no energy is stored."

Whoever disarms the battery also needs to make sure other employees know whether the vehicle is safe to work on. "Your technicians need to be aware that they can't touch the vehicle unless they know the battery is disconnected," Yeung says. "You need signs to put on the vehicle to indicate if it has a charge, so there is awareness of the vehicle's status. You don't want your janitor to walk by and touch it or lay something on it if there is a risk of a shock."

Each manufacturer also has specific requirements for battery handling. "There's an itemized list for each brand," Yeung says. "They don't want the battery stored below or above a certain temperature for a certain amount of time. If the vehicle sits, the battery can also discharge. If you're waiting on a supplement for a week, the battery might discharge 50 percent, so you'll have to recharge the vehicle prior to returning it to the owner."

Prevent improper towing

Most EVs also have regenerative braking systems, which affects the way you can move them around the shop or tow them from an accident site. If you push the vehicle around the shop, you could

PHOTO: TESLA

TESLA is unique among OEMs in that it does not have a traditional dealer network outfitted with service centers.

generate enough current to injure someone, even if the battery is disconnected.

"If the high-voltage wiring is damaged and you roll those cars around, the regenerative braking system may still be working, which will generate electricity and possibly expose your staff to electric shock," Pruden says.

Generally, EVs should be towed on a flatbed, and moved around the shop on a dolly. "If the drivers aren't educated, they can damage the vehicle by pulling it up on a flatbed or because they've not used a correct tow point," Yeung says. "If the car has been towed, you have to check for damage. Most of these cars have a manual way to release the brakes or move them. We have transport dollies for Teslas so we can roll a dead vehicle into a work area."

Keep it cool

High voltage batteries are sensitive to heat, so they should be removed before the vehicle is placed in a paint booth where heat may be applied. Each vehicle also will have recommendations relative to welding near the high-voltage battery. Removal of the battery requires special lifting equipment and a battery table.

Employees should wear alkali- and acid-resistant face shields and safety glasses. Leaks are also dangerous.

"The batteries have electrolyte in them, and you can use litmus paper to detect a leak," Pruden says. "You need the proper protective gear. A lot of these batteries are oddly shaped and pretty heavy, so you will need lifting assistance to remove them and will need to check to determine if the battery itself is damaged."

If battery electrolyte is leaking, employees may need to wear synthetic rubber aprons or boots along with their gloves and face protection. If the spill is from the 12V battery, the acid can be neutralized with ammonia or baking soda. An alkali leak from the high-voltage battery can be neutralized with vinegar or boric acid.

Training is critical

All vehicles are becoming more technologically complex, and EVs are no exception. In addition to safety and physical repair procedures, shops need to be knowledgeable about how to work with the ECMs and software on these vehicles as well.

"The technicians have to be up to speed on the electronics and computer systems in the vehicles," Yeung says. "Every vehicle has to be reprogrammed once the power is disconnected, and you have to understand how that concept works. We've found that technicians that come from a mechanical background have an easier time adapting than conventional body techs."

Troxel says that his Columbus shop has repaired hundreds of Teslas, and that the biggest challenge in working on the vehicles is knowing what can and cannot be repaired. "It becomes very labor intensive because they can't be repaired like conventional vehicles," Troxel says. "A small job can quickly turn into a large job. There are certain things you just can't repair; they have to be replaced."

A lack of parts can also delay those repairs. "It can be difficult to get parts," Troxel says. "They are getting better at providing parts in a timely fashion, but if you know you are going to be waiting a few weeks for parts, you have to make that part of your plan."

Manufacturer-specific training and in-depth knowledge of repair procedures is also a must. "The most important thing is to follow the OEM procedures," Yeung says. "Everyone has a different set, and you have to follow them A to Z so you don't kill yourself."

Because of those variations, Yeung suggests specializing in specific brands in order to keep the equipment and process requirements simple. "If we get something in our shop that we aren't familiar with, we are apprehensive about touching it," Yeung says. "We frequently refer vehicles to shops that specialize in those brands. Everything is getting so complicated now; you just cannot be a repair shop for every vehicle and expect to do quality work 100 percent of the time."

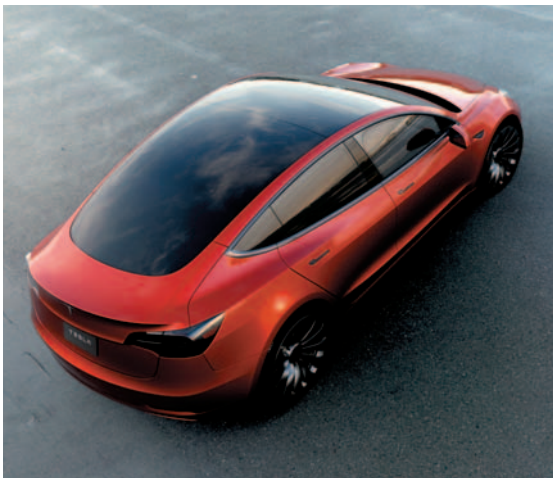

PHOTO: TESLA

THE TESLA Model S

That specialization presents both a challenge and an opportunity for shops. Even though market penetration is low, the expected rapid growth in sales could create a lucrative opportunity for collision shops that make an investment in training now.

"The emergence of electric vehicles is almost as exciting as when manufacturers switched from carburetors to fuel injection," Pruden says. "There hasn't been an industry-wide revolution as big as this since then. The battery technology has really advanced, and it's exciting to see manufacturers incorporate electric motors along with gas engines to get the ultimate performance out of these vehicles. There hasn't been this type of change since the 1980s, and it's really cool to see."

BRIAN ALBRIGHT is a freelance journalist based in Columbus, Ohio, who has been writing about manufacturing, technology and automotive issues since 1997. He is a regular contributor to *ABRN*, *Motor Age* and *Aftermarket Business World*. *b-albright@sbcglobal.net*

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ALUMINUM REPAIR BAY

Manufacturers of aluminum vehicles have set guidelines for repair, including creation of a separate work area. Aluminum vehicles undergoing repairs must be able to be separated from vehicles undergoing steel repairs to prevent cross contamination from compromising the repair. Goff's new Aluminum Repair Bay includes a clear "tent style" curtain top that allows for use of existing light while creating maximum containment separation.

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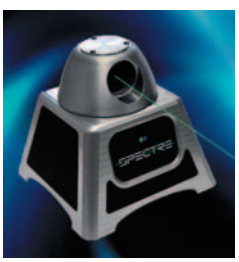
MEASUREMENT SYSTEM



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PRO SPOT

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