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Not Today, Rust

Years of corrosion, vibration and other destabilizing forces can wreak havoc on the natural components that ships, dams and buildings are made from.

But these examples prove that innovative design, engineering and a little biological wonder can help ease the test of time.

BROOKLYN BRIDGE Manhattan's unofficial emergency exit was challenged during the Northeast Blackout of 2003, when the vibrations of intense, heavy and synchronized pedestrian traffic caused the limestone, granite and cement landmark to sway. But the bridge withstood the sudden impact thanks to its independent suspension system, diagonal stay system and stiffening truss that help make it six times stronger than necessary.

TAIPEI 101 In areas prone to earthquakes, skyscrapers are often built with tuned mass dampers, or large pendulums suspended from cables at the top of a building. When a seismic event disturbs the building's natural vibrational frequency and moves it in one direction, the pendulum swings opposite to help restore balance. Taiwan's 1,667-foot Taipei 101 building hosts the largest, heaviest mass damper in the world, a 730-ton gold ball.

RMS TITANIC

Considering it's spent more than a century under 2.4 miles of saltwater, the Titanic is well preserved. But microbes eating away at the ship's metal in small communities of "rusticles" threaten its continued stability. A plan to coat the entire wreck with antifouling paint similar to that used below its waterline in 1912 could prevent rivets from rusting out, in turn preventing the ship from splaying apart.

STATUE OF LIBERTY

Lady Liberty slowly turned into a giant battery in her first century, with years of wet paint charging her iron frame and copper exterior. By the 1980s, the copper had pulled enough iron ions away to corrode the interior support by half. Engineers ensured the statue would remain on guard by carefully replacing portions of her iron frame with stainless steel and insulating her copper exterior with a low-friction coating.

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CO-LOCATED EVENTS

BUSINESS OUTLOOK CONFERENCE OFFERS INDUSTRY INSIGHT

Organizers of NACE Automechanika, the largest U.S. trade show dedicated to high-end technical and management-related training for automotive service and collision repair shops, will host the first annual Business Outlook Conference, offering shop owners and managers, parts distributors and suppliers insight into new technology, economic trends and the changing automotive landscape.

Featuring high-level thought leaders from widely recognized companies, the Business Outlook Conference will be a two-day event taking place July 26-27 each morning prior to the opening of NACE Automechanika at McCormick Place West in Chicago.

Dan Ricci, global automotive leader with IBM Cognitive Solutions, will head-

line the event with a discussion on big data and analytics impacting the automotive sector. Additionally, Dan Hearsch, director with financial firm AlixPartners, will speak to economic trends impacting the automotive aftermarket. The two-day conference will also feature:

- A panel discussion focused on telematics and in-vehicle connectivity moderated by Greg Potter, executive manager and COO with the Equipment and Tool Institute;
- A peak at key legislative issues, "How Capitol Hill is impacting your business?" from Bob Redding, Washington D.C. representative with the Automotive Service Association (ASA);
- A regulatory session, "Staying Compliant: Helping Shops and Distributors

>> CONTINUES ON PAGE 6

BREAKING NEWS

ON THE SHOW FLOOR

SHOW FEATURES, NETWORKING ABOUND IN CHICAGO

NACE Automechanika 2017 offers training and networking opportunities throughout a myriad of events and features. Elevating your expectations for a trade show, NACE Automechanika is bringing new and innovative features to the show floor in Chicago.

Along with a multitude of co-located events, numerous trade show floor features serve as added incentive to attend the training and exhibition event, set for July 26-29 at McCormick Place West in downtown Chicago.

Hit the show floor this summer and check out these great features:

AUTOMECHANIKA TRAIN STATION: Exhibitors from around the world will share how to become more efficient using their products and services. Training takes place every hour.

>> CONTINUES ON PAGE 6

TRENDING

TRENDS, TECHNOLOGY TO BE FOCUS OF TRAINING AT NAMC

With four full days of training and education, NACE Automechanika 2017, July 26-29 in Chicago is a "must attend" for technicians, shop owners and educators. MOTORAGE.COM/EDUCATE

GET A GLIMPSE OF THE SHOW FLOOR PLAN

Need help visualizing the set up of the exhibition hall and want to check out where companies and show floor features will take place? Look at the floor plan now! MOTORAGE.COM/FLOORPLAN

NAMC SCHOLARSHIPS AWARDED AT TST EVENT

Two technician attendees of the 14th annual TST Big Event can now add a second training event to their schedule after winning a scholarship to attend NACE Automechanika 2017. MOTORAGE.COM/WINNERS

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Avoid Costly Violations,” presented by Charles Ayers, president of the Coordinating Committee for Automotive Repair.

“The Business Outlook Conference was developed to help attendees better understand the future of automotive. We hear a lot about connected vehicles, new fleet technology and crash avoidance systems,” said Michael Wilkins, UBM Automotive Group content director and conference coordinator. “The technological revolution we are witnessing will change how parts are delivered, what parts are needed for vehicle repairs, the repair services that shops offer and the overall repair process. Rather than being fearful of what’s coming, we think this creates a lot of opportunities for forward thinkers, and that’s the goal of the Business Outlook Conference — to get them thinking about what’s possible.”

The conference will also showcase

a special presentation from Mike Jones, president of Discover Leadership, who will help attendees “Win the Moment” personally and professionally. Mike will show attendees the value of being outcome-focused in life and business.

The Business Outlook Conference will be a must-attend event for all shop leaders, distributors and suppliers. Register today at MotorAge.com/BOCregister.

The conference is one of many events taking place at NACE Automechanika designed to benefit automotive parts distributors and suppliers interested in working more closely with shop customers. The event provides matchmaking and concierge-serviced meeting times and spaces during the show in an effort to help attendees build business relationships. Rather than scheduling multiple trips for a sales force, distributors simply can complete a matchmaking profile and watch their schedule grow with valuable customer

meetings. Anyone registering for NACE Automechanika can indicate their interest in participating.

NACE Automechanika features more than 140 training courses covering a variety of mechanical, management and technical topics at no cost. Free training continues on the show floor inside the OE Coliseum Training Theatre, through demonstrations on the show floor and at the Automechanika TRAIN Station. Not to be missed, more than 40 collision-focused courses are also available throughout the week.

There are several other co-located events taking place during NACE Automechanika including the annual MSO Symposium and the Advanced Technology & Diagnostic Repair Forum, as well as the Collision Industry Conference.

You can view a full list of co-located events, register for courses and receive a free expo pass at www.NACEAutomechanika.com/register. 

>> CONTINUED FROM PAGE 4

CAREER CONNECTION: Looking to make a change or tackle a new challenge? Want to connect with the hottest jobs in your field? The Career Connection is the place for you. Speak with career counselors, learn about résumé building, pick up your training certificates and network with the industry — trainers, associations, organizations and others.

COMMITMENT TO TRAINING LOUNGE: Didn’t get enough time in class? Need to ask more questions? Just looking to talk shop with the experts? Stop by and connect with the industry’s leading trainers in a relaxed environment.

INNOVATION ZONE: Catch a glimpse of the industry’s most innovative automotive products and services. Whether it’s a new tool or a piece of equipment, a product advancement, new packaging or technology, this is where to find what’s cutting edge in the automotive aftermarket.

MEDIA MOMENTS: Stop by the stage and hear the latest news on a variety of revolutionary products, support the Recycled Rides program as they donate vehicles to families in need, or take a stand to applaud CREF as they donate a check in support of the Chicago area automotive students.

OE COLISEUM: Your one-stop shop for all OEMs: Toyota, Nissan, Fiat/Chrysler, GM and more. Come see what’s new, get trained on each of their products, expand your knowledge and become more competitive.

SCAN-A-PALOOZA: Listen to industry guru Mike Anderson as he gives real insight into the world of diagnostics. Then get up close with a variety of companies as they demonstrate their products on a range of vehicles — all happening right on the show floor!

THE COLLECTION – DEALER DRIVEWAY – THE PARKING LOT: Don’t miss the hottest cars with the

coolest vibe in these special vehicle areas! From the newest to the antiques, we will cover it all!

THE SHOP OF THE FUTURE: Powered by AutoVitals, experience each of the many sections of a full-service shop. See how you can make large and small changes to bring your shop into the future.

TOOL ALLEY: Take a walk on the wild side and check out the latest, greatest tools and equipment hitting the market.

TRUCK COMPETENCE: Interested in the big trucks? Check out the heavy duty industry’s newest vehicles, aftermarket parts and advancements.

VIRTUAL STAGE: Step into the driver’s seat and get hands-on training without getting dirty, or even touching a vehicle.

Come check out these features — and more! — at NACE Automechanika. Register today at NACEAutomechanika.com/register. 

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TRAINING

LEARN REPROGRAMMING, DIAGNOSTICS, HYBRIDS FROM AN INDUSTRY MASTER

PETE MEIER // Technical Editor

Jerry “G” Truglia has been a noted educator, trainer, author, shop owner and technician for many years, and it has been my pleasure to work with him on a variety of projects, including the quarterly webinars that we do with the not-for-profit group he is president of, Technicians Service Training (TST). In fact, it was the existence of TST that led me to him when I first joined the magazine back in 2010 as the new technical editor.

He, like many others I have had the good fortune of meeting since then, has a passion for giving back to the industry. He has a personal drive to help technicians of all skill levels achieve that next level of competency. That drive, that passion, is one factor that led to his founding of TST — an organization dedicated to helping technicians get the professional-level training they need at a cost they can afford. Having been one of those technicians who could use all the help they could get, I was eager to learn more about him and from him.

And that’s why I’m writing about him today. To let you know that you, too, can

learn from a master by attending any one of the multiple sessions he is presenting at NACE Automechanika 2017 in Chicago, July 26-29.

On Thursday, July 27, Truglia will be sharing his skills as a successful technician and shop owner in his class, “Reprogramming with J2534.” His shop in New York caters to all major brands and includes a heavy mix of German imports. His customer base also includes area shop and collision centers that often rely on his expertise to solve issues that they find themselves faced with. One is the art of reprogramming with a J2534 device when you don’t own the factory-specific scan tool. He’s learned all the ins and outs, often through hard experience, and attending the class will help you avoid what could be costly mistakes.

Register for Reprogramming with J2534 and enter code ATSG2017 to register for free at MotorAge.com/reprogramJ2534.

In the morning on Friday, July 28 (and again in the afternoon on Saturday, July 29), Truglia will present one of his newest training programs, “Critical Thinking Diagnostic Strategies.” This class will not

only streamline and improve your diagnostic process, it will also help with the nervousness and uncertainty we all face when trying to solve an issue on a new system we are not that familiar with.

Register for Critical Thinking Diagnostic Strategies and enter code ATSG2017 to register for free at MotorAge.com/thinkcritical.

In the afternoon on Friday, July 28, G. breaks from the main line and offers a more specialized session entitled “Hybrid Vehicle DTCs.” Truglia has extensive hybrid experience, and actually owns a Chevy Volt (his second) in addition to servicing the needs of his hybrid customers. Want to know what the more common problems are and how to solve them AND gain an understanding of hybrid vehicle systems in the process? Then be sure to include this class in your “to do” list!

Register for Hybrid Vehicle DTCs and enter code ATIF2017 to register for free at MotorAge.com/hybriddctcs.

No matter what sessions you choose, I can promise you will not regret the time you spend with this instructor. All that’s left for you to do now is register! **TM**

COMPANIES REALIZE THE IMPORTANCE OF TRAINING

Registration for NACE Automechanika 2017 is well underway, but as you start making your course selections, let’s recognize our sponsors that are making this training possible.

A number of manufacturers are sponsoring NACE Automechanika 2017, making all of the mechanical, technical and management courses available to you at no cost.

Each of the following manufacturers, groups and associations recognizes the need for quality, affordable training available to anyone in the industry. So no matter what skill level you are or what role you have in the repair shop, there is a course at NACE Automechanika Chicago that will fit your needs.

PLATINUM: Federal-Mogul Motorparts; NAPA; Motor Age Training

GOLD: Automotive Training Institute; Automatic Transmission Service Group (ATSG); Carquest Technical

Institute; Mitchell 1; National Alternative Fuel Consortium; Standard Motor Products

SILVER: Auto Career Development Center; Autoshop Solutions; Bosch; MACS; Pico Technology; Tenneco

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Incorporating online forums such as the SureTrack Community is important to your success as a tech or shop.

BUILD YOUR COMMUNITY, BUILD UNDERSTANDING

TSCHANEN BRANDYBERRY //

Special Projects Editor

While your repair shop works to maintain and repair your customers' vehicles and keep the bays full, in some ways it does take a village to keep technicians performing at their best.

With rapidly changing vehicle technologies appearing on vehicles today, not every technician can be an expert in every area. And while shops would love to have a number of experts in every

field, that also isn't possible. So technicians now work together through a variety of platforms online and through internet-connected tools and equipment to share information, offer suggestions and generally help move the business of vehicle repair forward.

One such platform many technicians, service writers and even owners turn to is the SureTrack Community, part of the ProDemand system from Mitchell 1. This community is an online group of professional technicians who ask and answer questions about a wide variety of vehicles and complaints.

Chances are if you are seeing an issue on a vehicle, someone somewhere else has seen a similar issue, if not the exact same one, and can provide insight.

Among those leading the way for information sharing among technicians is Eric Girard, a shop owner who still does his fair share of diagnostics in the bays of his North Carolina shop.

"I find it extremely helpful. I feel sort of like there's almost a safety net there I could fall back on," he explains. "It's just feeling like I have backup. Being a shop owner, the buck stops here. Having this entity behind me, it's given me the cour-

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age to make a couple of calls I normally wouldn't make and the information to know when not to do something."

Girard, who owns Eric's Complete Automotive Service in Weaverville, N.C., was an early adopter of the SureTrack Community, finding the service after purchasing a new scan tool with online capabilities and access to ProDemand. While he was looking up repair information, he found that he could ask questions.

In his position at the shop, which employs three other technicians, Girard does some diagnostic work and more complex technical repairs. But he said he also finds time in his role to answer more questions and help out others around the country.

"I don't have the need to ask a lot, but I do step outside my realm and find myself doing research for guys," he says. "I have learned as much as I have helped."

In one case, going to the Community and asking for help not only potentially saved a customer thousands of dollars, but ensured that the customer stayed with Eric's Complete

Automotive Service. Girard shared how he was going to perform a timing chain job on a Cadillac with a 3.0L engine. He asked the Community "if it was an aggravating job to do."

"The first reply I had was within 10 minutes. It said don't touch it without these special locking tools, which I didn't have," he notes. "I priced the tools, looked at the process and opted out of the job. The engine had to come out of the vehicle to perform this repair, and we were talking up in the thousand-dollars of repairs. I didn't want this good customer to be used as a guinea pig."

But saving his own customers time, money and helping them avoid headaches is just the start. He shares a story

about a technician trying to work on a broken lock cylinder in a Honda. The local dealership was backed up, so this particular technician was stuck trying to help his customer. Girard recalls that tech was able to get the lock cylinder into the car but with the security system, the car wouldn't start. He didn't have the proper programming equipment.

"I told him to call his local locksmith," Girard says, adding that that call solved the problem. "The locksmith charged him \$40 and he was tickled to death."

Over the years, as Girard has helped build the expansive library of questions, answers and scenarios, he has seen changes. He notes how the quality of questions has im-

proved. "I've seen it as vague as 'I've got code P0602, I've scanned the car, how do I fix it?' I've had it right down to where you read their question and see what they're missing. You can go back and say, 'You skipped step 4.'"

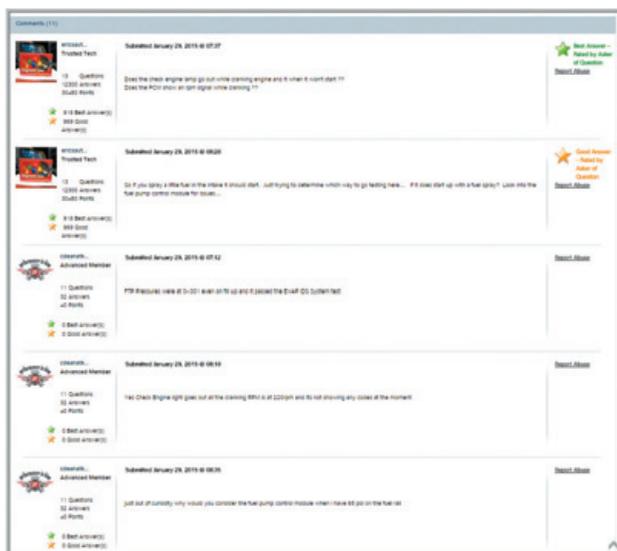
The Community also is just one part of the growing SureTrack content, which includes Probable Components, Real Fixes and a solid library of known good wiring diagrams. That feature is one Girard uses nearly as much as he is in the Community. He says he enjoys being able to access these systems from his scan tool, allowing him to, for example, get a picture of a fuel injector signal and compare it to a known good image.

"Sometimes it's having that right information for something that could have gone really bad," he says. "I love doing the work for the first time, but I want to be able to keep it simple."

With his experience as a technician and owner, Girard brings both hats to the experiences and expertise he offers in the SureTrack Community. He says from the front counter with service writers to the bays with the technicians, the ability to ask questions and gather information is invaluable.

"It doesn't matter how much it costs, it's how much it helps," he says. "I have been in a pickle a time or two and not been familiar enough with a type of engine and there were people who helped me out."

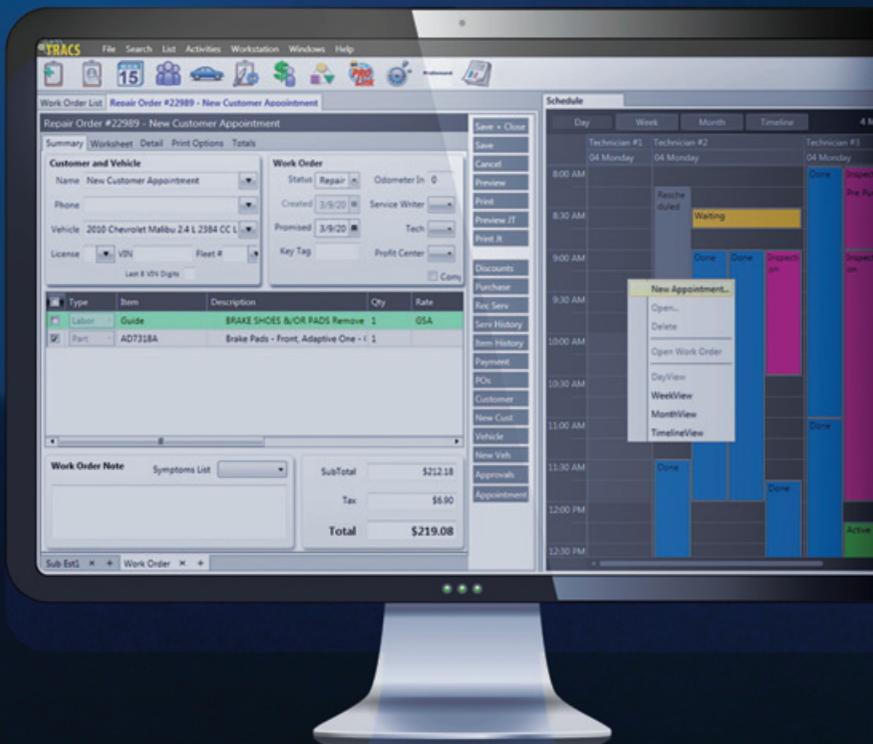
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TSCHANEN BRANDYBERRY is Special Projects Editor for the UBM Americas – Automotive Group, moving into the position following roles as managing editor of *Motor Age* and associate editor of *Aftermarket Business World*. She joined the Automotive Group in 2006, and has editing and writing experience at multiple Ohio newspapers and in public relations. tschanen.brandyberry@ubm.com

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Behavioral interviewing for technicians, management

An applicant's past behavior is the best indicator for what their future holds

I've conducted thousands of interviews throughout my career, and the only secret that has come to light is that preparation is key to a successful interview process. On average, potential employees have had between 8 and 16 employers in their lifetime. By the time they reach you, many have been "trained" to interview and have heard all of the potential questions and their outcomes. How often do you interview potential employees? Often times even after the best interview by the best interviewer, applicants still know themselves better than the interviewer does. A good interview provides the applicant with a detailed, realistic preview of the position so they can self-select in or out of the process —thus introducing the need for behavioral interviewing. Let's listen to ATI Coach Colter Shaffer tell it: The past is the best predictor of the future; people are likely to do what they have always done. Behavior-based questions about the applicant's past provide the best factual data for making good hiring decisions.

What is behavior-based interviewing?

Behavior-based interviewing is a technique that examines past behavior to determine if the candidate will fit within your business model. It focuses on listening to applicants' answers rather than bombarding them with closed-ended questions that produce a yes or no answer, which allows you to hire based on the facts by gaining insight into how the candidate will react when placed into your work environment. The process is very structured and normally has a core set of open-ended questions pertaining

to the position, which reduces intuition-based hiring mistakes.

There is a wide range of benefits from the behavioral interviewing process. It allows you to evaluate the presence/absence of critical-job related skills, attitudes and values. It helps you to hire the best candidate and avoid costly hiring mistakes. It helps to determine how the candidate is likely to act if put into the position. Last, this process helps ensure that you stay legally compliant during the interview process. It also allows you to identify the four types of applicants you will come across in the process: the unable/unwilling, unable/willing, able/unwilling and the able/willing applicants.

Creating the ideal interview setting

The idea of setting the tone is to make the applicant feel that the interview is focusing on them. You need to create a bond as quickly as possible so that the candidate can build a relationship with you. This is important to ensure you get honest answers to your questions. Make eye contact as much as possible and take notes. Set up the seating so the candidate is sitting next to you, not across from you — you don't want any barriers separating you. Being on the same level as the candidate will strengthen the bond and help build rapport. The interview should be uninterrupted and in a safe environment for the potential employee.

Initial interview anatomy

The initial meeting should include a five-step process that makes a 30-minute interview. The first stage should begin with explaining how the interview will

be conducted, setting the tone for the meeting, lasting five minutes. Next, review the resume chronologically while asking open-ended questions to confirm the information. This should take around 15 minutes. Then, you will dive into each inconsistency by asking the right questions, which should take an additional 15 minutes. Then, you go into selling the job and the organization, assuming it's going well. This should last about eight minutes. Last, close the interview and advise the candidate on the next step in the process. Ensure you take detailed notes and follow up with them.

Asking the right questions

Most behavioral interviews will consist of open-ended questions to get a true re-

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flection of the candidate's qualifications. Although this is true, closed-ended questions still serve several purposes to help in the process. If you feel the candidate is feeling nervous, you can ask a yes or no question to put them at ease. You can use these questions to verify information without getting a long detailed response, which would waste valuable time. You can also use closed-ended questions to probe a candidate to lead into a truthful answer. An example would be asking, "Did you work under tight deadlines?" Then asking, "What were the circumstances?" On average, 60 percent of your interview questions should be behavior-based questions, beginning with words like "Describe a time," "Give me an example," "What did you do?" and "How did you feel?"

Stages of questioning

There are several stages of the interview process where you want to ask specific questions to garner a specific response. For building rapport you could ask, "I noticed you lived in _____, how do you find living here in _____?" During the confirmation stage you could ask, "What courses did you take?" Or "How did you go about achieving your goals?" When probing a candidate, be sure to ask supporting questions until you get the answer you're looking for. An example would be as follows:

Interviewer: "How did you implement your plan?" **Candidate:** "I had a meeting and discussed the process and how to get things done." **Interviewer:** "What processes did you apply and how did you measure it?" **Candidate:** "I conducted a role-play event where we all participated in critiquing each other to form a fluid process," or, "We measured it by the number of surveys that were submitted, which we used as an accountability opportunity." As you see in the example, the candidate didn't give the exact response needed to the original question. So the interviewer probed further, and asked the

same question in a different way in order to get a more detailed response.

Another effective technique used in behavioral interviewing is the pause method. Once you ask a question, pause, no matter how uncomfortable the silence gets. Hold the silence until they issue a response, then continue with the next line of questioning. This creates the impression that no matter what, you need a valid response, and you are willing to wait until they can give you that information.

It is also important to sequence your questions to obtain any unfavorable information. You could ask a candidate, "Tell me about a time when you successfully worked with a difficult boss." Then follow up with, "Tell me about a time when you had difficulty working with someone." You will get the information you need because the applicant speaks spontaneously and doesn't fight you, withdraw or babble. The idea is to have the applicant leave the interview saying three things: I liked the description of the job; I think the interviewer liked me; and I have no clue if I'm going to be offered the job.

Using your collected data

In the decision-making process you should look for consistency in the events you discussed. Also, gauge the amount of favorable versus unfavorable information you collected, such as overstatement of accomplishments. Ask yourself, does this person, while qualified, "fit" within my

business? Look back at your notes referring to body language and eye contact — were they smiling or did they seem excited? Everything from the moment they entered the building should be considered in the decision-making process. Were they on their phone, or did they seem interested in the surrounding environment? Did they acknowledge my co-workers as they passed by, or are they standoffish? Did they look happy sitting, or were they antsy and needing to keep moving? When they came in, did they own the room? These are all questions to ask yourself because they show how the candidate will conduct themselves in the future. A good candidate will recognize they are at your business for an opportunity. With that being said, they should act like they are excited to be there and interested in being part of the team. They should want to stand out and be noticed in a positive light.

If you would like the ATI Hiring Checklist to help you prepare for your next interview, simply go to www.ationlinetraining.com/2017-06 for a limited time. 



CHRIS "CHUBBY"

FREDERICK is the CEO and founder of the Automotive Training Institute. ATI's 115 associates train and coach more than 1,400 shop owners every week

across North America to drive profits and dreams home to their families. This month's article was written with the help of Coach Colton Shaffer. chubby@autotraining.net

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Chris "Chubby" Frederick, CEO



Re-evaluate your business road map

Slow down and get focused to meet your annual goals

We are at the halfway point in the year; let's evaluate where you are compared to where you wanted to be by this point in time.

It is hoped that you have prepared an annual budget with revenue, gross profit and key measurement projections. If not, are you running the business by your bank account balance? Are you just looking at sales? If so, you are also heading into troubled waters. It is time to get proper help and advice/training; please stop fooling yourself.

If you have the numbers, review and do your comparisons. Calculate the average labor hours produced per work order for the first half of the year compared to last year at this time. If it is down, consider your processes. Do you have a solid inspection plan? Your objective in a maintenance shop is a minimum of a 2-hour average per work order with 2.5 hours as the ultimate target. Slow down and look at your shop processes.

Review the shop's gross profit by each revenue category compared to expectations. Are your buy/sell habits in check with your supplier? Are you maximizing your relationship with your supplier to ensure 85 percent or more of your aftermarket purchases are going to one competent supplier?

Cost of products is not the only thing that creates profit in your business. Shop efficiency, business/customer/client relationships, gross profit mix and cash management drive the real profit to a business today, and a competent supplier can assist you on these items, but the business relationship with the supplier must be in place first. All relationships must be a win/win — one-sided relationships do not work.

Revisit your current labor rates. The maintenance/mechanical rate should be at 4.5 times the top maintenance/mechanical technician's hourly wage. The diagnostic rate should be a minimum of 5.35 times the top diagnostic technician's hourly wage and the re-flash rate should be 6 times the top technician's hourly rate. Review your menu pricing



EXAMINE THE PERCEPTION YOUR SHOP IS SENDING OUT. PERCEPTION IN BUSINESS IS EVERYTHING TO ATTRACTING THE RIGHT CUSTOMER BASE.



items to ensure the labor component is reflected properly in the price.

Examine the revenue mix of aftermarket parts to dealer parts. The average shop is 80 percent aftermarket and 20 percent dealer. If you are at least 70/30 aftermarket vs dealer, traditionally your shop works on newer vehicles and your rates must reflect the knowledge and equipment required to maintain this level of expertise. If you are 95/5 (or higher), traditionally you are working on a lot of older vehicles, and you should examine your marketing strategy to secure a better balance of clientele.

Does each revenue category of oil, tires, batteries and parts inventory turn over in accordance to guidelines? Carrying stock that does not turn over does not create useable gross profit dollars and net income.

Examine the perception your shop is sending out to the marketplace. Stand across the street with a clipboard and paper. Ask yourself, "What would make me want to turn into this place for

maintaining my vehicle? Does my website reflect reality or a fantasy? I'm looking for someone I can trust, so why should I, and what makes me want to try you out?" Are you sending out a perception of professionalism and a highly skilled shop? Perception in business is everything to attracting the right customer base.

These are just but a few items to review at this time of year, so you can target the issues within the business to get the results desired for the second half of the year.

Slow down, get focused. Our business is constant and always in perpetual change. Growth is optional, but we must choose wisely if we are to succeed. **ZZ**

BOB GREENWOOD, AAM, is president and CEO of Automotive Aftermarket E-Learning Centre Ltd. (AAEC), which provides business management resources for the automotive aftermarket. Bob has more than 36 years of business management experience and is one of 150 worldwide AMi-approved instructors. greenwood@aaec.ca

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Specialty in Mercedes-Benz, BMW vehicles drives continued investment

ROBERT BRAVENDER // Contributing Editor

➔ “Fortune favors the bold” goes an old Latin proverb, so when an independent Mercedes-Benz-oriented repair shop in Waltham, Mass., was sold to a dealership, three visionary individuals took it upon themselves to create a new one: European Auto Solutions (EAS).

As one-third of this partnership and service director of EAS, Ed Owen was a service advisor at the old shop when the dealership took over. “They loved our customer following, but (said) we weren’t ‘selling urgency,’” he wryly notes. “I just didn’t want to be in the car business if that was the case. Stroke of luck: one of our big customers had taken a big buyout from (his corporation) and wanted to do something entrepreneurial.”

Along with another technician from the old shop, the trio recognized — as per their website — “the shortage in the Boston marketplace of a truly independent repair facility that delivers the highest caliber of service at a competitive price.” Therefore, in July 2006 they opened a shop where the parking was admittedly sparse, but the facility itself quite large at 9,000 square feet.

They built a technical foundation focused on Mercedes-Benz exclusively, although they would add BMW later. “Our belief in doing one marque at a time is like the medical field — you have a specialty,” says Owen. “There aren’t any general practitioners anymore, it’s all specialty stuff, and with the amount you have to invest in the software and the tools, it’s really hard to be a full service for the line without investing heavily in it.”

And Owen used this to EAS’s advantage in marketing and customer service efforts. “Waltham is a pretty big city,” he confides. “In fact, it’s got a lot of mom-and-pop automotive places because you can repair cars without a special permit.” Historically associated with the start of the American Industrial Revolution, Waltham still supports this impresario spirit.

“That favored us for location,” he reports, “but I went to every one of those shops in town and introduced us by saying we’re not competition. We have scan tools, so instead of taking that Mercedes to the dealer and having them charge an hour or two every time to read a code, we’re happy to do it for half that, even less. Instead of creating animosity, we worked out a partnership. At some point a lot of the shops were saying ‘I don’t work on Mercedes; you need to see these guys.’”

Within three years EAS had outgrown its original facility. To find a new one, they once again networked through the client base. “One of our customers was a realtor who had found a



EUROPEAN AUTO SOLUTIONS

Waltham, Mass. // www.virtualeas.com

Edward Owen & Scott Penney

Owners

6

No. of technicians

1

No. of shops

13

No. of bays

11

Years in business

48

No. of customer vehicles per week

13

No. of employees

\$3.6 million

Annual gross revenue

9,600

Total square footage of shop

property,” says Owen. A 10,000 square-foot building on about 2.5 acres, the facility was only four years old, sporting such modern conveniences as radiant floor heat and gated security.

“Nothing else could compare to it,” Owen remarks. “But we were still growing the business and weren’t big enough to take this [property] on — the price tag was a little bit out of our reach, and this was in 2010 when no one was lending. But we thought we could do it; we put together a package and went to the bank, and they said ‘maybe.’”

Within a year, the EAS partners convinced the bank to say yes, but it was still a big step for the company. “At that time, we were doing probably 30-35 cars a week, and for a lot that size that was basically nothing,” Owen recalls. “I thought, ‘we’ll never

fill this.' Of course now we're doing between 55-65 cars a week and the parking lot's always full."

EAS's growth was also bolstered by participation in the Automotive Training Institute (ATI). ATI's programs helped EAS refine the structure and management of their shop. "They helped us to refocus a bit on maintenance and understand how we needed to build the shop, understanding who the 'C,' 'B' and 'A' techs were and not to get overloaded with 'A' techs," Owen explains.

That requires balancing staff ambition with profitability. "When you're building a shop, you've got to understand that you need level C work, but B work is pretty much the most profitable," Owen continues. "And then you've got your diagnostic work, which is always a struggle to get paid for, so you need to build that mix. It's always grooming people as you go, because they always want to grow and sometimes you lose people over that."

They also began marketing maintenance programs. "We had to suggest it, remind customers about it, bring up what the book said about maintenance," says Owen. "But these really helped build understanding and plant the seed for future work, doing it in a way that advised them, not give them a sales pitch. You coordinate with the client, trying to help them manage their budget, their expectations."

Then three years ago EAS invested in solar power. "It always seemed too expensive, but we were told that was the year to do it because incentives were going to change," Owen recalls. "We had

a perfect location for about 248 panels. We were revenue neutral in about a year and half, and have recovered (the cost) since. We're using only about 50 percent of the capacity we're generating, but with the size of the property we can grow up to 25,000 square feet, so maybe someday we'll put a charging station in."

EAS also recently expanded into

car sales, keeping 10-12 on the lot, but selling a few at auction — which gives the shop national exposure. But what brings a sparkle to Owen's eye is the vintage work. "I call that the romance of the business, like the 1971 Mercedes 280SL or the '68 280SE or the '73 BMW — that's the stuff people like to see on social media." *TL*



ROBERT BRAVENDER graduated from the University of Memphis with a bachelor's degree in film and video production. He has edited magazines and produced shows for

numerous channels, including "Motorhead Garage" with longtime how-to guys Sam Memmolo and Dave Bowman.

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Create a pipeline of talent for your business

THE MOST SUCCESSFUL SHOP OPERATORS CONTINUE TO INVEST IN THEIR PEOPLE

CHRIS CHESNEY // Contributing Editor

Focusing on training and making a commitment to enable your team to become the best at what you need them to do is a noble and worthy task; however, it is of no use if you don't have anyone to train. Many times I hear the statement, "I don't want to train my people because they'll just leave, and I'll have to train their replacements."

The most successful operators are those who invest in their people with the goal of growing a successor, creating advancement opportunities for their team by adding new locations or will help them open their own business. Investing in people instills a strong bond and loyalty that pays dividends. If your manager or lead technician learns enough to have the confidence to strike out on his or her own, you should celebrate that accomplishment, encourage them fully and continue to invest in their success. The byproduct of this is the creation of a program that can grow talent on an ongoing basis, allowing you to have the team you need at the ready no matter

the stage in life you decide to add another location, step aside or retire. Sounds easy, right? But how do we get there?

The first step in creating a pipeline of talent is to develop the process that grows talent, followed by the acquisition of the people you put into that process. Invest in the earliest stages of the pipeline, whether that be your time, effort or money. If you have a high school automotive program in your town, step one is to get involved. Meet with the instructor and determine if the school is NATEF certified. The National Automotive Technician Education Foundation is the entity that sets standards for vocational automotive programs to ensure students are receiving the proper education needed to meet the needs of the industry.

Once you've gotten involved and offered your help, continue adding value for the local program. Become familiar with the AYES process (www.ayes.org). Invite students and instructors to your shop to shadow your team on a regular basis, allowing them to observe each position for several hours. Get to know the students and identify those who fit

your culture. As part of their high school automotive curriculum, invite a student to intern at your shop over the summer or during their senior year. Work with the instructor to allow the student to complete required tasks in context of how they are performed in your shop. For example, allow a student to assist in a brake job with a mentor technician. They may only get to do one or two hands-on tasks in the classroom, while you are going to allow them to do the entire job for a customer. Let them participate in work from start to finish.

If an intern fits in with your team and shows promise, determine if you want to continue your investment. Consider sponsoring your intern in a post-secondary vocational education work study program. Enter into an agreement where you pay his or her tuition and provide them with a part-time job and tools in exchange for their commitment to continue their apprenticeship with your shop. Continue providing a mentor who assists the student in completing their task list in context with

>> CONTINUES ON PAGE 24

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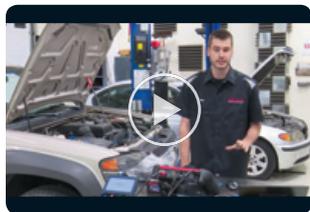
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>> CONTINUES FROM PAGE 22

your shop's processes. Work with the vocational school and your mentors to ensure the process is valuable to all involved. This process should remain in place until the intern completes his or her formal education and, depending on

your goals, should continue with you in an apprenticeship role for at least one — and up to five — years.

At the appropriate time, make your investment a full member of your team. You already know what kind of team

member you have. But it doesn't stop here. While you've invested at least 4-5 years in this person, their learning should not stop. In this industry, the process of staying current and relevant on trends and new technologies is ongoing. Make sure you include new team members and apprentices in your learning plan for the rest of your team. This will differentiate your operation from the majority in our industry. You can create a stable team that is ready to service your customers each and every time.

Then what? Do it again! For those thinking "but I don't need a tech, so this doesn't apply to me," eventually you will. Investing in the growth of young people entering this industry will pay dividends in the future. By always having a "tech in progress," you will be able to grow and react to unforeseen needs without the stress of trying to find an experienced technician when you desperately need one.

There is currently a growing effort in our industry to enhance the process of filling the talent pipeline by assisting schools, students and repair facility owners. The new technologies that are being installed on today's and tomorrow's vehicles will, no doubt, expand the education requirements needed to provide quality service to your customers. Don't be caught on the outside looking in. Become involved by joining local or national efforts. A great place to start is what is being driven by the National Automotive Service Task Force (www.nastf.org). If you become a part of the solution, the problems we face today will only provide opportunity. **TL**



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NEW GENERATION FUEL TRIM DIAGNOSTICS

THE BASICS HAVEN'T CHANGED, BUT THE STRATEGIES HAVE. ARE YOU UP TO DATE?

ALBIN MOORE // Contributing Editor

When were you introduced to fuel trim and the power it gives us as technicians in the drivability diagnostic process? For me, it was quite late in life, since I didn't get into the car-fixing business until 1992. Trust me: there is a huge difference between this business of fixing cars and the business of cutting, skidding and loading logs.

Sometime in 1998 I found the fuel trim data on a scan tool and with the help of some very good friends, I learned how to use those numbers. Well, using the numbers was rather confusing and these friends introduced me to the concept of using a scan tool to graph engine

data. I thought it was pretty cool to be able to use a scan tool on a drivability problem and tell whether the problem was an oxygen sensor, low fuel supply, restricted exhaust or even a MAF or MAP sensor that was not reporting correctly.

Has fuel trim changed since its inception in the early '80s? I guess that depends on a lot of things, although my answer would be yes. Please let me qualify that answer — the basics of fuel

trim have not changed. The way it is reported and many of the strategies that are used have changed, and all of these changes have been for the better.



2010 SUBARU FORESTER



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The scan tools we have today do a much better job of getting this information, since the speed of the data is many times faster today than in yesteryear, and to make the deal even sweeter, today a scan tool will graph that data and put it in a format that can be easily understood and used.

Taking full advantage of the info

In the last few years, some new things that made their way into the fuel trim data PIDs are front and rear oxygen sensor trims. Equivalency ratio is another rather new PID that will give us some great information about what is happening with the fuel control.

The vehicle of the day is a 2010 Subaru Forester. This vehicle is powered with the 2.4 4-cylinder engine and the power runs through an automatic CVT transmission. The customer complaint was noisy brakes, and several warning lights were illuminated in the instrument cluster and by illuminated, I mean this instrument cluster was lit up like a Christmas tree (Figure 1).

With the engine idling, the cluster had warning lights for the tire pressure monitoring system, transmission oil temperature, traction control, cruise control and the check engine light was on.

My first step with problems like this is to fire up my favorite scan tool for the job and do a full system scan. This is a quick way to get an overview of any DTC that

2010 Subaru Forester (4eAT Naturally Aspirated) 3

GENERAL DESCRIPTION(H4DOTC) > Diagnostic Trouble Code (DTC) Detecting Criteria [Report a problem with this article](#)

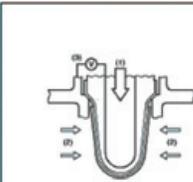
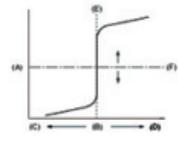
DTC P2097 POST CATALYST FUEL TRIM SYSTEM TOO RICH (BANK 1)

1. OUTLINE OF DIAGNOSIS

Detect the malfunction of fuel system from the size of the sub feedback learning value.

Sub feedback learning is being performed. When the learning value goes to the rich side, judge as NG.

2. COMPONENT DESCRIPTION

(A) Electromotive force	(B) Air fuel ratio	(C) Rich
(D) Lean	(E) Theoretical air fuel ratio	(F) Comparative voltage
(1) Atmosphere	(2) Exhaust gas	(3) Electromotive force

3. ENABLE CONDITION

Secondary Parameters	Enable Conditions
Conditions for carrying out the sub feedback learning	Completed
Continuous time when all conditions are established.	≥ 1 s

4. GENERAL DRIVING CYCLE

Perform the diagnosis continuously when the vehicle is idling or running at a constant speed of 80 km/h (50 MPH) or more.

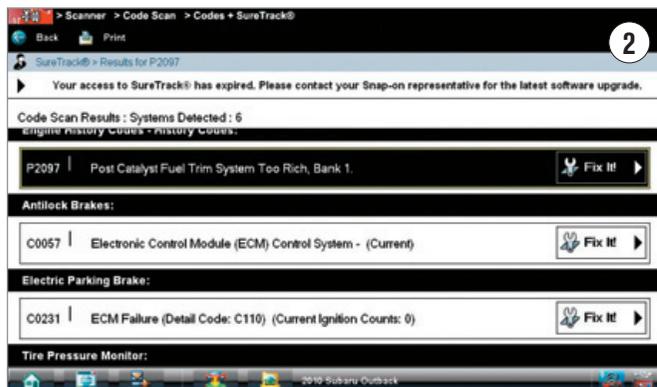
is stored in the modules and possibly get a quick direction. In my last 20 years of diagnosing problems like this, I have never found the problem with the first test I have done. I always start by using the tool I think will gather the most information in the shortest amount of time and in this case, my tool of choice was the scan tool.

I found there were diagnostic trouble codes stored in three

different modules — the ECM (engine control module); ABS (antilock brake module) and the EPB (electronic parking brake) (Figure 2).

With DTCs stored in three different modules, where do you start? This is a tough question, but in this case, I started with the engine trouble codes, the P2097. The code description (Figure 3) and code set criteria shows the DTC is for “post catalyst fuel system rich.” In days gone by, we only had system rich and system lean codes.

Before I get on with the fuel trim discussion, I need to mention the other two modules with diagnostic trouble codes. The TPMS light is on, but I’m not going to worry about that, since the vehicle has a





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set of snow tires, which have no pressure sensors installed. Up here in snow country, this is quite common. The other two modules are the ABS with a DTC C0057, which is for an electronic ABS module failure and in the electric parking brake, a DTC C0231, which is for an ECM failure. This is sounding expensive. Oh, and the transmission temperature light was also glowing. I don't know how this can be, since the vehicle had been sitting outside in the snow overnight.

First things first

My first place to visit was the engine control module, where I found the DTC P2097. Service information says this DTC is for the rear oxygen sensor showing a rich fuel mixture. In searching the service information, it tells me to check for water in the harness plugs for both front and rear oxygen sensors, check to see the wires are not welded to the exhaust and several more places to go looking for problems. For those who don't know me, I will be the first to tell you that I'm lazy. I also don't like getting my hands dirty if I can help it. The first place I will go is to the front seat of the vehicle and get comfortable with my scan tool and from there, I can get access to fuel trim, oxygen sensor and all kinds of engine sensor data. With all these data resources at my fingertips, I can tell if I am going to need to open the hood, and when I do open the hood, I will know where to look.

This DTC P2097 is interesting. It would be easy to just toss a rear oxygen sensor at the problem, which might keep the light out, but then again there is a chance the bullet would miss the mark. Several things can set this DTC, and I want to make the vehicle tell me exactly where the problem is by taking a test drive while recording scan data.

Since there was some fresh snow on the ground, I don't want to sit out in a cold car, so let's take it on a FRTD (flat



Inputs:		Input Altitude Off From Barometric pressure, Not both.		Override Volumetric Efficiency	
3	Your Actual MAF Value in gms/sec	Engine Displacement in Liters	RPM	Altitude in Feet	Barometric Pressure**
4	121.70	2.4	4982	2000	0.00
5				Altitude Based on Altitude= 27.86	Input value above 0.00? If you know the vehicle's true VE at the specified RPM range, input as decimal i.e. 75% = .75
6	Temperature °F	Relative Humidity %			
7	45	90%			
8	*Temperature and relative humidity have small impacts on VE calculations.				
9	If left blank, calculations assume 70°F and 90% Relative Humidity... an average day.				
10	**Input relative Humidity as a decimal (i.e. .80 = 80%)				
11					
Outputs:					
14	MAF reading should be about (in grams/sec)				
15	Percentage difference				
16	Allow for a +/- 8% margin of error				
17	Actual Volumetric Efficiency				
18					
19	Under Calculating Air flow (negative %) will give positive fuel trim.				
20	* * * * * WOT VE Calculation... Sheet3... Ready				

rate test drive) and get the car talking so I can interrogate the system (get the scan data talking). This vehicle uses an AFR (air fuel ratio) sensor ahead of the front catalytic converter and a common zirconia oxygen sensor behind the catalytic converter. Figure 4 is the enhanced data I captured on the FRTD. I want to glean several things from the data. Since the DTC is for the rear oxygen sensor

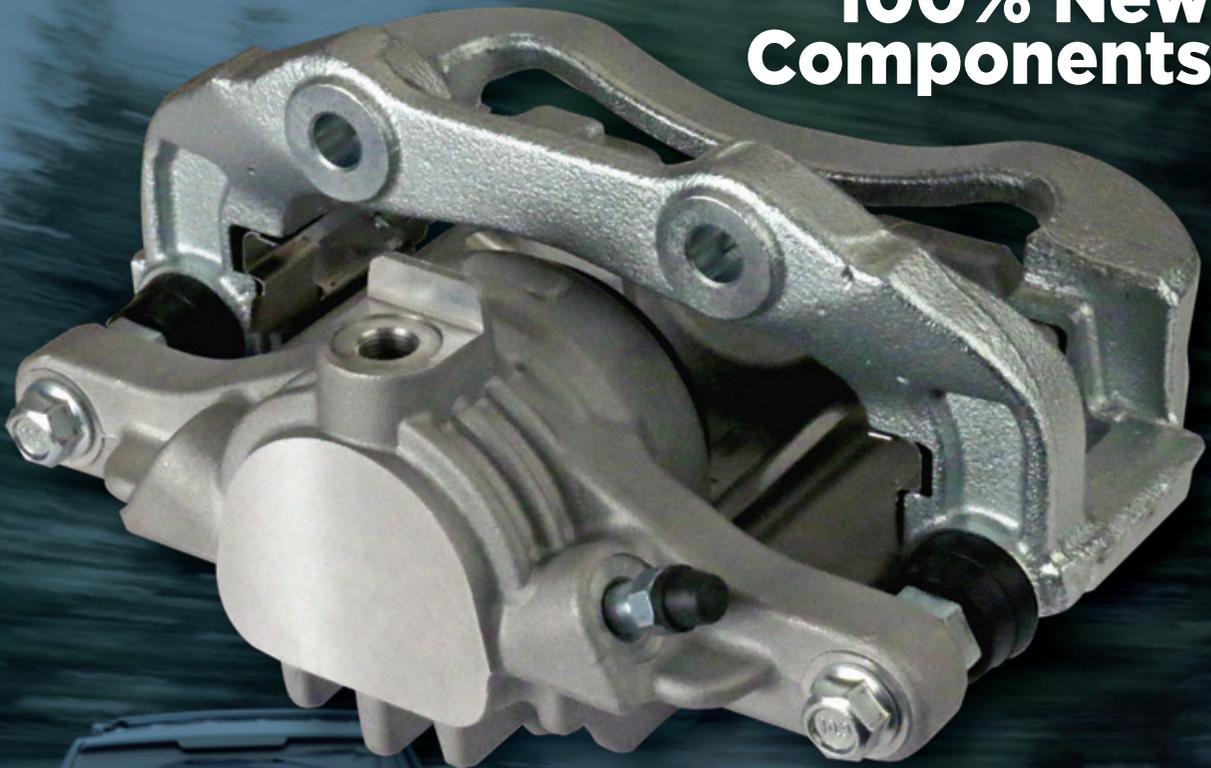
showing a rich condition, ultimately I want to know why. Is the system actually rich and if so, why, or is the rear oxygen sensor not reporting correctly?

The captured data shows the fuel trims, which Subaru has labeled “air fuel correction,” which is long-term fuel trim and “air fuel learning,” which is short-term fuel trim. In the enhanced data, there is nothing mentioned about

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rear oxygen sensor fuel trim. Should the rear oxygen sensor be misreporting, there is the possibility of the fuel trims being skewed by this misreporting sensor. The enhanced data does not list a loop PID either. This is a very important PID, since we need to know if and when the system is in open or closed loop. Fuel trim data that is displayed when the system is in open loop is not reliable.

Take a look at Global OBDII data

By using Global OBDII data, we have a loop PID along with other very valuable data that is not shown in the enhanced data side. Take a look at the data in Figure 5. Some things listed that are not in the enhanced data are fuel trim for the rear oxygen sensor and the load PID displays, both calculated and absolute load calculations. Take a close look at the oxygen sensor data. Global OBDII data lists the front air-fuel ratio sensor as oxygen sensor 1-1, but the voltage displayed is the same voltage that is displayed in enhanced data. It also provides “equivalence ratio” and oxygen sensor current for the front sensor. The equivalence ratio PID is displayed as “lambda.” This is the displayed air-fuel ratio calculation; in other words, it is the air-fuel ratio calculation the ECM wants to see. By using the front AFR (air fuel ratio) sensor voltage, the equivalence ratio and the AFR current data graphs, it is easy to determine if the front AFR sensor is working properly or not.

In this case, the data graphs of the front AFR all follow each other as the engine load and speed was changed. By using the captured data, I’m confident the MAF and front AFR are reporting properly. The data that is waving the red flag here is the rear oxygen sensor voltage. The voltage is stuck at .95 volts, which should indicate the engine is running rich. Please keep in mind what the



DTC information is pointing to — “post catalyst fuel trim system rich.”

I want to add one more piece of data to the information captured in the first FRTD; I want to run the captured numbers through a volumetric efficiency calculator. This calculation can be helpful to determine the state of the MAF sensor and air flow through the engine. The data calculation shown in Figure 6 shows the volumetric efficiency to be 105 percent. This seems a little high, since this is a naturally aspirated engine, but on the other hand, this engine does pump air pretty good! The engine uses the Subaru version of variable valve timing, so I’m not going to get too concerned.

If the MAF were over reporting, the

fuel trims would be waving a red flag about this problem. If you ever run into an MAF that is reporting more air flow than the engine is actually inhaling, the fuel trims will be showing a positive number at most all engine speeds and loads. In this case, I am satisfied with the trim numbers, so I will concentrate on the rear oxygen sensor.

Getting down to the fix

The fix for this problem was a new rear oxygen sensor. With the new sensor installed, I cleared the memory from the ECM, hooked up my scan tool and took it out on another FRTD. This “after the repair” test drive is as important as the one done to find the problem. The final FRTD is used to verify the repair

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was correct and that there are no other problems hiding in the wings. Figure 7 is the enhanced data from the new rear sensor.

On an FRTD, you need to drive at wide-open throttle through at least one shift point. In this case, the vehicle is equipped with a CVT (continuously variable transmission), so I opted to run at wide-open throttle from start up to 5,000 RPM; that is why you do not see any shift points in the engine RPM. Figure 8 is the generic fuel trim data from the test drive. Any time I take a vehicle on a FRTD, I always use the same stretch of road, and drive the vehicle the same way, FLATRATE!! This makes the stored data as close as possible to the same on all cars. This way it is easy to use that data to pinpoint drivability problems that show up in the fuel trim.

The recorded data now shows the rear oxygen sensor operating properly as the engine loads are changed. It is time to close the RO and collect the money and move on to the next exciting problem.

By the way, this story all started out with the instrument cluster warning lights looking like a Christmas tree. There were diagnostic trouble codes stored in the ABS module and the electronic parking brake module. In my research on this vehicle, many times these lights will be illuminated when there is a DTC stored in the ECM. After the repairs were made to the oxygen sensor, the DTCs cleared from the ECM, all warning lights went away from the instrument cluster. See, behind every black cloud is a silver lining. *ZZ*



ALBIN MOORE spent 21 years in logging before opening in 1992 a shop that specializes in drivability problem analysis. He is an ASE CMAT L1 technician with 40 years of analyzing and fixing mechanical and electrical issues.
bwrench@yahoo.com

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VIEW FROM THE MOBILE TECH

A LOOK INSIDE WHAT IT'S LIKE TO BE THE GUY CALLED IN TO HANDLE THE "TOUGH" ONES

EDWIN HAZZARD // Contributing Editor

Over the past 35 years, I've witnessed a change in the way vehicles are repaired. The diagnostic approach or game plan to finding the cause of a vehicle's problem has changed as well. For example, the strategy used for a 1982 Chevrolet Camaro in the shop for a "cranks, no start" complaint could be entirely different than it might be for a 2017 Chevrolet Camaro with the same complaint. Yes, you might start your diagnostic approach the same way by checking for spark or fuel, but with today's vehicles and the increased use of electronics, sometimes it might be easier to start looking into the problem using a diagnostic scan tool first. With modern technology changing drastically

over the course of the last 20-plus years, your thought process needs to change as well. In this month's article, as a mobile diagnostic technician, I'm going to highlight a couple of case studies that I solved using a diagnostic approach that works for me. You might find that these methods will work for you, or you might find that your own diagnostic approach could be completely different. It doesn't matter which way is better. What matters is that whatever way you choose, you are able to find the solution to the problem that leads to fixing the vehicle.

Drama, drama, drama

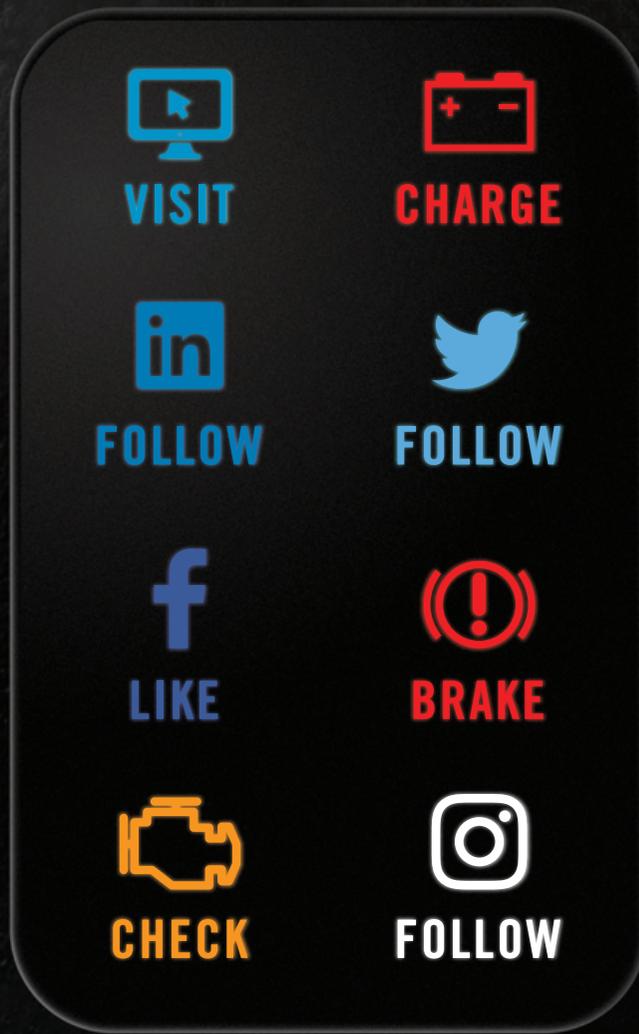
When I get called to a shop about a vehicle that has a problem, it usually has what I call "drama" attached to it. The vehicle has probably been in the shop longer than it should have been, the technician working on the vehicle is probably frustrated and I'm sure his boss is as well. It is also probable that the vehicle has had more parts added to the ticket than my wife has shoes. Well, maybe not that many, but the situation is not good and the frustration level is high. When I approach a diagnostic job I always try to keep two things in mind: keep it as simple as possible — meaning don't over think or over analyze — and know the system you're working on.

The first vehicle that I want to talk about is a 2006 Pontiac Solstice that has a 2.4L engine with 78,000 miles (Figure 1). The vehicle came into the

shop with a check engine light on, and it's the second time back for this vehicle. This vehicle has a stored code of a P0011-00 for an intake camshaft system performance fault. This code is a "type A" code, meaning that after one failed drive cycle the light will be illuminated and a failure record will be stored.

Remember, knowing how the system works and reading the description of what the code actually means will make your diagnostic job much easier to solve. So after retrieving the code I looked at the description — "intake camshaft performance." What that tells me is the performance of the intake camshaft is not good enough for the ECM to be happy. Think about it like a child day care center. If the child does not play nicely and follow the rules, then that child will get a time out. The ECM has a strict set of rules that have to be followed, and if the camshaft doesn't follow those rules the ECM will illuminate the check engine light and put the camshaft in a "time out" — at a rest position. So, my next step in my diagnostic thought process would be to hook up my scan tool and look at the DTC status of this code (Figure 2). The DTC status told me that this code did not run this ignition cycle, but it has failed since it was last cleared. The code did pass the last time the ECM ran the test for this code. So as of now this code is a history code and it did set the check engine light. What does this tell me? That





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just clearing this code and sending the customer on their way did not fix this car. The shop did this on the customer's first visit with the thinking that this was a history code and possibly a false code. Looking at the DTC status tells me that this vehicle has a problem.

This is a performance problem in the intake camshaft circuit, so I want to test this circuit to see if the ECM is processing the signal properly or if the intake camshaft solenoid isn't sending the correct information to the ECM. So let's keep it simple. You have two components here — the ECM and the intake camshaft solenoid. Let's isolate the two. When we start our testing process by disconnecting the connectors at the solenoid or ECM, we take the chance of disturbing the connections, which could be our problem. So let's leave the circuit intact first. I hooked up my scan tool and wanted to look at the data that the ECM was looking at. As I looked at the scan data for the intake cam angle percentage, I watched the desired cam angle and compared it to the actual cam angle (Figure 3). Throughout the rpm range, both the desired and actual specs matched. What that tells me

is that right now the problem isn't happening.

On this particular vehicle, I was able to perform a bi-directional test and command a change in the intake camshaft angle. I went into the test and was able to send a command to the ECM and watch whether the ECM acknowledged the change. Looking at the data PIDs as I altered the command (Figs. 4, 5) showed me that the ECM did, in fact, see the signal sent but did not acknowledge a change. That tells me the ECM is at least awake. So is the ECM not able to make the change or is the camshaft solenoid not moving with the command sent?

Now it's test time. Since the camshaft solenoid is easier to get to than the ECM, I have decided to start my testing there. I hooked up my scope to the solenoid connector on the intake camshaft solenoid (Figure 6). I put my scope on channel 1 and my time base setting to 50 ms. I set my voltage scale to the 20-volt setting. My positive test lead hookup was attached to the solenoid connector by back probing into the connector's purple wire, which is the solenoid's actuator control circuit. My negative test lead went straight to the negative terminal at the battery. I activated the bi-directional test with the scan tool and once again there wasn't a change in the circuit and my scope reading didn't change as well.

Now I feel it's time to break the circuit open or separate one component from the other. The next test was a resistance test. I disconnected the solenoid connector and set



my DVOM to the Ohms scale. The spec for this solenoid is 8-12 ohms. By placing my test leads across both solenoid terminals, I measured the resistance. My first reading was a little over spec (Figure 6), which I contributed to the fact that this engine was at operating temperature and my reference information didn't specify a hot or cold reading. I tried the same measurement a few minutes later and that showed that this solenoid is way over spec (Figure 7). I assumed that my two readings were different due to the change in the engine temperature after cooling down for a couple of minutes.

Based on my testing and scan data readings, I knew this was a bad solenoid. The whole process took me only 10 minutes. By past experience, I knew that these solenoids were known to have a high failure rate. I could have had the shop try a new solenoid and it probably would have fixed the vehicle, but as a mobile tech, it's my job to make sure that there isn't something else going on that could lead my diagnosis in a different direction. I like to "test, not guess." This vehicle issue was solved based on knowing how this particular



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system works and by isolating the players involved and focusing on what the diagnostic trouble code actually means.

Not every call is for a car

My next vehicle is rather unique in that it is a commercial truck used in the shipping business down at my local port. It's called a spotter tractor (Figure 8) and is manufactured by a company called Tico. This unit is a 2016 that has a QSB 6.7L Cummins engine, which is an industrial, or off-highway engine. It has a check engine light and a stop engine light illuminated on the dash. The main complaint is that the truck is not responding to the accelerator pedal. The emission system on this truck has what is called a Tier 4 system in that it has a selective catalytic reduction (SCR) system installed (Figure 9). As I mentioned previously, you need to properly understand the system you're working on and keep the problem as simple as possible.

I hooked up my Cummins Insite scan tool. That is the factory tool used by the Cummins engine company. I retrieved multiple diagnostic trouble codes (Figure 10). Looking at the codes and their descriptions gave me a pretty

good idea of what was happening here. Codes 3497, 3498 and 1673 are all showing that the DEF tank level sensor is telling the ECM that the tank level is getting low, then lower and finally extremely low (Figure 11). These codes are set as inactive codes, meaning there was a problem at one time but not now, just like your history codes in your light duty scan tools. Code 3547 shows the DEF tank was empty and now it's an inactive code due to the fact that the tank was filled after the fact.

The next three codes are active codes, meaning the fault is currently happening. Code 3714 has given the truck the dead accelerator pedal. The ECM has disabled the accelerator pedal in an effort to prevent the truck from operating any further. This code is activated to protect the SCR system from being damaged until repairs can be made. The next code is 3547, which set due to the tank being empty at one time, and code 4769 was set due to the fact that the DEF fluid was added to the tank at an abnormal rate of change and that it was noted by the ECM. Now the very last code is the reason this truck is in this condition. Code 3712 was set

by operator inducement. The driver ignored all the warning lights on the dash, along with the DEF level gauge, and continued to drive the truck. Eventually the ECM will say enough is enough and disable the accelerator pedal, putting the vehicle in limp mode, or a power derate. In order for this condition to be rectified, the DEF tank needs to be filled to the full mark and the system needs to be reset. For a reset to be accomplished, the active codes need to be cleared along with the inactive codes. After clearing all the codes, should any code come back as active



or inactive, then there is still a fault in the system and that will require normal diagnostics.

On this truck, just clearing the codes will not bring back the inoperative accelerator pedal. This truck will have to have a manual regeneration performed along with a SCR performance test (Figure 12). Any codes stored in the system will prohibit the capability of performing the tests. Only then will the system be reset and the accelerator pedal return to its normal operating condition. After doing the necessary tests and procedures, the truck returned to its normal state. I have seen the same type of problems in the light-duty vehicles as well. The SCR system on diesel engine-equipped vehicles are to be included as part of the maintenance requirements and should be performed during regular maintenance checks.

Both of these case studies illustrate the fact that I didn't need to get real deep in the diagnostic thought process

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INSITE 7.6.0.272 - QS86.7 CM2350 ECIAN - Engine Serial Number - 74045259 - ECM Code - ER80418.00

Fault Code	Status	Count	Lamp	Description	PID	SID	J1587 FMI	J1939 FMI	SPN
CM2350A	ECM Time(Key On Time)	941:42:45	Last	HH:MM:SS					
	Engine Hours	914:09:35		HH:MM:SS					
	Keyoffs	882							
4769	Active	1	Amber	Aftertreatment 1 Diesel Exhaust Fluid Tank Level Sensor - Abnormal Rate of Change		233	10	10	176
3714	Active	4	Amber	Engine Protection Torque Derate - Condition Exists			11	31	156
3712	Active	2	Red	Aftertreatment SCR Operator Inducement - Data valid but above normal operational range - Most Severe Level			0	0	524
3498	Inactive	3	Maintenance	Aftertreatment 1 Diesel Exhaust Fluid Tank Level - Data Valid But Below Normal Operating Range - Moderately Severe Level			1	18	176
1673	Inactive	3	Amber	Aftertreatment 1 Diesel Exhaust Fluid Tank Level - Data valid but below normal operational range - Most Severe Level			1	1	176
3547	Inactive	3	None	Aftertreatment Diesel Exhaust Fluid Tank Empty - Condition Exists			11	31	409
3497	Inactive	4	Maintenance	Aftertreatment 1 Diesel Exhaust Fluid Tank Level - Data Valid But Below Normal Operating Range - Least Severe Level			1	17	176

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10

to achieve a successful outcome. I kept it as simple as I could. When I get a call from a customer to do a diagnostic job, I always try to get as much information from the customer as I can. The more information, the better. The first thing I look at is what is involved in the system I'm working on, who are the players in the system and how does the system operate. You have to know how it works before you can fix it, right? It doesn't take



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very long to go to your information system and read about that particular code or codes that set. Find out what specific criteria had to happen when that code set and what the control module needs in order for that code not to set. Look at the components in the system that are involved with that specific code or codes. Look for similarities between codes. Did the same components play a part in all the codes set? What's important to note is that every code has a description that will tell you what that code means. Along with understanding how the code set criteria work, you should pay particular attention to the fact that the codes that set could belong in the same system. If they don't, then perhaps you might have to alter your diagnostic game plan to account for those systems that are not directly involved in your vehicle issue. Some codes will set in multiple systems, but just be aware that they could be the cause of another system's fault. Experience will help you with that thought process. So when that

Name	Value
Aftertreatment Diesel Particulate Filter Soot Load Status	Normal
Aftertreatment Diesel Particulate Filter Intake Temperature	1023.8
Aftertreatment Intake NOx	357
Aftertreatment SCR Outlet Temperature	915
Aftertreatment SCR Intake Temperature	529
Aftertreatment Outlet NOx	204

Status

- The Aftertreatment SCR Catalyst Outlet NOx Sensor test has passed.
- The Aftertreatment SCR Catalyst test is running.
- The Aftertreatment SCR Catalyst test has passed.
- The Aftertreatment SCR Performance test has completed. Please key off and restart the engine.

12

next vehicle arrives in your bay with a check engine light illuminated on the dash, just keep a couple things in mind. Keep it simple and don't over think. Remember to "interrogate" the problem, then "separate" the players involved and finally "isolate" the culprit. Doing so will ensure a successful repair so you don't "evaporate." *TLZ*



EDWIN HAZZARD has more than 30 years' experience in the automotive industry as a technician, service consultant and mobile diagnostic tech. He is the owner of a successful

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POCKET POWER

SCAN TOOLS COME IN MANY SHAPES AND SIZES, OPENING UP OPTIONS TO THE WORKING PROFESSIONAL WHO JUST NEEDS BASIC INFO OR A QUICK LOOK

TRACY MARTIN // Contributing Editor

Professional technicians don't generally purchase tools that do it yourself. The reasons for this can include tool quality, availability of specialized tools, longevity and ease of repair or replacement. In general, the adage that "you get what you pay for" holds true for automotive tools. This reasoning also applies to electronic tools as well. For example, a \$30 digital multimeter can provide basic electrical measurement capabilities, but it's no substitute for a professional meter like the Fluke 88V that retails for \$449 and is designed for automotive use with features like Min/Max record, millisecond fuel injector pulse width and an analog bar graph.

Scan tools are no different. DIY models range in price from \$35 for a

simple coder reader to around \$500 for a scan tool. Professional scan tools start at about \$800 and can exceed \$6,000 for the most sophisticated models. Spending \$6,000 for a scan tool may not make economic sense for every technician and many shops have one high-end scan tool that multiple technicians use on an as-needed basis. Depending on how big and how busy a shop is, having only one scan tool can create a diagnostic bottleneck, particularly when a vehicle first comes into a shop for an estimate. Having an inexpensive scan tool for every technician can speed things up on a busy morning when lots of vehicles show up with their check engine light on. There are alternatives to using a hand-held scanner to perform basic functions like reading trouble codes and turning the check engine light off and many technicians already own half of an inexpensive, portable, highly functional scan tool — a laptop or smartphone.

Technicians who already own a laptop can avoid some of the cost of a hand-held scanner or code reader by using it as a scan tool. A laptop with OBDII software installed, and a connection to the vehicle's OBDII data link connector (DLC), can provide technicians with the same or greater levels of functionality as many high-end scan tools. The hardware component of this setup is a USB cable and adapter that plugs into a vehicle's DLC, connecting it to a laptop. Wireless communication is also available via Bluetooth, or WIFI connectivity. There are numerous soft-



BY INSTALLING DIAGNOSTIC SOFTWARE and purchasing an OBDII interface, a laptop can become a powerful, portable scanner with a large high-resolution display screen.

ware programs available that turn the laptop into a scan tool, including free "shareware" that can be downloaded. In addition to reading and erasing DTCs, this software can also display customized gauges (analog and digital), graphs, tables, charts and alerts, all of which can be viewed as a virtual dashboard. Because of their portability, a laptop can be taken along for a test drive to record OBDII data.

The downside of using a laptop as a scan tool is that many are too fragile to survive a typical shop environment for long. Laptop keyboards and greasy fingers are not a good combination, and a laptop that makes an unintentional "trip" from the workbench to the shop floor is going to be expensive, if not impossible, to repair. They also take up lots of space in a toolbox drawer. A better alternative to a hand-held scan tool or laptop is the other device that most technicians already own — a smartphone.



PICK A PHONE — both iPhone (left) and Android smartphone platforms allow users to download OBDII-related apps that turn their phone into a portable dynamometer, scan tool and trouble code library. iTunes and Google Play websites have a mind-boggling number of these types of apps that range in cost from free to \$10.

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What do smartphones have to do with OBDII? You may have heard the saying, "There's an app for that." And there are many OBDII-related mobile applications. Searching Google Play and Apple's iTunes websites, over 500 applications can be found that allow a smartphone access to OBDII data via a dongle, or adaptor, that plugs into a vehicle's diagnostic connector. Adaptors are available online from \$10 to \$100, and many have Bluetooth or WIFI capabilities to connect with a smartphone. Some adaptors work only with their specific apps and offer more than a generic interface of OBDII vehicle data.

OBDII-related apps are an inexpensive way for technicians to have a fully functional Global OBDII scan tool that as a bonus receives and makes phone calls. Many of these applications do more than simply read and erase trouble codes. They can display real-time data from the car's engine management system, provide instant fuel economy numbers and display custom dashboards with all types of gauges. With all the OBDII data available, it's no wonder that some of these applications also offer some fun, behind-the-wheel features. Because smartphones are equipped with accelerometers and GPS-locating capabilities, OBDII apps can provide a sophisticated view of a car's performance. The vehicle's weight, horsepower, torque and acceleration can all be calculated and displayed in the form of performance gauges or

graphs. We'll take a closer look at some OBDII adapters and smartphone apps that are especially useful for professional technicians.

BlueDriver Adapter and smartphone app

Lemur Monitors (www.lemurmonitors.com) provides advanced diagnostic solutions via their BlueDriver platform. The BlueDriver app is designed to work exclusively with their adapter as a complete system. Available for both Android and iOS devices, the BlueDriver app focuses on repair instead of fuel economy or engine horsepower information and is ideal for the professional technician.

Using the BlueDriver app is easy. On vehicles from 1996 to mid-2000, just type in the VIN number and the app will populate the vehicle's information fields. Entering the VIN number from most mid-2000 to present vehicles is not necessary, as the app will automatically recognize them and record their information. The app is well organized with two tabs: Scan Tool and Live Data. The Scan Tool tab is the main feature and presents functions that include reading/erasing codes, generating repair reports, freeze-frame data, smog check information, Mode \$06 data, MIL status, vehicle information and a handy flashlight for locating the DLC. The Live Data tab monitors real-time performance by displaying sensor values and data using customizable gauges and graphs. Standard OBDII nomenclature is used so professional

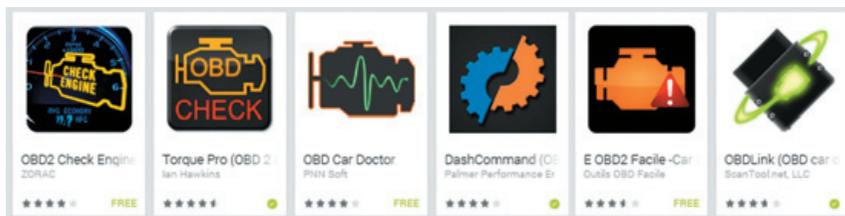


SMARTPHONES, LIKE THE IPHONE (left) and Android-based Samsung can communicate with the BlueDriver adapter and its dedicated app. The app can be downloaded for free from either the Apple Store or on Google Play.

technicians will easily understand what's being displayed.

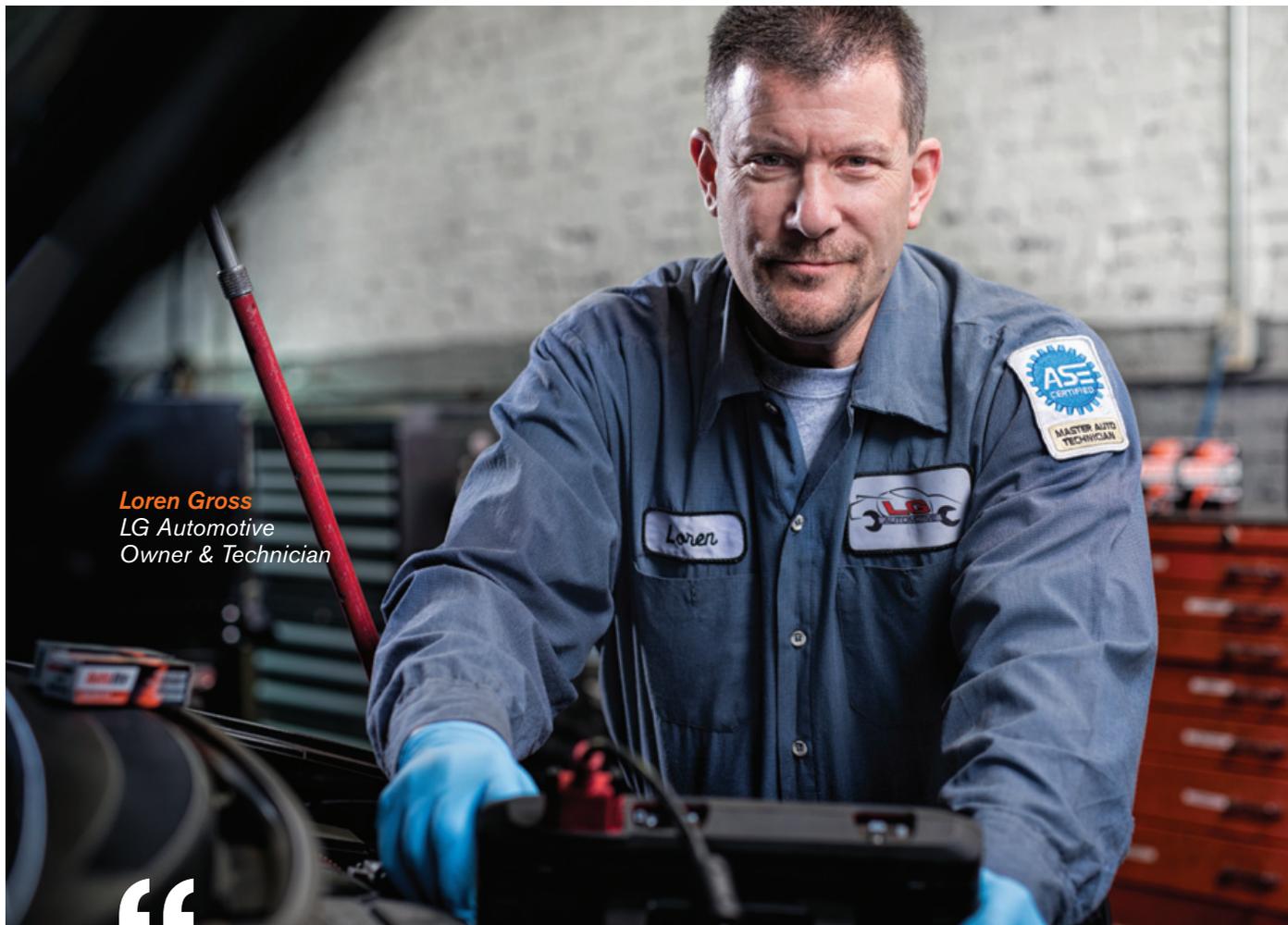
One of the most useful features of the BlueDriver app is its reports function. When a DTC is present, a report can be generated and emailed directly from the app. Reports list the DTC set, its definition, possible causes and a list of repairs that address the root cause for the DTC. The BlueDriver repair database contains over 4.5 million experienced-based reported fixes for DTCs that are ranked as Top Reported Fixes, Frequently Reported Fixes and Other Reported Fixes. A technician could use the report information to assist in filling out an estimate for repairing the cause of the DTC. The report could be emailed to the customer; however, some judgement should be exercised before sending this information directly to a customer and should be dependent on the specific DTC and the possible "fixes" that the app suggests.

Another feature of the BlueDriver app is its ability to display Mode \$06 data. Available on all Global OBDII vehicles, Mode \$06 is a listing of all the individual tests an ECM makes as part of its various monitors. Mode \$06 can provide technicians an additional di-



BETWEEN THE GOOGLE PLAY STORE (ANDROID) and Apple Store (iPhone) there are over 500 apps that utilize on-board vehicle computer output from the OBDII data link to interface with these applications. They provide a wealth of information, education and entertainment all at a low cost to the user.

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“

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agnostic path toward determining the root cause of a DTC. Other features of the BlueDriver app include enhanced diagnostics for ABS, airbag and transmission systems for General Motors, Ford, Chrysler, Toyota and BMW/Mini for North America. In addition, Smog Readiness Check and multi data (PID) interactive graphing and logging are available. The BlueDriver app can be used on an unlimited number of vehicles to read all of the aforementioned data at no additional cost.

The BlueDriver adapter retails for \$99.95, and the app can be downloaded for free from Google Play or the Apple Store without purchasing the adapter. Lemur Monitors has a professional helpdesk staff available to answer phone calls, emails or chat online regarding use of the BlueDriver app and adapter.

U-Scan adapter and app

Actron, a division of Bosch Automotive Service Solutions, offers the U-Scan CP9600 Smartphone Wireless Vehicles Diagnostics. The U-Scan CP9600 adapter plugs into a vehicle's DTC and works exclusively with the U-Scan app for both Android and Apple iOS devices. The adapter retails for \$108.95 and uses a Bluetooth connection to pair with a smartphone and works on 1996 and newer vehicles, including those using CAN protocols.

The U-Scan app is free and can be downloaded from Google Play or the Apple Store. Included with the app are AutoLink, which automatically identifies most 2000 and newer vehicles upon connection; Vehicle Activity, a log that provides a history of vehicle tests and procedures; QuickCheck, which reads and erases DTCs, provides code definitions and shows I/M emissions status; and MyGarage, which provides easy access for users to manage vehicles that the tool has been previously connected to. Included with the U-Scan

app is Powertrain Enhanced Data that allows users to access manufacturer-specific diagnostics and code definitions. Freeze-frame data can also be viewed and the app can display over 300 sensors (if supported by the connected vehicle) as numbers or graphs.

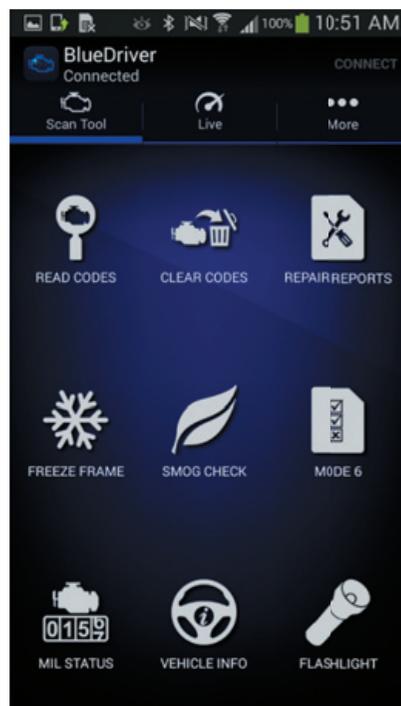
To take advantage of the full potential of the app, technicians should consider purchasing U-Scan's advanced applications. These include Unlock CodeConnect (\$39.99) that lists the most likely cause for specific DTCs; ABS DTCs and Definitions (\$29.99), which accesses ABS brake data; and Airbag DTCs and Definitions (\$39.99) that accesses vehicle airbag systems. If all the advanced applications are purchased, they add up to \$109.97 plus the cost of the U-Scan adapter, for a total of \$218.92.

OBDLink MX adapter

OBD Solutions is a leading provider of onboard diagnostics. Their hardware and software offerings cover the full spectrum of onboard diagnostic applications including smartphone-to-OBDII Bluetooth interfaces. They can be found on the web at www.obdsol.com. OBDLink, a subsidiary of OBD Solutions, makes two interfaces — the LX and MX Bluetooth adapters — both of which can be purchased at www.ScanTool.net.

The OBDLink MX Bluetooth is an easy-to-use, inexpensive, Bluetooth OBD adapter that can turn a smart phone, tablet or laptop into a sophisticated diagnostic scan tool, trip computer and real-time performance monitor. Pairing the MX with a smart mobile device or Bluetooth-equipped laptop is easy and only takes a few minutes. The MX is small enough to leave plugged into a vehicle's DLC while driving. Leaving it connected, even when the vehicle is not in use, does not drain the vehicle's battery as the adapter features automatic sleep and wake-up functions.

The MX Bluetooth works with all



THE BLUEDRIVER MAIN SCREEN

is well organized with scan tool and live data tabs, making navigating the app easy. Reading DTCs can be accomplished quickly and pressing the Repair Reports icon allows the user to email a report of any trouble codes set and other vehicle repair information.



THE U-SCAN ADAPTOR works

exclusively with Actron's U-Scan app, which can be downloaded for free from either the Apple or Google Play stores.

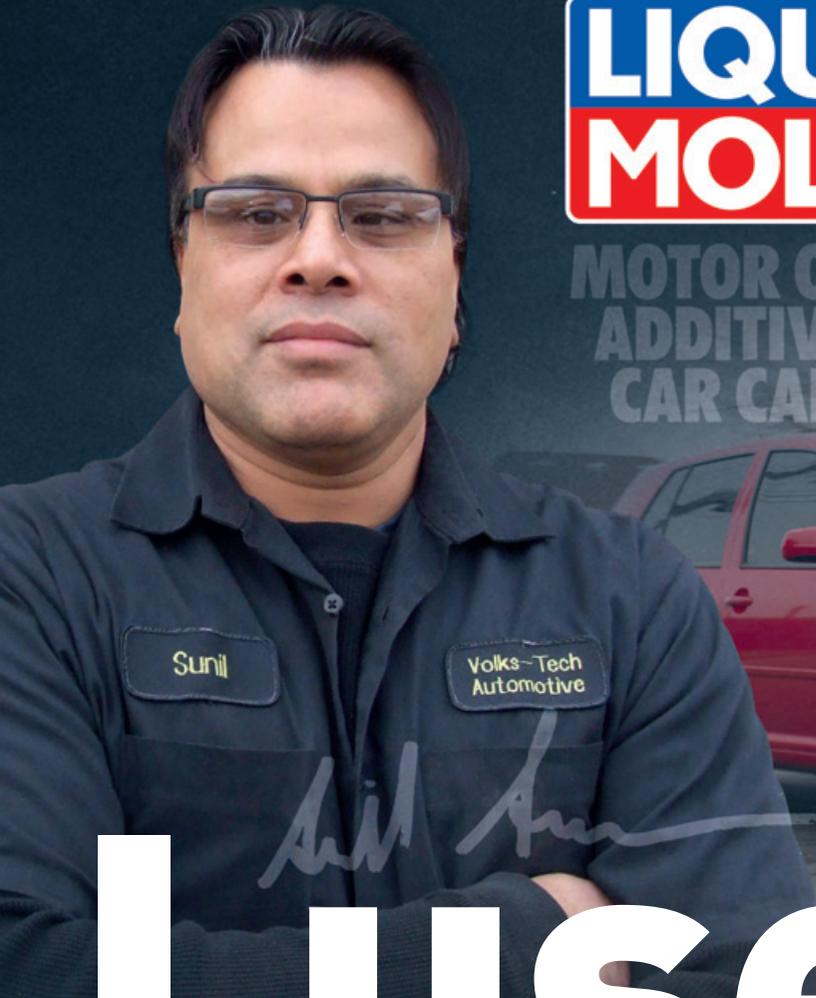
1996 and newer cars and light trucks sold in the United States. It supports all legislated OBDII protocols including EOBD, JOBD and all other international variants of OBDII. In addition to standard OBDII protocols, the adapter can communicate with General Motors SW-CAN and Ford MS-CAN networks to access body, HVAC and other on-



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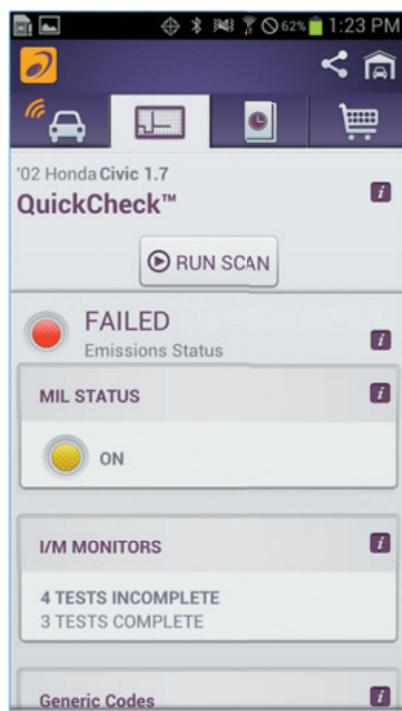
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board systems. The processing speed of the MX adapter renders smooth graphics and rapid changes in gauge readings on smartphone or tablet displays.

Because OBDLink MX is backwards compatible with the ELM327 command set, it will interface with dozens of third-party apps for Android-based smartphones. It does not work with iOS operating systems. The OBDLink MX Bluetooth sells for \$79. To keep the MX operating system up to date, free firmware and software updates are available via the OBDLink website. Also included with all OBDLink products is a license key for OBDWiz diagnostic software that runs on a Windows-based PC or laptop. All OBDLink products are covered by a three-year warranty and a 90-day money-back guarantee.

Smartphone apps

OBDLink — The Android-only OB-



THE U-SCAN QUICKCHECK SCREEN

offers a view of emissions, MIL status and I/M monitor information. When the “i” icon next to each feature is pressed, a pop-up screen is displayed providing information about that function — a very handy feature.

DLink app was developed specifically for the OBDLink adapters and can be downloaded for free on Google Play. The app turns a phone or tablet into a full-fledged diagnostic scan tool that can read and erase diagnostic trouble codes, display emissions readiness and estimate fuel economy. The app can display emissions readiness standards specific for each state in the U.S. In addition, it can create customizable dashboards that use multiple trip meters, log engine management data in a CSV format (used in Microsoft Excel), and track vehicle performance in real time. Unlimited software updates for the app are available at no cost.

Torque Pro — One of the most popular apps that uses OBDII inputs is Torque. This Android-only app comes in both free (Torque Lite) and paid versions (Torque Pro) for \$4.95. Torque functions as a scan tool and provides the ability to read and erase trouble codes, display freeze-frame data, view live sensor data, check OBD readiness monitors for emission testing and provides access to a DTC database of fault codes from different manufacturers. Using a smartphone’s GPS input, the app features a Track Recorder plugin that correlates the vehicle’s location with OBD II data.

After inputting vehicle-specific values for engine displacement, vehicle weight and fuel type into a vehicle profile, Torque Pro can use this information to calculate vehicle performance. Using the phone’s GPS location, internal compass, barometer and accelerometer, Torque can calculate vehicle acceleration rate, 0-60 times, quarter-mile time and speed, horsepower, engine torque and fuel economy. Some of these features are found in the Pro version only.

Users can store multiple profiles for many different vehicles and store separate logs and dashboard layouts for each profile. The View Map func-

tion displays a Google Map with a color-coded log of a user’s last few trips that indicate relative speeds along a route. Users can also choose to display G-forces on this map. This function is useful for autocross events or amateur road racing, as it indicates speed at various points along a racetrack.

The app provides lots of entertainment value from software that costs less than \$5. A word of caution: Trying to set up all the screens, gauges, graphs and other information while driving on the road is not a good idea, as these activities are very distracting. Setup should only be performed when the vehicle is parked in a driveway or as a passenger during a drive.

In this article we have only scratched the surface of all the available OBDII adapters and smartphone apps. Assuming that a technician already owns a smartphone, these tools offer an inexpensive, pocket-sized scan tool that can quickly be used to perform basic, and even advanced OBDII diagnostics. Because of the processing power of a typical smartphone, the graphics displayed of OBDII data can be visually stunning and provide a wealth of easy-to-interpret information. The apps and adapter firmware can be kept current via the smartphone’s online connection and additional OBDII data features can be purchased as well. Smartphone scan tools offer a wealth of information for professional technicians and have one function that even a \$6,000 scan tool can’t provide — a phone call from your significant other reminding you not to be late for dinner. *TM*



TRACY MARTIN has covered the powersports industries since 1998. He is also the author of six Motorbooks Workshop Series books published

by the Quarto Publishing Group and is a regular contributor for *Motor Age*.

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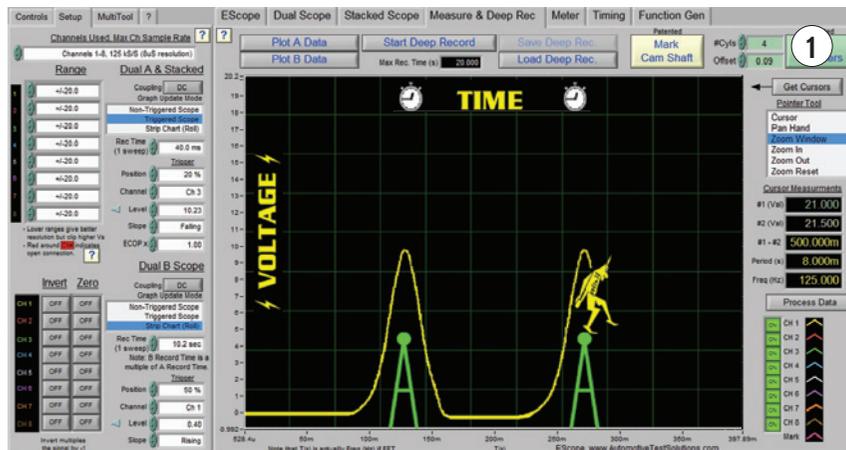
Contributing Editor

It has been stated that a picture is worth 1,000 words; this is perhaps an understatement when working on a vehicle. In order to properly diagnose vehicle systems, a picture into the electronics is a necessity. Modern vehicle systems are based on electronic controls over mechanical systems. To diagnose failures within these systems, we must first separate these systems from one another by analyzing the electronic control system. We need to look at a vehicle's circuits for voltage change over time. This will be accomplished with an oscilloscope.

Defining the DSO

What is an oscilloscope? Webster's Dictionary states: an oscilloscope is an instrument in which the variation in fluctuating electrical quantity appears temporarily as a visible waveform on a fluorescent screen of a cathode-ray tube.

What is important with this statement is "variations in a fluctuating electrical quantity" or "variations in fluctuating voltage." So what is voltage? Voltage is a unit of measurement based on an electrical force or the electrical pressure difference between two points of a conductor. What this indicates is the scope or any voltage-measuring instru-



ment is only displaying the difference of electrical pressure. So if both the positive and negative leads are connected to the positive post of the battery, the display would show 0 volts. On a charged vehicle battery, both leads would have 12.6 volts on them, so in this case there would not be a voltage difference between the leads, thus a display of 0 volts. If the negative lead was then moved to the negative post of the battery, the display would now show the source voltage of the battery, or 12.6 volts. Be aware the measuring device only shows the difference of voltage between the two leads. Where the leads are placed is the test! When first connecting a voltage-measuring instrument to the vehicle, it will be important to connect the negative lead to the negative post of the battery; this will ensure that you are on the low-

est point of potential of the vehicle, thus providing you with accurate test data.

The oscilloscope is a tool used to enter into another dimension of time. In our dimension of time, you can move from one point to another point fairly quickly. For instance, a Top Fuel Dragster can travel ¼ mile in less than 4 seconds. This takes a nitromethane supercharged engine that produces more than 10,000 horsepower. Electricity, however, can go around the earth 7.5 times in just 1 second. This is far faster than the human brain can recognize. Therefore, this electrical movement must be altered so we can recognize or see it. This is done by having the force that is pushing the electrons (voltage) leave a trace behind it as it changes over time (Figure 1). This trace that is left behind is now in our dimension of time.

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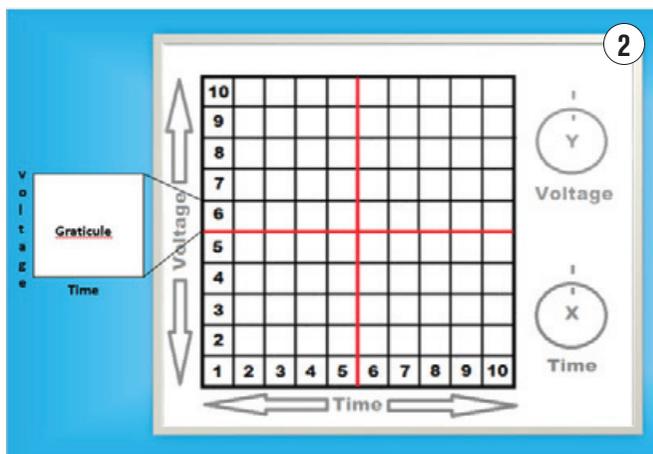


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This allows us to physically see the voltage movement in time, and it's what will be displayed on the screen of the oscilloscope.

It is important to understand what the voltage is indicating to you. Since voltage is only present to push electrons through resistance, if the voltage changes, then the resistance within the circuit is also changed. This can be demonstrated by analyzing a good circuit from the point where the source voltage is present on the power side of the circuit to the point of the load or resistance. As soon as you pass the point of the load or resistance on the ground side, there is very little voltage remaining. Voltage in a circuit is only present with resistance within that circuit or if the circuit is open. In the case of an open circuit, source voltage is present to the point where the circuit is open. Each voltage change displayed on the scope screen will be indicative of what is occurring in the circuit.

The oscilloscope display is shown in Figure 2. As can be seen, the screen is divided into two planes, that of a horizontal plane (X axis), and that of a vertical plane (Y axis). The vertical plane — or up-and-down plane — will display the voltage level. The horizontal plane — or side-to-side plane — will display time. These planes will be divided into 10 grids, referred to as graticules. A graticule is a network of lines representing

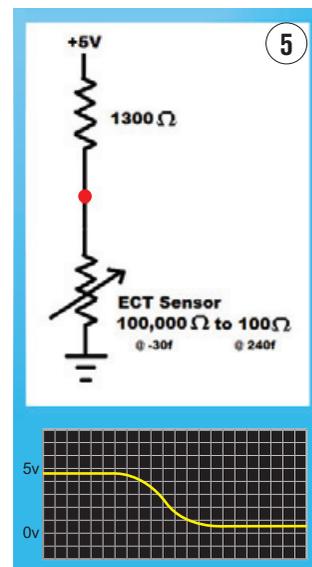
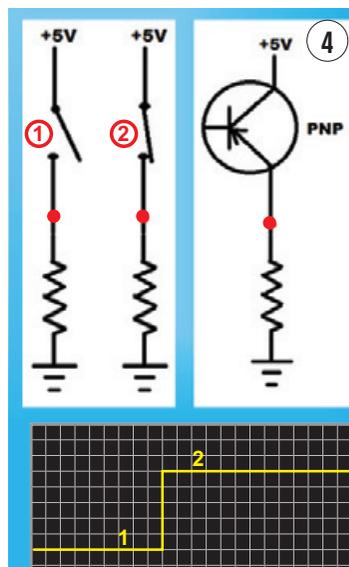
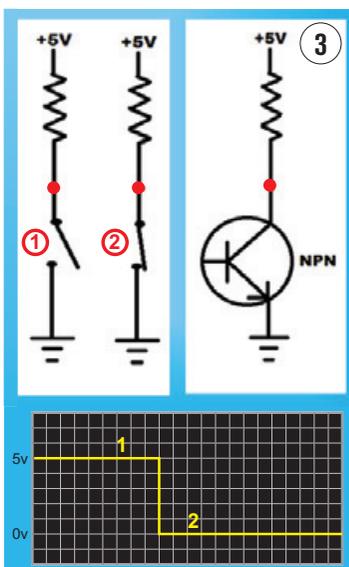


meridians and parallels, on which a map can be represented. The voltage changes over time will be mapped on the oscilloscope display. Each line will represent a value; those vertical division lines will show voltage and those horizontal division lines will show time. These divisions can be adjusted by the controls on the oscilloscope. To adjust the scope settings, simply watch the waveform on the display and make changes to the voltage and time settings until the waveform is clear on the scope display. This is very similar to taking a picture with your camera. In order to take a good picture, you adjust the lens while viewing the object. This lens movement will focus the light on

the object for a clear view. It will not be necessary to know exactly where you will need to adjust the camera lens. Once the lens is adjusted, the settings can be looked at to see where they are. This is similar to the scope settings; you do not need to know exactly where the scope needs to be adjusted to, just get a clear picture and then look at the setting to determine what

the voltage and time of the signal being viewed is. A scope is a very simple tool to set up — don't over complicate it.

Another adjustment of the oscilloscope is how the data will be displayed. This can be set up with a trigger mode, roll mode or non-trigger mode. The trigger mode is used to stabilize the waveform being viewed. These settings are adjusted by the channel, voltage level, voltage slope and display position. The channel will represent which channel will be used for the trigger. The voltage level or trigger level will represent the voltage needed to break a threshold that will allow the screen sweep to occur. This is usually set to half of the voltage of the waveform being viewed.

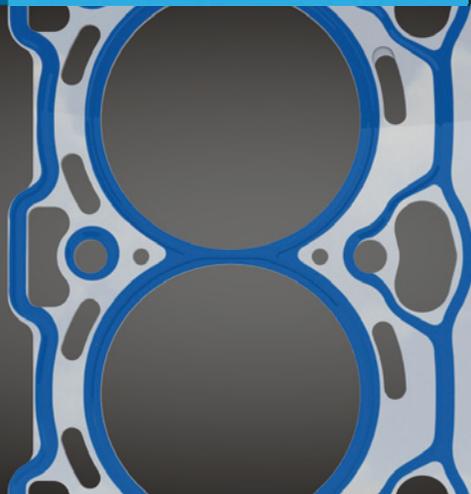


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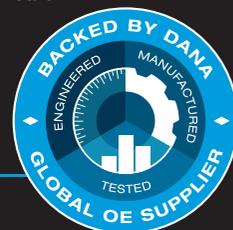
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In other words, if the voltage is moving from 12 volts to 0 volts, the level would be set at 6 volts. The voltage slope will be set for a falling edge or a rising edge. In other words, if the slope is set to a falling edge, the trigger voltage that is set will have to be at a higher level and drop to a lower value in order for a screen sweep to occur. If the voltage slope is set for a rising edge, the trigger voltage that is set will have to be at a lower level and rise to a higher value in order for a screen sweep to occur. The display position is the point on the display the voltage trigger level will start from. It is important to understand that a trigger can hide a failing circuit. This occurs when the set voltage level is not broken, and thus a screen sweep will not occur. On all oscilloscopes, the last triggered event will remain on the scope display. Let's say the waveform is present on the scope display and is active. If the circuit driver fails intermittently, the trigger level is not broken and therefore does not make a screen sweep. However, the last screen sweep remains on the scope display. This will hide the failing circuit. This is why it is best to avoid the use of triggers. It will

be best to use the strip chart roll mode.

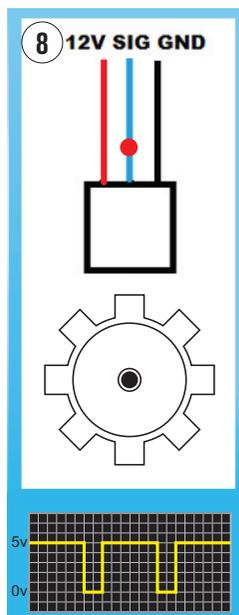
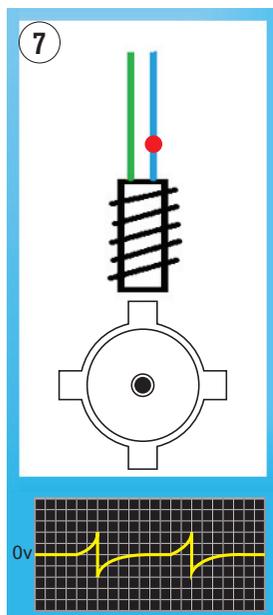
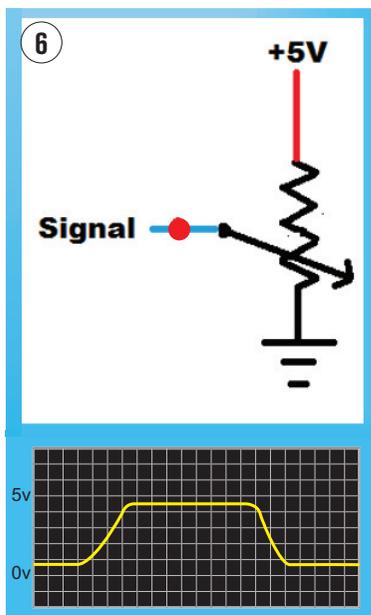
The strip chart roll mode acquires all of the data and displays it on the scope screen. The difference between the triggered mode and strip chart roll mode can best be understood by comparing a single-shot camera with a video camera. If you are moving on a highway at 200 mph and take a single picture of the buildings passing by, then reset the camera and take yet another picture of the buildings, it would be clear that there would be missing data between the points that the pictures were taken. However, if this same scenario took place but a video camera was used then no data would be missing between the buildings. All of the data would be present for your review. This is why it is best to use the scope in a roll mode and then go back through the acquired data to determine what caused the failure.

Understand what you are connecting to

It is important to have an understanding of what you are connecting to on the vehicle. The vehicle has many physical events that will need to be monitored

in order to control a system. In order to monitor these events, electrical sensors are used. An electrical sensor converts a physical quantity into an electrical output. The microprocessor can then use these electrical outputs from the sensors to control the system. Electronics are about timing. In order to see where the timing events are, you will need more than one channel. One example would be using the oscilloscope to see the ignition coil fire. With only one channel you could see the coil fire but could not tell where in space this occurred. For instance, if the coil fired at BDC the engine would not start, but with no other reference you would not be able to see where this event occurred, only that it had occurred. The oscilloscope takes the voltage and displays this in a graph format. In order to take advantage of this graphing format, multiple channels will be used. These channels will then be compared to one another in order to determine if the events occurred at the correct time and in the correct sequence.

When using the oscilloscope it is important to have an expectation of what will be displayed. By looking at a wiring diagram of the circuit under test you can determine what the circuit is most likely going to do. Let's look at Figure 3. In Figure 3, if the positive lead of the measuring instrument is at the red dot and the ground lead is at the battery ground, you can anticipate what the voltage reading will be. With the switch in position 1, which is an open circuit, the circuit will have source voltage on it. An open circuit will always have source voltage to the point where the circuit is open, and source voltage in this case is 5 volts. When the switch is moved to position 2, which is a closed circuit, the circuit will have 0 volts on it. When





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the switch is closed (position 2), the test point is on the ground leg of the circuit, thus the voltage will be very close to 0 volts. If this circuit has a Negative Positive Negative (NPN) Transistor, which is one of the two types of bipolar transistors, consisting of a layer of P-doped semiconductor (the “base”) between two N-doped layers, the collector and emitter. A voltage increase on the base is amplified to produce a large collector and emitter current. This NPN will have two circuit states open, and closed. Additionally the NPN can have a third state where it is partially on. This would depend on the base voltage level applied to the transistor.

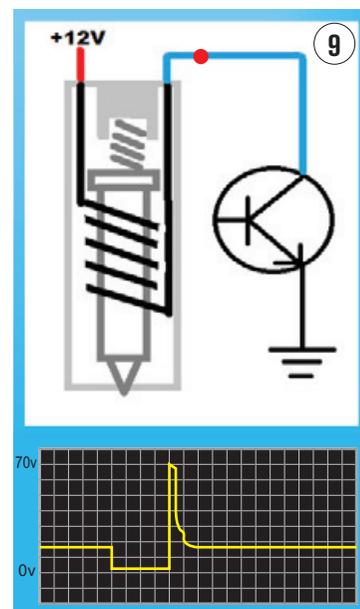
In Figure 4, if the positive lead of the measuring instrument is at the red dot and the ground lead is at the battery ground, you can anticipate what the voltage reading will be. With the switch in position 1, which is an open circuit, the circuit will have 0 voltage on it. When the switch is moved to position 2, which is a closed circuit, the circuit will have 5 volts on it. When the switch is closed (position 2), the test point is on the power leg of the circuit, thus the voltage will be very close to 5 volts. If this circuit has a Positive Negative Positive (PNP) Transistor, which is one of the two types of bipolar transistors consisting of a layer of N-doped semiconductor (the “base”)

between two P-doped layers, the collector and emitter. A voltage decrease on the base is amplified to produce a large collector and emitter current. This PNP will have two circuit states: open and closed. Additionally, the PNP can have a third state where it is partially on. This would depend on the base voltage level applied to the transistor.

In Figure 5, the circuit is based on a voltage divider. A voltage divider is a circuit that is based on two resistances in a series circuit. The voltage will be consumed or used as it pushes the electrons through each resistor. The amount of voltage used will depend on the size of the resistors. If the resistors are equal, the voltage will divide equally between them. With 5 volts supplied to the circuit, if the positive lead of the measuring instrument is at the red dot and the ground lead is at the battery ground, you will read 2.5 volts on the circuit. If the first resistor is larger than the second resistor, the voltage will be smaller than 2.5 volts. If the first resistor is smaller than the second resistor, the voltage will be greater than 2.5 volts. This circuit will produce an analog voltage output, or a voltage signal that continuously changes over time.

In Figure 6, the circuit is based on a potentiometer. A potentiometer is a variable resistance with a third adjustable terminal. When placed between a power source and ground source, the resistor will consume voltage. The third terminal is then moved on the variable resistor, thus producing an analog voltage output based on where the third terminal is positioned on the resistor. If the third terminal is closer to the power source, the voltage output will be higher; if the third terminal is closer to the ground source, the voltage output will be lower; and if the third terminal is centered on the resistor, the voltage will be divided equally.

In Figure 7, the circuit is based on induction. Induction is based on the production of an electric current in a conductor by varying the magnetic field applied to the conductor. This is a non-contact sensing device that works through magnetic intensity. When a magnetic field is moving across a conductor, it releases electrons, thus producing voltage, which in



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turn produces current. Generally the sensor is made with a magnet and is wrapped with winds of a conductive wire. As the trigger wheel rotates, being made of a ferrous (magnetic) metal, the magnetic field moves. This magnetic field in motion produces voltage, which pushes electrons through the circuit. This is used to produce an analog voltage that is proportional to the shaft rotation. As the shaft rotates, each tooth or target produces a voltage output. This is used to calculate the shaft's velocity. If an index tooth (e.g. missing tooth) is used, then the shaft position can be determined.

In Figure 8, the circuit is based on magnetic intensity. This is accomplished by using a voltage regulator, a thin rectangular piece of indium arsenic, and a magnetic field. The magnetic flux imparts a force on the conductor (indium arsenic), which causes the voltage or holes (positive force) to drift to one edge while the electrons (negative force) drift to the opposite edge. The force that is exerted on the current flow is called the Lorentz Force. While the magnetic force is applied to the conductor, the carriers will stay at opposite sides. This sets up a voltage drop across the conductor. This voltage differential that is created is the Hall voltage. This Hall voltage is used to turn on or off a transistor, which in turn produces a digital signal. Thus, this signal will be in one of two discrete states; off/on, 0/ 1, false/true. This circuit is one that operates like the circuit shown in Figure 3. When the transistor is off, an open circuit is created, so the voltage is that of source voltage, which in this case is 5 volts. When the transistor is turned on, the circuit is pulled to ground. Thus, this sensor produces a 0- to 5-volt signal.

In Figure 9, the circuit is based on an inductor. An inductor is also known as a coil or reactor. The inductor resists changes in electrical current. This occurs due to the nature of the current passing through a conductor, which creates a magnetic field. If the current increases the energy contained within the magnetic field, it also increases, absorbing some of the current and thus stabilizing the current. If the current decreases, the magnetic field's energy is put back into the conductor, thus stabilizing the current within the circuit. When current is flowing in an inductor, a magnetic field is produced that is proportional to the current flowing through the circuit. This magnetic field is used to move or lift a pintle off of its seat. This pintle is used to seal the solenoid or to open the solenoid. When the circuit is open the voltage will be that of source voltage. When the circuit is closed the voltage will drop very close to ground. When the circuit closes, current flows through the circuit creating a magnetic field. This magnetic field lifts the pintle off of its seat so the solenoid can establish flow through it. When the circuit is opened the mechanical spring pushes the pintle back

onto its seat, thus closing it. Additionally, when the circuit is opened, the current is shut off. The stored magnetic field around the conductor windings falls back into the conductor to stabilize the current. This magnetic field in motion crosses the inductor's windings, which induces voltage into the conductor. This produces a high voltage spike, referred to as fly back voltage.

Learning to use an oscilloscope is just like anything that you want to do well — repetition makes you proficient at it. It is important to use your oscilloscope every day. Have an idea of what the circuit you are connecting to is going to do. Once you start to see what the picture on your scope is telling you, you will be able to speak the language of electronics. This language will teach you many things and soon you will wonder how you ever repaired a vehicle without it. *TM*



BERNIE THOMPSON is an automotive diagnostician and trainer, and co-founder of Automotive Test Solutions in Albuquerque, N.M. He is an expert at diagnostics and repair strategy and designs award-winning diagnostic tools and software for the automotive industry.
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KEEPING COOL

IT'S THE MIDDLE OF SUMMER AND THE DOG DAYS ARE UPON US. HERE ARE A FEW THOUGHTS ON KEEPING YOUR CUSTOMERS COOL.

PETE MEIER // Technical Editor

While I don't want to believe it, I have to think that at least one of you reading this column has had a customer walk in the door with a bag full of "DustOff" in hand that he just bought at the local big box store. He had come in a few weeks ago needing repair work on his air conditioning system but couldn't afford the repair. That is, until he saw a YouTube expert online demonstrate how you could use this stuff in place of the R134a the system required and save a bundle in the process. If you have, please email me and share the story!

For those who don't have a clue as to what I'm talking about, hop on the closest computer and do a Google search using the phrase "dustoff for car ac." I got over 1 million results! Granted, they didn't all cover the so-called "air in a can" product used for cleaning computer keyboards and other sensitive parts, and that makes the whole thing all the more ridiculous. And potentially dangerous for all of us.

You never know

For those of you who didn't know, the refrigerant used in many of these "air in a can" products is R152a, a flammable refrigerant that is on the EPA's SNAP (Significant New Alternatives Policy) list and is approved for use in automotive air conditioning systems with "subject to use" provisions. What that means is that



MORE THAN EVER, your shop needs an identifier to protect not only your own refrigerant supply from contamination, but your techs from personal injury.

it is illegal to use it in an existing R134a system. Yet there are videos on YouTube that demonstrate how to replace your existing charge with this product, some even supposedly produced by "professional" technicians. As far as I'm concerned, if you are a "professional" and you promote this kind of nonsense, you should be forced out of our business and sent to work on something that is less capable of hurting someone!

And it isn't just DustOff that is being recommended as alternatives. Other dangerous blends are also demonstrated online and the number of views these videos are getting tells me that there are a lot of cars out there coming into your shops that contain chemical concoctions in their systems you do not

want in your recovery equipment.

How do you protect yourself? It is a must that you use a refrigerant identifier on every car before you attempt to service it, even if it's a low-budget tool that will only tell you whether or not it's R134a or "other." If the system tests anything less than pure, you must recover the contaminated refrigerant in a special container for disposal — and charge your customer accordingly.

Reminds me of one of my favorite sayings, "I didn't build it, I didn't break it, and I didn't buy it — but I can fix it." Add to that now, "I'm not the one who put DustOff in your air conditioning!"

R1234yf – It's here to stay

Recently, I had the opportunity to lis-

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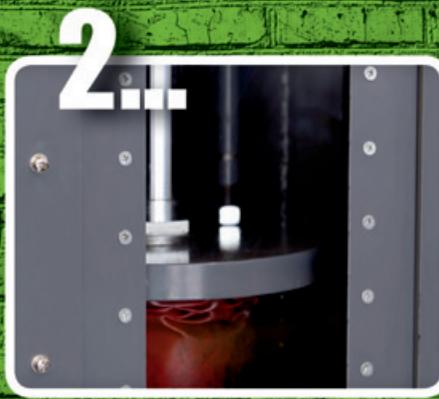
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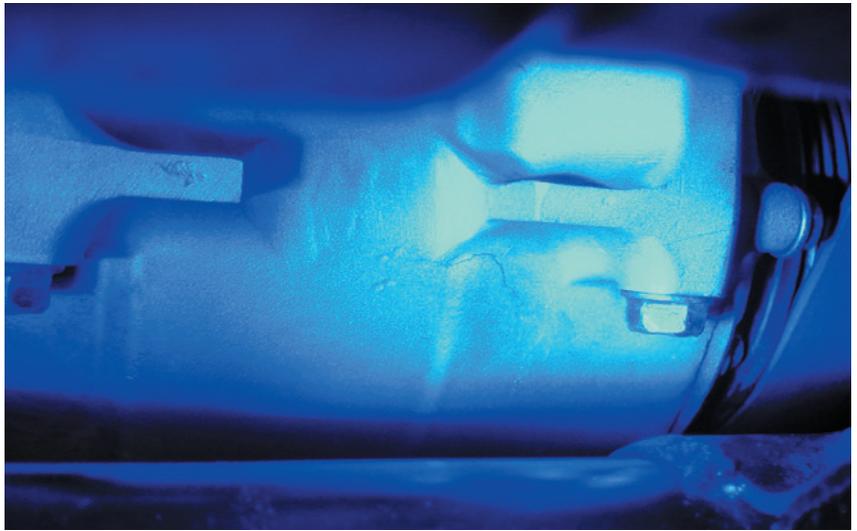
ten to Neutronics Vice President Peter Coll talk about the impact of R1234yf, its increasing use among the OEMs and his responses to questions asked by the technicians and shop owners present at this event. I was surprised to hear how many were still unprepared or unaware of the upcoming challenges they were facing. After all, this is not a new topic and one that we've reported on heavily since this process of incorporating a new refrigerant began.

Let me see if I can help get everyone up to speed.

The Europeans declared R134a was bad for the planet due to its contribution to global warming. And no matter what side of the environmental impact fence you fall in, the simple fact is that the OEMs can't use R134a in their cars anymore. At least, not the ones for sale in Europe. So the search for a replacement began and the candidates that have ended up in the final selection include R1234yf, R744 (CO₂) and R152a. Most OEMs have elected to go with R1234yf.

Here in the States, OEMs who make the switch earn "carbon credits" and that's a big deal. GM was the first domestic OEM to offer models equipped with the new gas and all have some plan to start adding it to their lines in the near future. Additionally, the EPA has begun a phase out of R134a that will ultimately require the use of a replacement refrigerant by everyone who wants to sell a car here.

So, if you haven't already seen R1234yf systems showing up in your shop, you will. This means you'll need new equipment and some training on the differences between R134a cars and those with the new stuff in them. For one, R1234yf is considered mildly flammable, but don't let that throw you. Nearly everything under the hood of the car is mildly flammable. But to be on the safe side, the machine you'll



THE SERVICE AND REPAIR TECHNIQUES you already know can be applied to R1234yf systems – but you may need to use products designed for it.



THAT ORANGE HARNESS on top of the compressor is telling you to stop and consider what you're doing before attempting to service it – this is an electric compressor operating on high voltage.

need is made to minimize any risk involved. Another important consideration comes to replacing the evaporator core (when needed). It must be a new replacement certified to SAE standards.

Speaking of the equipment you'll need, remember that I mentioned using an identifier. You'll have to use it when recovering R1234yf, and that's a good thing. R1234yf is not cheap, and the last

thing you want to do is contaminate a 10 lb. container worth \$1,000-plus!

Servicing itself is the same as any other system you work on, so no surprises there. Your existing sniffer may or may not work with the new gas, so factor in a leak detection system in your shop budget while you're at it.

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tomechanika 2017 at McCormick Place in Chicago this July and learn from the experts firsthand. Peter Coll will be there hosting a session on exactly what the story is regarding R1234yf, and MACS Director of Training Steve Schaeber will be presenting multiple sessions, including the opportunity to get your required Section 609 Certification while you're there. Even if you have yours, the new material includes a lot on R1234yf, and if you don't have the card, you leave yourself open to some heavy fines if you get caught. You can register for these, and any other classes you'd like to take advantage of, at MotorAge.com/Register17. I'll even give you my own personal code so you can lock in the mechanical repair tracks you want at no cost! Use "PMYT2017."

What else is in the wings?

Many of you may remember that Daimler was a hold out when it came to using R1234yf. They feel that R744 is a better option and do have plans to use CO₂ systems in a few models offered for sale in Europe. R744 operates under extremely high pressure, and many experts agree that it will not cool as well as the alternatives in climates with high heat and high humidity — Arizona and Florida come to mind. Just be aware that it's out there for the time being.

And don't forget that hybrids and their electric vehicle cousins are consistently gaining ground in the U.S. fleet. Those equipped with High Voltage (HV) compressors require special cautions and procedures when servicing them and making a mistake here could cost you thousands when you're forced to replace the entire system because the wrong oil was used.

As with many other areas of our industry, the fundamentals of how we practice our professions hasn't changed — much. But it is increasingly important that we pay attention to the

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Register for "Tomorrow is Now: What You Can Expect When Servicing R-1234yf Systems," presented by Neutronics' Peter Coll and Mary Koban at MotorAge.com/lyexpect with code NEUT2017.

Register for "MACS A/C Services Best Practices," presented by Steve Schaeber, manager of service training with MACS, at MotorAge.com/macscac, and use code MAC2017.

Register for "MACS 2017 Mobile A/C Update," also taught by Schaeber, at MotorAge.com/acupdate, with code MAC2017.

details and follow the OEM-specified processes to ensure that we not only perform a proper repair but also that we don't break something expensive in the process.

And there's only one way you can know you're doing it right. Invest in yourself by attending the training opportunities you can. For one, I hope to see you at NACE Automechanika 2017 in Chicago in July! *TM*



PETE MEIER is an ASE certified Master Technician and sponsoring member of iATN. He has over 35 years practical experience as a technician and

educator, covering a wide variety of makes and models. His primary goal is to bring working techs the information they need.

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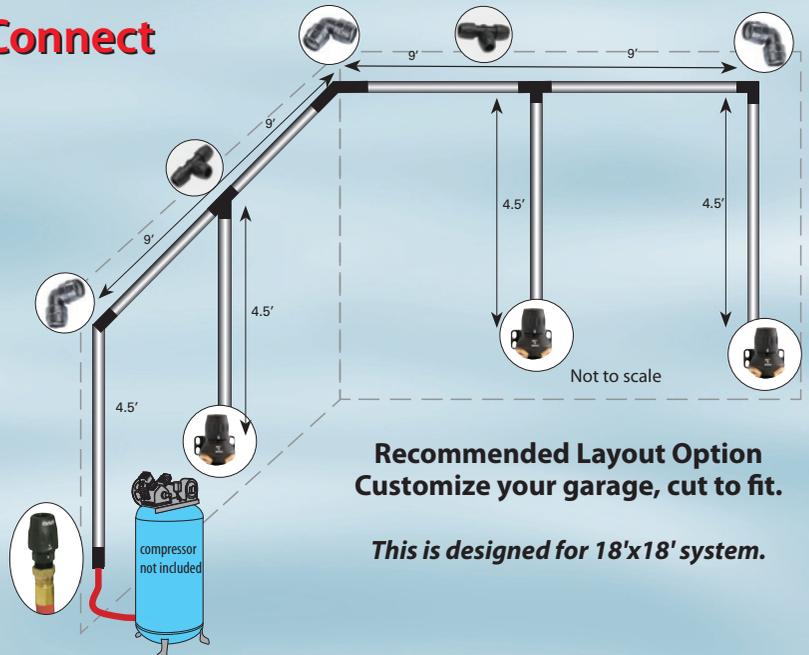
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FIGHTING THE KNUCKLE BUSTERS

THESE ARE THE JOBS YOU JUST WANT TO BE DONE WITH

RICHARD MCCUISTIAN // Contributing Editor

Whenever we get a vehicle in for one simple service and find a lot of other stuff that needs attention, any well-trained, reliable technician will make a list of the needed repairs for the customer, putting the safety-related ones at the top — loose front-end parts, failing brakes, expired or worn out tires, and so on. The caveat is that if a customer is shocked by a large estimate of needed repairs they didn't expect, they'll tell all their friends your shop tried to sell them the moon. And today, it doesn't take many needed repairs to produce an estimate that climbs off the chart above what some customers can afford to have done. Even if they can afford the repairs, some savvy customers will opt to get a second opinion, so honesty is always key when making a list like that.

Show and tell is the best way to handle those situations, and your communication skills must peak in situations like this. Someone has quoted Einstein as



THIS CANTEEN GREEN PATHFINDER hadn't darkened our door before, but we had done numerous jobs for these folks on their other vehicles.



THE CLUSTER'S TEMP, tach and speedo needles were typically dead, and warning lights seemed to come and go at will. We got a network code or two and the cluster wouldn't talk sometimes. Was it a network problem?

having said, "If you can't explain it to a six-year-old, you don't understand it yourself." And we all know some customers are sharper than others when it comes to absorbing what you're telling them.

The other way the laundry list estimate goes is when they bring one with them when they come, and in my department, we get that regularly. These folks are typically the busy drivers who have been putting off first one repair and then another one for quite a few thousand miles and

then they'll decide they want all those problems handled all at once. And some of their repairs aren't quick and easy, either.

One of the recent ones we got was a 2005 F-150 with an inopera-

tive moon roof that was stuck in the open position, no taillights, inoperative outside rearview mirrors and an erratic gas gauge. That same day we got a 2009 Chevy C2500 with a "fix whatever you find wrong" order, and there was quite a lot we had to do to that one. Then there was the 2005 Nissan Pathfinder with a laundry list that was a knuckle-busting adventure from beginning to end.

Happy customers

This family loves the work we do, and they tend to bring us most of it, but this was the first time we had ever seen the Pathfinder, which had 185,654 miles on the odometer. On the phone, the owner told me the instrument cluster was acting crazy, and I figured that's all she wanted done initially, but then by the time her husband got there with it, she also wanted the heater core replaced — what an afterthought that was! It had long ago been bypassed.

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As for the instrument cluster, it was doing wacky things. The temp gauge, the tach and the speedometer would come and go, and the brake, ABS and VDC warning lights would flash on and off just as randomly. The scan revealed a network code or two, but not much else. One thing we did notice is that the cluster couldn't communicate during the dead-needle times. Filing that away mentally, I had Thomas launch into the heater core job.

In the meantime, the two other laundry-list vehicles rolled in. That 2009 2500-series Silverado mentioned earlier had been neglected for many a mile and year, with StabiliTrak and tire pressure monitor messages, a gaggle of inoperative and busted lights and inoperative door locks. The 2005 F-150 was one a police officer brought in with an inoperative moon roof, tail lamps that didn't work and a squirrely gas gauge.

The Silverado wasn't all that interesting, except for the StabiliTrak message displayed on the cluster. The DTC and the troubleshooting led to the replacement of the steering angle sensor, which was fairly involved because of the rusty, dusty fasteners. Robert jerked the steering column out, put it in a vise, and did the surgery — that took care of the StabiliTrak. The rest of the repairs



QUITE PREDICTABLY, the heater core job was a meat grinder — the replacement heater core was about three times as expensive as other heater cores, too.

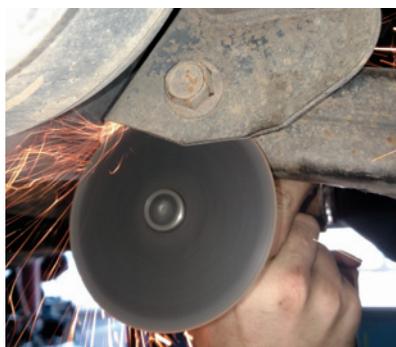
were fairly straightforward, but we did need to mount a couple of universal tag lights in the rear bumper — you can get a traffic ticket in these parts if your tag lights are out. We also replaced the busted CHMSL/Cargo lamp assembly. We replaced the driver-side power door lock switch for corrosion, but then found two of the four door-lock actuators were dead, along with two of the tire pressure monitor sensors.

The 2005 F-150's moon roof was open and wouldn't close (not good on rainy days), and so when we ran through the process of checking switches and wires we found a bad moon roof motor. We left the permanent magnet casing off the motor, remounted it and turned the armature with fingers to close the moon roof, because he didn't want to

spend the \$300 on a motor. The issue with the gas gauge and the taillights had its roots in an oddly melted connector shell just outside the frame rail on the left side. The wires leading into the front side of that connector looked like a flame had been held under them — the tape and insulation was melted, and that side of the connector was, too. We could twist and wiggle the connector and get taillight and gas gauge normalization, and so we opted to clip that connector out and bypass every wire with solder and heat shrink. It was a good repair, because even if we were to find new replacement connector shells for this, they'd be too expensive.

A patch job and a no-fueler

One of our directors owns a fairly decent little 2001 Tacoma he uses for deer hunting, and he came to me one day because he was having to add a gallon of water a week to keep the cooling system filled. It turned out that the coolant was making its way into one of the cylinders and out the tailpipe — one of the spark plugs was ultra-rusted. He made it plain that he didn't want to start with a head job on that deer hunting truck, and so he asked if I had any other ideas. For his purposes, we decided to run some head gasket sealer through it, carefully



THE REAR CONTROL ARM ADVENTURE was quite the knucklebuster. We attempted to drill this (didn't have a Rescue Bit® on hand), but it was pointless. We opted to engage the high-speed cutter, get some replacement cam bolts and put a new control arm on it.

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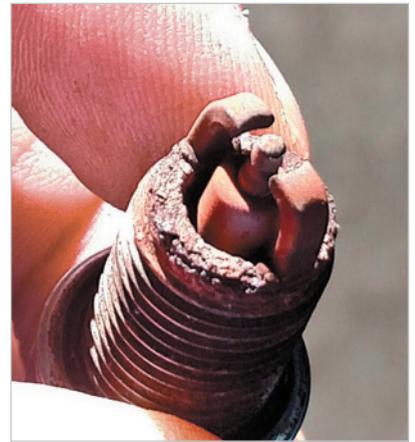
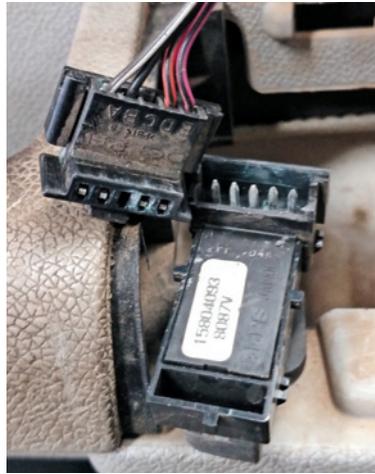
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THIS WAS THE RUSTY PLUG from the Toyota Tacoma that fingered the cylinder head gasket as the cause of coolant loss. The liquid head gasket sealer paid off on this one. We'll see how long it lasts.

THE 2009 SILVERADO'S "STABILITRAK" PROBLEM called for this steering angle sensor, which wasn't such a terribly bad job, but it took several wrenches and most of an hour to get it done. The Silverado's door lock switch had been wet, and when we replaced it we got two operative locks – it'd need door lock actuators on two doors.

following the instructions on the bottle for time, then we refilled it with coolant mix. About a month later he came by and told me that he hadn't had to add any more water. Take that for what it's worth. When somebody's in a bind, we do what they ask — if it's not dangerous.

About that time a 1999 Lexus rolled in that wouldn't take gas at the pump, which can be one of the most frustrating issues known to man, and we found a plugged vent hose. Some insect lost his homestead and that customer was a lot less frustrated the next time he pulled up to the pump.

Back to the Pathfinder

With the heater core in place on the Path-

finder, Thomas came to inform me that the brittle heater pipe manifold under the hood had broken when he was reattaching the hoses to the heater core, and this wasn't something we could fix, so we ordered the \$220+ manifold with its built-in plastic water pump and did that job up right. Filling the cooling system was challenging, but with the front jacked up, we managed to make it happen.

Before we re-attached the cluster issue, we figured we'd do the alignment, and Thomas started out with the rear wheels because we always align those first if there are adjustments. The problem was that the adjustment bolts were rusted to the bushing sleeves on one side and the first bolt he fought

with popped off right below the nut, which had become an irremovable part of the bolt. This was becoming difficult and irritating beyond words.

I called the owner to enlighten her, and she told me the Pathfinder had found most of its early paths at the beach, because that's where it lived for the first five years of its life. Yeah, I know you Northern wrench guys see this every day, but we aren't used to it down here in the South, although we do see some rides from up your way now and then. We ordered replacement cam bolts from Nissan and a lower control arm from the parts store, but to get the old control arm out of there we had to use the high-speed cutter's 4-inch wheel to clip the adjustment bolts just inside the flanges.

Got that part of the job done, finished the alignment, and then we went after the cluster. Checking the network with the Pico, we found a pattern that was somewhat noisy, but after eliminating first one module and the other to no avail, we decided the cluster itself must be at fault because sometimes it'd talk and sometimes it wouldn't.

This cluster is a plug-and-play unit, and when we told the customer what we had decided, the owner found a



ON THE 2005 F-150, this oddball melting almost looked like somebody had built a fire under it at some point. When we wiggled it, the tail lights and the gas gauge would go nuts, so we removed the connector and made the harnesses one at that point.



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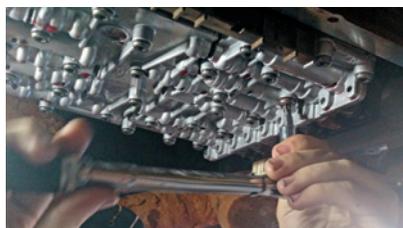
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used one for \$75, and when we popped it in there everything was peachy keen.

The 2009 F-150 transmission problem

In and among all these jobs, we had a 2009 F-150 with intermittent 6R80 transmission problems. The symptom was that the truck would have spells where it wouldn't back up, and during those times it would also stick in third gear until you cleared the codes. We were told that a transmission shop had pulled the pan and found good fluid and no debris, and they were kind of stymied as to what needed to be done next, so they sewed it up and the owner brought the truck to us.

We got a Transmission Range sensor code, but that was pretty much it. In the years that I've done this, it's a pretty good bet that the transmission control module (or PCM) is suspect if the transmission starts acting strange and



THIS IS THE "LEADFRAME" as Ford calls it that actually turns out to be the TCM. We wound up having to replace the whole valve body on this 2009 F-150 — when we first removed the valve body we found this broken adapter and replaced it. And every time, we were careful to use a torque wrench when reinstalling the valve body.

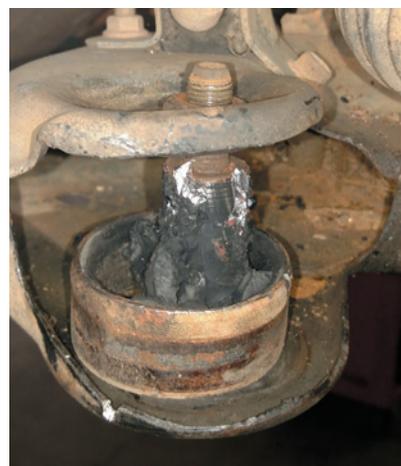
wiping the codes clears it up for a while. This is obviously not always the case — sometimes the transmission controller will go into limp-in mode for other reasons. With zero experience on this 6R80 gearbox, I called one of my guys who does them all the time — only he's accustomed to the newer ones. He told me we'd need the "leadframe," because he has to change them regularly for this kind of problem. That device looks like a big hard-wire harness with the speed sensors built in, but it's actually the Transmission Control Module. Why they call it the "leadframe" is beyond me.

My guy decided to help out and called the parts department to ask if they had one, and then I called, gave them a purchase order, and they billed it out at \$125. The way this went down was a perfect-storm situation, because the year model was lost somewhere in the process of passing information from pillar to post, and it cost us some work.

When we pulled the valve body to replace the leadframe, we saw that the plastic-and-rubber adapter between the valve body and the pump was cracked, so I got another one of those from my guy at the Ford place. The only problem was that when we put everything back together and put the fluid in, we found that the transmission wouldn't engage at all and the TCM (leadframe) wouldn't talk to the IDS either. But we could plug the old leadframe into the wires and let it swing and it'd talk to the tool just fine. What was going on here?

This was strange to me — for years Ford told us that electronics couldn't cause a no-engagement issue, but here it was. Things have obviously changed. With the absence of electronics, this one dumps the pressure instead of raising it.

It was then we discovered you can't buy a leadframe for a 2009 model — you have to buy the whole valve body, leadframe and all (\$1,000). And even though the later leadframes look identical and



EVEN IN THE SOUTH, we get seized parts, and they're always fun to deal with. One thing we do get a lot of down here are dirt-dabber nests in annoying places — the Lexus wouldn't take gas with this clog.

are replaceable separately, they won't talk to the IDS and they won't function on a 2009 model. So we got a whole valve body, installed and torqued it, did the fluid fill and fixed the truck. It was messy but fun pumping transmission oil into that one through the hole where the dipstick tube used to go and checking it with that tiny plastic dipstick right next to the catalyst with the engine running and hot. That was a knuckle-BURNER. One way or another, we won that fight and all the rest of them on this round, with busted and burned knuckles galore. Who knows what we'll see next week? **TZ**



RICHARD MCCUUSTIAN is an ASE-certified Master Auto Technician and was a professional mechanic for more than 25 years. Richard is now an auto mechanics instructor at LBW Community

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FINDING THE VOLTAGE DROP CULPRIT

A minor collision repair misstep causes a multitude of system DTCs



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Understanding the need for scans, calibrations

Vehicle health, safety is dependent upon proper diagnosis, repair of all systems

DARRELL AMBERSON //

Contributing Editor

Scans, calibrations and new vehicle technologies have been THE hot topics for the last two years in the industry, although in many ways they still feel like relatively new issues — primarily because we are still far from having industry-accepted, standard policies, procedures and compensation methodology.

I know from my own experiences and anecdotal information that far too many shops are not yet performing pre- and post-repair scans. Information providers have yet to establish definitions and pricing guidelines for scans and calibrations. Pricing is based on who is performing the procedure and who is paying for it. Most insurance companies lack clear and concise policies on when to scan and calibrate, as well as on payment. Some instruct staff to address scan and calibration authorization and pricing on a case-by-case basis, which adds to inconsistency and confusion. Some insurers concoct their own policy and pricing methodology, sometimes at local levels that can differ by region. Some insurers are critical of shops that perform scans and calibrations according to manufacturer directives, accusing them of being “uncompetitive” because they charge for them, and then rewarding shops that don’t perform the procedures because they are “competitive.”

While many OE manufacturers have established definitive policies and procedures, there are still some manufacturers

who have not provided clear and concise direction. Policies and procedures and required equipment vary from one manufacturer to another. And to complicate matters, many people — often insurers — question the motives of the manufacturers, implying they are self-serving in protecting their own interests and passing liability issues on to repairers and indirectly to insurers in the form of potentially unnecessary procedures. We are in a state of confusion. How disappointing that our industry doesn’t evolve better in the face of change, especially as we are dealing with critical safety issues, including accident avoidance and airbag deployment systems.

Yet, we know we are making progress because there are so many discussions taking place, there are new training opportunities and equipment manufacturers are starting to develop collision-specific tools.

Education

Of course the key to making progress is education. There are some excellent classes on the topic:

- I-CAR, class # VT210E01, “Introduction to Diagnostics and Scan Tools” is a great place to start; it’s an hour-long online course. They also have other classes on new technologies and calibrations.

- Automotive Management Institute (AMi) offers “Management’s Guide to Scanning and New Technology.” This online class is closer to 90 minutes; some insurers are using this to educate



PHOTOS: DARRELL AMBERSON

their claims people.

“Shop owners, managers, estimators and insurers who are not making a concerted effort to understand the topics of scanning and calibrations are doing a disservice to their customers, their businesses and to themselves,” said AMi president Jeff Peevy. “The AMi online course was designed for those not necessarily doing the scans, but those needing to understand and manage the process. Regardless of your approach to becoming informed on the subject, it is important that you not be passive about it.”

I know from personal experience that the more information I seek, the more I find. In addition to the obvious factory bulletins and repair information, there are many articles — such as those included in this special section — releases from I-CAR and many presentations and training opportunities at industry events such as NACE Automechanika, SEMA and the Collision Industry Conference.

Getting started on scans

After becoming educated on the topic, most collision repairers conclude that scanning is a necessity. A significant concern is the potential exposure in a worst-case scenario of a safety system failure

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resulting in injury or loss of life that could have been avoided through appropriate diagnostic and calibration procedures. Most OE manufacturers have formal positions on the topic and many insist on pre- and post-repair scans on all of their brand vehicles after any collision. Today's collision repair businesses have many choices regarding how to approach performing scans. The most simplistic approach is to simply sublet the work to a dealer or an independent contractor. The alternative is to start performing some or all scans in-house. A good starting point is with an analysis of the shop's current mix of work by age and model; shop procedures and how to integrate scanning; staff competence and staffing needs; tool and equipment needs and options; budget; and shop IT infrastructure including WIFI or cable internet access and capacity, as well as adequate security features to prevent viruses and hacking.

Assuming you decide to start doing some or all scans in-house, your scan tool choices include OEM and aftermarket tools. Both have advantages and disadvantages.

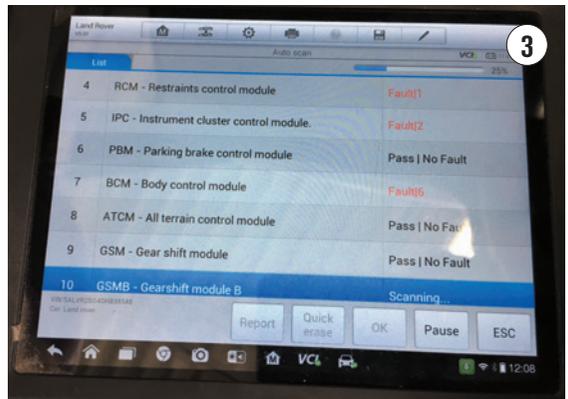
The big picture

It's most important to consider the basic function and design of these new technologies. It was mandated that all 1996 and newer vehicles have an On Board Diagnostic system II (OBDII). Included in that requirement is the use of a specific 16-pin connector that is universal to all models and is to be located within two feet of the steering wheel (Figs 1, 2). The system monitors an incredible number



of functions and when something goes awry, it creates and stores a Diagnostic Trouble Code (DTC), often referred to as a fault code. The purpose of the DTC is to aid technicians in locating the source of problems, presumably leading to a corrective repair. Depending upon model and options, systems can be capable of producing hundreds or even thousands of different DTCs. Very few of them will light a dash warning indicator.

“Clearing codes” is a phrase that has become common in the collision repair industry. Unfortunately, too many people have the impression that it is our job to make the codes go away, and then everything is fine. Instead, we need to understand that the code is an indication of something wrong and therefore it is our job to identify the source and address it accordingly. The process of the scan (Figure 3) identifies the codes. Determining what the codes mean may require additional research of factory data and repair information from sources such as OE websites or ALLDATA. It can be time consuming. If the



source of the DTC is unrelated to the accident, the consumer — and perhaps insurer — should be informed. If they elect to not correct the issue, it is best that the code be left in the system for diagnostic purposes at some potential later date. (It is prudent to have the consumer sign a release before starting the repair that allows the repairer to obtain their vehicle's data and share it with the insurer.) If the code is related to the accident, steps should be taken to correct the issue and clear the code before handing the vehicle back to the customer. If the code is not cleared, you leave the vehicle with a potentially permanent record of the accident and/or repair, which may have negative implications for the customer in the future, such as from diminished value at trade-in time.

OE SCAN TOOLS VS. AFTERMARKET SCAN TOOLS

OE scan tools:

- Coverage limited to specific manufactured vehicles
- More than one may be required for each manufacturer
- Contains the latest and most complete functionality
- Validated by the OE manufacturer
- Updates released frequently
- May provide capabilities that aftermarket tools don't, such as build data, freeze frames or frequency counters

Aftermarket scan tools:

- Wide range in capabilities and cost from the best units to most modest ones
- Some provide coverage for most vehicle brands and models
- Some provide procedures and functions for diagnostics and calibrations equal to OE tools on many vehicles.
- Cost effective
- Updates may not be as frequent
- Information may not be as current



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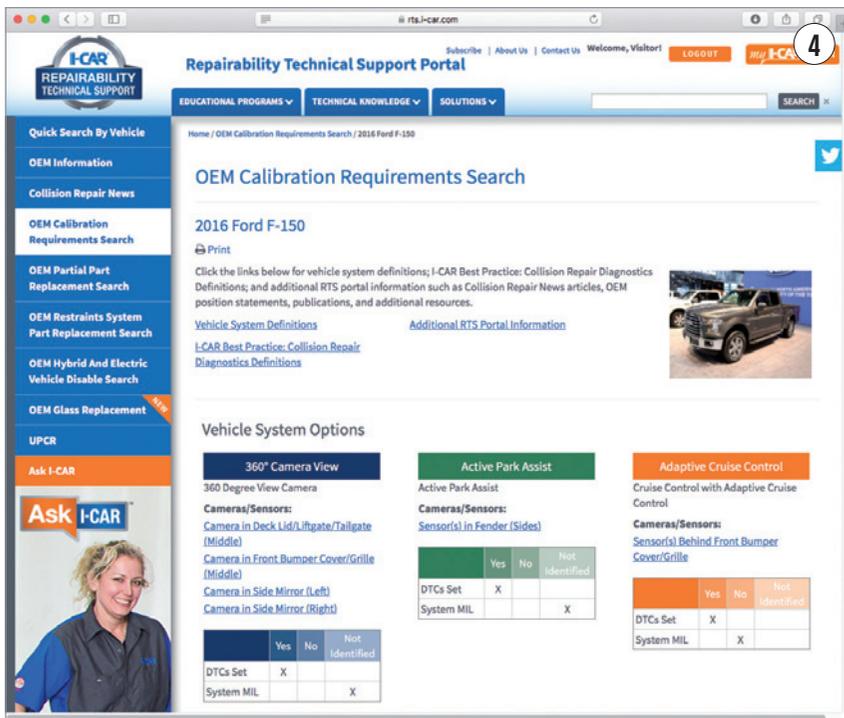
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Think of the scan as the only way that you can look into the system. Visual inspections are very limited in the problems you may detect. If you have a good understanding of all the systems, a road test may identify if most systems are functioning. However, so many systems are so complex that it is difficult to know how all systems on all vehicles behave. And even if you identify a malfunctioning system, you will in all probability need a scan to pinpoint the issue. A scan is by far the best tool to identify potential issues and the best tool to assure the health of the systems.

Calibrations

While scanning is the most thorough way of checking the health of these new systems, there is more that one needs to understand and consider. Calibrations are a key issue. A scan may identify that a camera or sensor is working and that there are good electrical connections in its system, but it may not tell the technician that the camera or sensor is in proper calibration. If a windshield

mirror-mounted camera was pointed in a direction out of its prescribed range of vision, it potentially may not see what it was intended to. If an adaptive cruise control was engaged, it may cause the vehicle to drive up on a small vehicle it didn't see, such as a motorcycle, because it was only seeing a larger vehicle, such as a truck, in front of the motorcycle.

It is a necessity for repairers to know when it is appropriate to perform a calibration. Factory bulletins and other factory repair information are great resources, especially when dealing with common calibrations such as seat weight sensors.

There is a relatively new source that may be the easiest and best tool to identify calibration needs. On the I-CAR Repairability Technical Support Portal there is a link to OEM Calibrations Requirements Search (Figure 4). You simply put in the vehicle information, and it will tell you what calibrations may be required and give information on what tools, such as scanners or object detection targets, may be required.

Programming

Some repairs include the necessity to reprogram Electronic Control Units (ECUs). Scanners that use an SAE J2534 standard may be required. Most aftermarket scanners don't include it. Some ECUs have anti-theft systems imbedded and require licensed security identification (LSID), which is available to the aftermarket through the National Automotive Service Task Force (NASTF).

The future

I just read of a new pedestrian detection system that Ford will offer on 2018 Mustangs and F-150s. It relies on information from a radar system in the bumper and a camera on the windshield, along with a database of pedestrian shapes. When detecting a pedestrian, the system warns the driver then automatically applies the brakes to avoid hitting the pedestrian. It works even in dim light and will not take such action on other shapes, such as deer. In the event of a collision repair, it may raise repair costs and require calibration. It's just one example of the anticipated onslaught of new technologies we will be dealing with. There is every reason to believe that as a percentage of repair costs, addressing new technologies will comprise an increasingly larger portion. If you as a repairer haven't reacted to these new technologies, you have a lot of catching up to do. All of us will have to devote more and more resources to equipment, staffing and training. 📶



DARRELL AMBERSON is the president of operations for LaMettry's Collision, which has eight locations in the Minneapolis and St. Paul area. He is a board member for the Automotive Service Association, and he has more than 40 years of collision industry experience.
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The why, how of scanning

Scanning is vital to proper repairs, and a mobile diagnostics company can help

ERIC ZIEGLER // Contributing Editor

Vehicles are becoming more complex with many consumer-driven feature improvements to vehicle navigation, infotainment and safety systems. The price tag on these modern high-tech marvels that many of your customers own is probably equal to or more than the house you grew up in! The modern automobile is usually one of the greatest investments, second usually only to the purchase of a home, that people nowadays make in their lives. Since vehicles are costing more, the cost of repairing them is also increasing. A lot of this is due to the advent of all the expensive safety systems like multiple airbags, passive restraints like seat belt pretensioners, collapse steering columns, adaptive cruise control, lane departure/collision avoidance and blind-spot detection systems.

The job of the auto body estimator can be a difficult one. Software estimating programs have been around for years to aid in this task of getting the estimate correct with the least amount of supplementation and to reduce cycle time. Matrixes of parts to be replaced after a certain type of deployment collision have traditionally been used to limit the insurance company's liability post-collision repair. But with the advent of more and more expensive mission-critical safety systems, the accuracy and cost effectiveness of these estimating methods is becoming more and more limited. The insurance companies have come to this realization and pilot programs for pre- and post-repair scans are in place in many markets and soon to become the status quo or industry

standard. I own and operate a mobile diagnostics and programming company providing dealer-level diagnostics such as pre- and post-scanning, programming and wiring repair to my collision and service repair facility clients.

Pre- and post-repair scans are becoming a bigger and bigger part of what we do in collision centers. While there are tooling and online options for pre- and post-scanning, establishing a working relationship with a local mobile diagnostics professional is your best bet if one is available in your area. No online service can realistically compare to having a "boots on the ground" professional when it comes to data interpretation and insuring a successful programming outcome. Module programming can be tricky at times. Proper tooling and technique are critical to the successful outcome. If the battery voltage drop is too low or if the key is cycled at the wrong time, the programming results can be catastrophic.

So, what is driving the trend shifting to pre- and post-scans? First, think of how the post-deployment airbag parts matrix model worked in the past. Parts were replaced based on a certain type of collision deployment. The matrix suggested replacement of all possible parts that "could" have failed in that deployment collision. Oftentimes, this resulted in the replacing of parts that may not have actually failed, and unnecessary losses for insurance companies. Insurers are always looking to reduce loss and liability and improve their bottom line. Second, and perhaps more importantly, consider that the modern late-model vehicle can have an upwards of 50 modules that communicate on multiple computer networks. There are

DG149746 - Taurus	Complete View
System :	
Software version : IDS-103.01	
Select Option	
Hold (saves recordings).	
Complete (deletes recordings).	
Delete (deletes session).	
Vehicle: Taurus	
Engine Type: TIVCT	
Capacity: 3.5L	
Transmission: Automatic	
Fuel Type: Gasoline	
Emission level: Federal Emission	
Odometer: 50102.9	
(VIN): #####DG149746	
Strategy : DG1A-	
Filename : DG1A-14C204-ATD	
Module Part Number :	
(ABS) Part Number = DG13-2C219-AE	
Standard Equipment Modules - Pass - (ABS)	
(ACM) Part Number = DG1T-19C107-DG	
(ACM)_FILENAME = DG1T-14D099-DF	
(ACM)_HARDWARE_NUM = DG1T-14F188-DC	
(ACM)_CALIBRATION_FILENAME = DG1T-14D100-DE	
Optional equipment Modules - Pass - (ACM)	
(APIM) Part Number = DG1T-14D212-AD	
(APIM)_FILENAME = DG1T-14D205-AB	
Optional equipment Modules - Pass - (APIM)	
(BCM) Part Number = DG1T-14B476-AA	
(BCM)_FILENAME = DG1T-14C184-AA	
(BCM) Software Part 1 (F16C) = DG1T-14F390-BC	
(BCM) Software Part 2 (F10A) = DG1T-14C636-AE	
(BCM) Software Part 3 (F16D) = BC3T-14F389-AA	
(BCM) Software Part 4 (F16E) = DG1T-14C408-AC	
(BCM) Software Part 5 (F16B) = BT4T-14F391-AC	
(BCM)_HARDWARE_NUM = BC3T-14F141-BC	
(BCM)_CONFIGURATION_FILENAME = DG1T-14C636-AE	
Standard Equipment Modules - Pass - (BCM)	
Optional equipment Modules - Fail - (C-CM)	
Optional equipment Modules - Fail - (DCSM)	
Optional equipment Modules - Fail - (DDM)	
Optional equipment Modules - Fail - (DSM)	
Optional equipment Modules - Fail - (DSP)	
(FCDIM) Part Number = DG1T-18B955-CC	
(FCDIM)_FILENAME = DG1T-14D358-CD	
(FCDIM)_HARDWARE_NUM = DG1T-14F180-CA	
(FCDIM)_CALIBRATION_FILENAME = DG1T-14D359-CD	
Optional equipment Modules - Pass - (FCDIM)	
Optional equipment Modules - Pass - (FCIM)	

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literally hundreds of Diagnostic Trouble Codes (DTCs) that can set — many of which may not turn on a Malfunction Indicator Light (MIL). Third, most of the modules have some sort of programming, setup, configuration or calibration requiring OE tooling and subscriptions either after collision repairs or module replacement. Because of the locations of some of these modules, it makes them susceptible to collision damage. Some safety equipment — like collision avoidance, adaptive cruise control, blind-spot monitoring and lane departure modules — are extremely expensive, so you must take time to assess possible damage prior

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ECU Summary Information

ECU	Name	Original VIN	Current VIN	Part Number	Flash Part Number	H/W Version	S/W Version	Spare Part Number	ISO Code	S/W Number	H/W Number	Variant	Version	Bus Type	Country Code
ABS	Anti Lock Brakes	2C4RC1BG2CR207336	2C4RC1BG2CR207336	05154911AE	05154911AE	0A.0E.00	#0: 11.34.30	Not Available		Not Available	Not Available	10	01	CAN C	N/A
CCN	Instrument Cluster/Cabin Compartment Node	2C4RC1BG2CR207336	2C4RC1BG2CR207336	68055682AG	68055736AG	FF.FF	00.02.04	Not Available		Not Available	Not Available	06	11	CAN IHS	USA
DMFL	Door Module Front Left	2C4RC1BG2CR207336	2C4RC1BG2CR207336	05026861AE	05026861AE	08.10	11.13.00	Not Available		Not Available	Not Available	08	07	CAN IHS	USA
DMFR	Door Module Front Right	2C4RC1BG2CR207336	2C4RC1BG2CR207336	05026860AE	05026860AE	08.10	11.13.00	Not Available		Not Available	Not Available	08	07	CAN IHS	USA
DMRL	Door Module Rear Left	2C4RC1BG2CR207336	2C4RC1BG2CR207336	68079910AB	68079910AB	07.08	02.03.00	Not Available		Not Available	Not Available	02	00	CAN IHS	USA
DMRR	Door Module Rear Right	2C4RC1BG2CR207336	2C4RC1BG2CR207336	68079910AB	68079910AB	07.08	02.03.00	Not Available		Not Available	Not Available	02	00	CAN IHS	USA
HFM	Hands Free Module(cell phone)	0000000000000000	2C4RC1BG2CR207336	68104904AB	68104904AB	14.00	63.01.23	Not Available		Not Available	Not Available	02	03	CAN IHS	USA
HVAC	Heat, Ventilation and A/C	2C4RC1BG2CR207336	2C4RC1BG2CR207336	55111236AF	55111236AF	0B.18.01	#0: 11.16.03, #1: 11.16.03	Not Available		Not Available	Not Available	10	03	CAN IHS	N/A
ORC	Occupant Restraint	2C4RC1BG2CR207336	2C4RC1BG2CR207336	68062118AF	68062118AF	10.12	10.40.00	Not Available		Not Available	Not Available	03	07	CAN C	USA
PCM	Powertrain Control Module	2C4RC1BG2CR207336	2C4RC1BG2CR207336	68185470AD	68185470AD	11.2F	11.10.00	Not Available		Not Available	Not Available	23	A6	CAN C	USA
PLGM	Power Liftgate	2C4RC1BG2CR207336	2C4RC1BG2CR207336	68079913AB	68079913AB	08.12	03.03.00	Not Available		Not Available	Not Available	05	00	CAN IHS	USA
PSDML	Power Sliding Doors (Left)	2C4RC1BG2CR207336	2C4RC1BG2CR207336	68079909AB	68079909AB	07.08	01.31.00	Not Available		Not Available	Not Available	02	00	CAN IHS	USA
PSDMR	Power Sliding Doors (Right)	2C4RC1BG2CR207336	2C4RC1BG2CR207336	68079909AB	68079909AB	07.08	01.31.00	Not Available		Not Available	Not Available	02	00	CAN IHS	USA
RADIO	Radio	2C4RC1BG2CR207336	2C4RC1BG2CR207336	05091201AC	05091201AC	02.07	33.00.41	Not Available		Not Available	Not Available	03	01	CAN IHS	USA
SAS	Steering Angle Sensor	2C4RC1BG2CR207336	2C4RC1BG2CR207336	56046497AD	56046497AD	03.00	03.05.01	Not Available		Not Available	Not Available	01	02	CAN C	USA
TIPMCGW	Central Gateway	2C4RC1BG2CR207336	2C4RC1BG2CR207336	68105507AC	68105519AC	01.10	09.02.00	Not Available		Not Available	Not Available	08	54	DIAG CAN C	USA
TPM	Tire Pressure Monitor	2C4RC1BG2CR207336	2C4RC1BG2CR207336	56029401AG	56029401AG	07.24.03	#0: 09.14.00	Not Available		Not Available	Not Available	01	04	CAN C	N/A

2C4RC1BG2CR207336 VEHICLE SCAN REPORT

to repair, rather than once the vehicle is in production or after it has been repaired. This is extremely important, especially if the repair of said systems could have totaled the vehicle. Moreover, these are usually big dollar supplements that have to be turned in. Replacement of these types of systems require programming and oftentimes special calibrations requiring OE tooling. Having a system-wide pre-scan of the vehicle before the estimating and repair process begins is a procedure that captures and documents any codes that are present or pending, and in some later-model vehicles, the time stamps associated with them. This can be extremely beneficial for both the insurance company and the collision shop. This is a great aid in determining any unreported prior damage and can help combat the “ever since you worked

on my car, XYZ doesn’t work” complaint. Collision centers and insurance companies usually have no leg to stand on due to not having any record of previous unreported failures. If an owner complains loud enough, the insurance will pay out to avoid the negative publicity. This may result in the collision shop having to foot the bill to avoid a poor BBB, Yelp or on-line review. Pre- and post-scans will be a great step in the right direction to combat this. Here are just a few scenarios that come to mind where pre- and post-scans could be beneficial.

Scenario 1

Let’s say the customer had bought a late-model vehicle with radar adaptive cruise control and hit something that damaged the ACC module but didn’t cause any other obvious damage. They got a \$2,000

estimate and elected not to repair. Six months later, the vehicle was rear ended, causing \$10,000 in damage. The vehicle was towed in on a flatbed with flat tires and a low battery from the flashers being left on. The body shop lacks the tooling to scan advanced safety features like ACC and obviously, they can’t drive it. So, post-frame pulling, sheet metal repair, blocking and painting, the vehicle is returned to the owner who soon after returns to the shop. “Since you worked on my vehicle, my ACC doesn’t work,” the customer explains. The ACC module is on the complete opposite end of the vehicle in relation to where the damage occurred. The part is extremely expensive. The owner insists that the ACC worked fine prior to loss, and neither the body shop nor insurance company has any documentation that the ACC was inoperative

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prior to the accident. Eventually, the insurance company pays for a completely unrelated repair. The pre- and post-scan documentation would have given both the shop and the insurance carrier a legal leg to stand on.

Scenario 2

The vehicle is a 2014 Ford Explorer Limited that has deployed the front airbags, pretensioners and has fairly extensive frame and sheet metal damage and is close to, but not at, total value. The insurance carrier approves it to be repaired. The collision shop orders parts based on a matrix for a driver and passenger airbag deployment. The matrix calls for driver and passenger front airbags, clockspring, crash sensors, both pretensioners and seat belt anchors and a Restraints Control Module (RCM). It also states: "all deployable devices should be inspected post-collision." Both front airbags are obviously deployed, the front seat belts are pulled on and they are as tight as a string bass. It all seems pretty obvious to the estimator.

Structural repairs include pulling the frame, and the sheet metal is hung. The vehicle is blocked and paint blended with no issues. Cycle time has been ticking away, and post-production, the SRS MIL is on — the shop realizes that the RCM didn't get programmed. The PMI of the RCM is performed. The SRS MIL remains on, and codes are read from the RCM. A code for the collapsible column deployment loop is the only code present. A closer inspection reveals the collapsible steering column has deployed and needs replaced. This is an expensive part that is not always stocked at the local dealer.

A pre-repair scan report from a mobile tech would have alerted the shop to closely inspect the column for deployment. Part of the OE's inspection process is to check for codes and deployment loop statuses with a factory scan tool. One could argue that a shop

with a scan tool could perform some of these functions. It could, if properly trained and tooled at a substantial cost of time and money.

Scenario 3

A late-model Mazda has been in a deployment collision. The RCM has been changed out. A mobile tech is called in to shut off the SRS MIL. The shop attempted to do the RCM setup with their recently acquired aftermarket scan tool. After they attempt the procedure, the light is still on. They reluctantly call in a mobile tech who is not initially told about their attempt to setup and program the new RCM, just that the RCM was replaced. The mobile tech realizes something is afoot when the usual U2100 module configuration code that is almost always present in Ford, Lincoln, Mercury and Mazda SRS modules that have been replaced and need a PMI performed is not present. Moreover, there are codes for the driver's third deployment loops. The mobile tech consults a wiring diagram, which shows no such deployment loop for this year, make and model of vehicle. A physical inspection confirms this as well. After some quizzing of one of the techs, the shop comes clean about their attempt to try out their new tool that was "supposed to" do this function. A PMI of the RCM is performed using hexadecimal data obtained from the OE, since the original RCM is no longer present. The SRS codes are cleared and the SRS MIL is no longer on.

While the shop had good intentions, it fell short of the task and set erroneous RCM codes that resulted in wasted cycle time that could have been better spent working on vehicles in production that were in the body tech's field of expertise. It also illustrates the need to have the proper OE tooling, subscriptions and "time in type" to expedite this repair in a timely manner and keep the collision shop's production running smooth.

Scenario 4

A late-model Toyota with Millimeter Wave Collision Avoidance/Adaptive CC rear ends another vehicle, causing significant damage to the front of the vehicle. The body shop is in a medium-sized Midwestern town that doesn't have a local Toyota dealer. The shop has elected to use an online service that, after purchasing their hardware, will "remote in" and do the pre- and post-scans and any programming needed. The shop is told to have a solid internet connection, dedicated bay and a tech on standby for a two-hour window. The pre-scan catches the damage to the Millimeter Wave unit, and it is replaced. The post-scan comes back with codes that the Millimeter Wave module calibration was not performed. This is a procedure that requires special targets, OE tools and the familiarity with the system and its operation. Oftentimes after performing a very specific calibration/setup, the vehicle is required to be driven in a certain manner. The online remote service providers cannot do this.

Pre- and post-repair scans are here to stay, and they are a great benefit to the collision shop, insurer and vehicle owner. They help take the surprise out of estimating and repairing the complex modern vehicle. There are a few options to doing these scans — a shop can purchase the OE equipment and subscriptions and do them in-house, or outsource them to either an online vendor or to a mobile diagnostics service. Regardless of your choice, pre- and post-scans will soon be part of your day-to-day operations, if they are not already. *ZZ*



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Diagnostic navigation

A guide to incorporating collision repair diagnostics into your current processes

JASON BARTANEN // Contributing Editor

If you haven't incorporated collision repair diagnostics into your repair process already, it's time. Advanced Driver Assist Systems (ADAS) are here to stay and will only continue to increase. By the year 2022, collision braking will be standard equipment on all vehicles sold by several OEMs in the North American market. If you're planning on continuing to repair late-model collision-damaged vehicles, you're going to have to be prepared to deal with some level of diagnostics; and those that are best prepared will likely have the most success.

After making the decision to get more active in diagnostics, questions quickly arise: Which tool(s) should I invest in?; Where am I going to do my diagnostics work?; Who is going to do my diagnostics work?; How do I incorporate these processes into my current repair process? The goal of this article is to help guide you through some of those questions.

Which tools should I invest in?

This is one of the most common questions I get about diagnostics, and it's one that isn't easily answered. If you've decided to bring your diagnostics work in-house, you'll have to answer this question early on. I suggest pulling your last couple years of repair orders and looking at the types of vehicles you're working on. If you're working on a few makes more often than not, you may want to consider an OEM scan tool for those models. The ones that you work on less frequently can be covered with an aftermarket tool, or by subletting to a local dealership. When choosing an aftermarket scan tool, it's important for you to know the capabilities of that tool. Work with the tool provider to confirm that it cannot only read and clear codes, but that it also has the required initialization/calibration capabilities for the makes and models you work on most frequently.

Another option, with excellent coverage, is a remote diagnostics tool. Collision Diagnostic Services and AirPro Diagnostics are two companies that offer this type of tool. Remote scanning offers you access to an OEM scan tool without the investment of having to buy several OEM scan tools or having the expertise for several to operate the different scan tools.

When is scanning required?

This question is one of the most hotly debated topics in the



PHOTOS: I-CAR

SCANNING is the only way to determine if there are any DTCs present.

collision repair industry today. Several vehicle makers have recently published position statements on when they require pre- and post-repair scanning. Others have questioned the necessity of doing it on "all" vehicles, including those with no Malfunction Indicator Lamps (MIL) illuminated. The fact is, not all Diagnostic Trouble Codes (DTC) will illuminate a MIL. Simply relying on the presence of an MIL to determine if you're going to scan the vehicle is not a sound process.

Personally, if it's my shop, I'd be scanning every vehicle — and not just because of the OEM position statements. Instead, I'd be scanning the vehicle to determine which, if any, DTCs are related to the collision and which, if any, are likely NOT related to the collision. Scanning the vehicle, researching the DTCs and making the determination of related/unrelated codes is the best way to ensure that all parties involved have a clear understanding of what is required for complete, safe and quality repairs. If the vehicle is hit in the front and has an adaptive cruise control-related DTC, chances are that it's collision related. However, if that same vehicle has a code for a rear-wheel speed sensor that has had 150 key cycles since setting, you can rest assured that the code isn't accident-related. Scanning the vehicle during the damage analysis process is the best way to ensure that you're writing the most complete assessment possible. Similar to 3D measuring, if you don't scan the vehicle, it's not possible to identify all of the "hidden" damage.

Scanning isn't only done during the damage analysis process. As part of a sound quality control process, post-repair scanning should also be done to ensure the vehicle is delivered to the customer free from any collision-related (or collision-

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repair-related) DTCs.

Post-repair calibration/aiming

While the debate on pre- and post-scanning has taken center stage, there is another important step that has gone largely ignored. Post-repair calibration, or aiming, is essential for many of today's Advanced Driver Assist Systems (ADAS) to function properly. Many of these systems are guided by cameras and/or sensors. When replaced, or sometimes simply moved, calibration/aiming is required. Without calibration/aiming, the system may not function properly, potentially causing a collision.

Vehicle makers have specific criteria for when calibration/aiming is required and, often, a detailed process for the calibration/aiming procedure. Recently, I-CAR announced the launch of an OEM Calibration Requirements Search feature on the I-CAR Repairability Technical Support website. Visit ABRN.com/ICARcalibrate. I-CAR staff invested thousands of hours of research identifying:

- which options were available on 2016 vehicles

- when calibration/aiming is required
- if the system will illuminate an MIL and/or set a DTC
- if a scan tool is required for calibration/aiming
- if any other special tools are required for the calibration/aiming procedure

Location, location, location

Many calibration/aiming procedures require targets to be placed at specific distances and may have requirements for how flat the area is and/or space requirements in the front, rear and sides of the vehicles. There may even be lighting specifications for some of the calibration procedures. Having the space to do many of the calibration/aiming procedures will be important.

When incorporating collision repair diagnostics into your repair process, pay close attention to these requirements and identify a location in your facility for this type of work to take place. Similar to a clean room for aluminum, you might want to consider a diagnostics room for scanning, calibration/aiming, more in-



SPECIAL TARGETS may be required for forward-facing cameras and sensors.

depth diagnostics and repair. collision repair technicians, the world of diagnostics is foreign. Many of us chose this side of the automotive world because we enjoy the artistic feel of taking a collision-damaged vehicle and restoring it to look as good, or better, than it was before the collision. We also like to work on visual, tactile things; diagnostics is much less visual and doesn't offer any tactile feedback, like removing a dent, straightening a body or refinishing.

One suggestion for staffing would be to seek a seasoned service technician. They may not only offer some expertise in diagnostics, you may also benefit from their experience to offer new services to your customer.

I believe we'll start to see many career and technical schools and colleges offering collision repair diagnostics as part of their curriculum. Get involved with your local school's advisory committee and encourage them to offer their students training in this area. Graduates with strong collision repair diagnostics are going to be in demand very soon.

If you opt to work with one or more of your staff members to get them up to speed on collision repair diagnostics, there is training available from many of the scan tool makers. This training will help ensure that they know the capabilities and limitations of the tools you've invested in. I-CAR also features three courses currently and is working on additional courses for collision repair diagnostics.

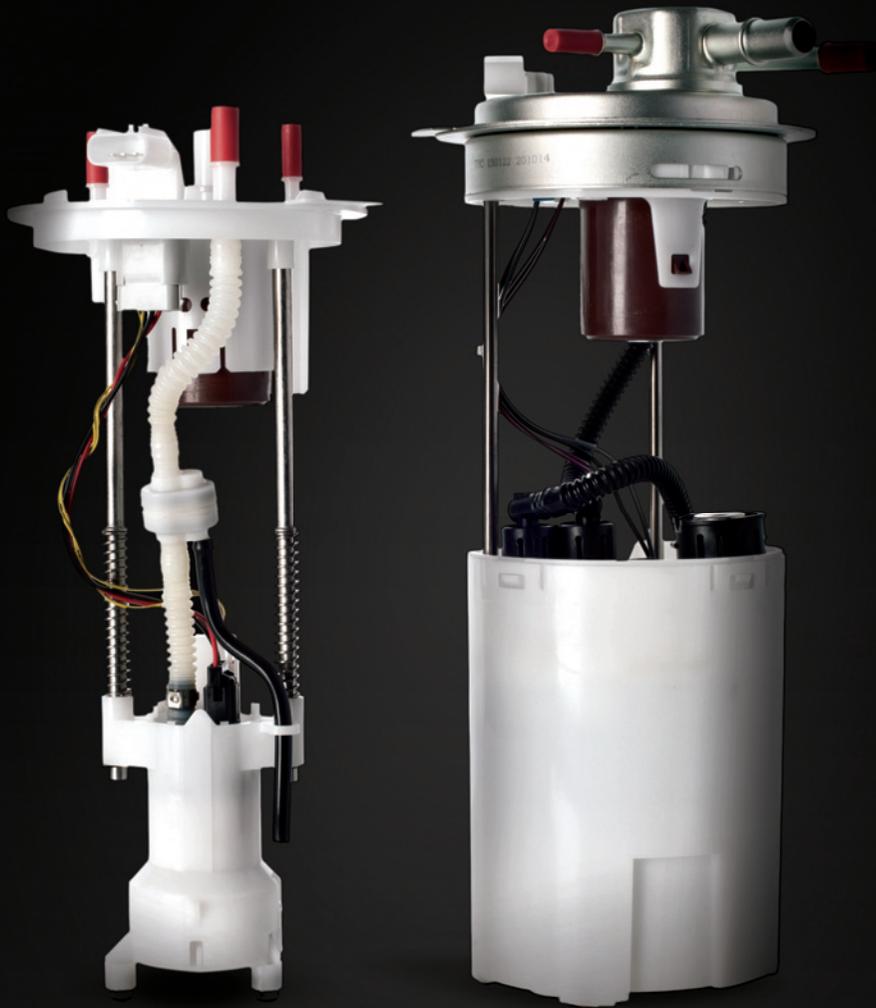
The process

In October, I-CAR hosted a Repairability Summit on the topic of collision repair

The screenshot shows the I-CAR Repairability Technical Support Portal. The main content area is titled "OEM Calibration Requirements Search" for a "2016 Ford F-150". It provides links for "Vehicle System Definitions", "I-CAR Best Practice: Collision Repair Diagnostics Definitions", and "Additional RTS Portal Information". Below this, there are sections for "Vehicle System Options" with three columns: "360° Camera View", "Active Park Assist", and "Adaptive Cruise Control". Each column lists components and their status (DTCs Set, System, MIL) with Yes/No/Not Identifiable options.

Component	Yes	No	Not Identifiable
360 Degree View Camera	X		
Active Park Assist			
Adaptive Cruise Control			
Cameras/Sensors: Camera in Deck Lid/Liftgate/Tailgate (Middle)			
Cameras/Sensors: Camera in Front Bumper Cover/Grille (Middle)			
Cameras/Sensors: Camera in Side Mirror (Left)			
Cameras/Sensors: Camera in Side Mirror (Right)			
DTCs Set	X		
System			X
MIL			X

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diagnostics. We gathered subject matter experts from vehicle makers, collision repairers, insurers and tool and equipment suppliers. Our goal was to publish an industry-developed and vetted process for collision repair diagnostics. The group convened again in November to review the process, and in January, I-CAR published the following Best Practice for ADAS collision repair diagnostics.

Disclaimer: Before any repair decisions are made, access to OEM repair information is required. Diagnostic Trouble Codes (DTCs) do not identify which part needs to be replaced, rather DTCs are a piece of the diagnostic process that will lead a trained and qualified technician to the correct test to accurately diagnose the damage. Ensure that you have proper battery support when scanning. Although this process was developed to cover Advanced Driver Assist Systems (ADAS), the process can be applied to other electronic systems, such as restraints, adaptive lighting and other systems that may require calibration and/or aiming.

Pre-scan process

1. Conduct customer consultation.
 - a. Gain customer authorization to scan vehicle and to share data with appropriate parties involved (Sublet Technician/Insurer/Repair Facility Personnel)
2. Check for Malfunction Indicator Lamps (MILs) and/or information display messages.
 - a. The 12-volt electrical system must be enabled to identify any MILs.
 - b. Not all systems will illuminate MILs, even if there is damage to that system.
3. Document any MILs and/or information display messages.
4. Identify Advanced Driver Assist Systems (ADAS) (Collision Braking, Lane Keep Assist, Adaptive Cruise Control, etc).
5. Document ADAS.
6. Document potential damage to ADAS, ADAS mounting location(s), damage that may affect ADAS, or parts that will need to be R&I near ADAS.
7. Identify calibration/initialization/aiming requirements for ADAS parts, including required calibration/initialization following R&I.
 - a. RTS — OEM Calibration Requirements Search
 - b. OEM information
8. Identify enable and disable switches
 - a. Enablement/disablement may be required for some calibration procedures.
 - b. If it is turned off, system may not be able to be calibrated.
 - c. Systems that can be enabled/disabled should be documented, so that a system is not turned on when customer wants it off.

9. Perform pre-scan.
 - a. A pre-scan is not possible if the 12-volt electrical system and vehicle communication networks are disabled or cannot be maintained throughout the scan. If a pre-scan is not possible because of vehicle damage, it should be done as soon as repair progress allows it to be done safely.
10. Document DTCs and other data.
 - a. Does not include black box info, speed of accident/accident recreation
 - b. Include pending, current and past DTCs
11. Access OEM information to identify system(s) affected by DTCs.
 - a. Access to OEM information is required
 - b. Check OEM information for bulletins/recalls/campaigns for DTCs
12. Determine likely related and unrelated DTCs.
 - a. Leverage the "Collision Advantage"
 - b. Key cycles/time stamps/freeze-frame data

Post-repair calibration(s) and post-scan processes

1. Perform all required calibration/initialization/aiming steps, following OEM published procedures.
 - a. Some systems will require the vehicle to be driven to perform calibration/initialization/aiming within the required driving parameters.
 - b. Some systems will not detect issues within the system until the vehicle is driven within the required driving parameters.
 - c. Some systems will require special tools and/or aiming equipment for calibration/initialization/aiming.
 - d. Some systems will require both.
2. Perform post-scan.
3. If related DTCs return, begin OEM published diagnostic process to determine error.

Conclusion

With the increase in ADAS systems on today's vehicles, collision repair diagnostics is going to continue to play a growing role in complete, safe, quality repairs. To remain competitive in this industry, you'll need to invest in the necessary equipment, training and space to repair vehicles with these technologies. Now is the time to start incorporating collision repair diagnostics into your work flow. **TL**



JASON BARTANEN is the Technical Director for I-CAR, the Inter-Industry Conference on Auto Collision Repair, a not-for-profit training organization focused on education, knowledge and solutions for the collision repair industry.
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Finding the voltage drop culprit

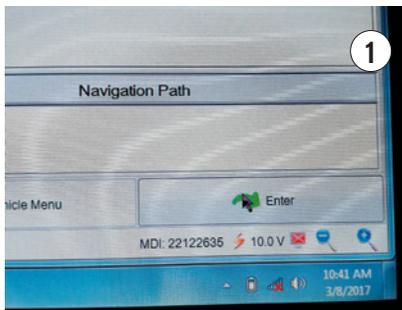
A minor collision repair misstep causes a multitude of system DTCs

JAIME LAZARUS // Contributing Editor

I always expect the unexpected, the unusual or the bizarre solution will be what it takes to fix the car when the owner of Ken Davis Auto Repair calls me in to look at a customer's vehicle in his shop. I was pleasantly disappointed this time!

I have a great deal of respect for Ken, and all others in automotive repair, who attend training on a regular basis. At an early point in my career, I recognized that in order to make my life easier during my work day and prove my claim of wanting to work smarter and not harder, I had to accept the fact that my job isn't just 9 to 5. It's one that requires frequent afterhours (and before-hours, weekends, etc.) investments in training.

I mean after all, when you think about it, where is the MOST expensive training facility? It's that service bay where a car sits, and you don't yet know how it's supposed to operate (and therefore, don't yet know how to fix)! I'd much rather the cars come in, get fixed, leave and it's on to the next one than to be stuck learning a new system, holding



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Global Diagnostic System 2		
Stored Data Review		
Vehicle Identification Number (VIN)	2G1155S34E9292252	
Report Creation Date	2017-04-01 18:00:01 EDT	
Slider Position Time	00:02:46.405	
Vehicle Configuration Property		
Headlamp Type	High Intensity Discharge (T4F TT2 TT6 TT7 TT8)	User
Steering Column Lock Control (ULS/N06)	Not Equipped	Control Module
Chassis Control Module Version	Fuel Pump	User
Telematics Communication Interface Control Module Version	9	Control Module
Make	Chevrolet	VIN
Model	Impala	VIN
Model Year	2014	VIN
Engine Identifier	3.6L (LFX)	User
System Information Property		
VCI Serial Number	MDI: 22122635	
Vehicle Session Creation Date	2017-03-08 10:12:04	
Test Start Time	2017-03-08 10:19:36 EST	
Software-Version	GDS 2 16 2.00900	
Control Module	Parameter Name	Value
Control Module	Parameter Name	Value
Control Module	Parameter Name	Value

GDS2 REPORT SCREEN

my bay hostage and impacting an entire shop's scheduled work load.

Ken is an owner/tech and is very much like me in his desire for peak efficiency. So when he calls on my diagnostic services, I kind of expect there's something REALLY weird going on. In the case of this 2014 Chevrolet Impala LTZ, this was so true!

During his initial phone call, he mentioned a few of the strange things the car started doing a couple of months ago that have happened on a more and more frequent basis. Ken told me, "The vehicle had been trouble-free in the 20,000 miles since the current owners had purchased this used car. Recently, an intermittent no-crank, no-start condition has worsened and now numerous systems are not performing as designed."

More specifically, the problems identified by the vehicle owner are that the starter would not make any sound when

the push-button to start the engine was depressed; while driving, the instrument cluster would suddenly and without any common reason, just go dark and all gauges would seem to lose power; the headlights illuminated normally but at times would go out and then come back on. There were more symptoms, but it isn't necessary to list them here. This description of symptoms sounds fairly complicated, doesn't it? What are your initial thoughts?

Then he went on to say the owners had first taken the car to the Chevrolet dealership where it was noted that there had been some body repairs made to the front of the vehicle, which the owners were unaware of at the time they purchased it. In part, due to the repairs, which included aftermarket parts, the dealership politely refused to accept the vehicle into their service bays and suggested Ken's shop might be better suited to "handle it"

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The image shows a man in a blue jacket holding a laptop and a PicoScope 6 device. The laptop screen displays a PicoScope 6 software interface with a waveform graph. The background is a screenshot of the PicoAuto website's 'Testing 12V alternator current and voltage at idle' page. The website page includes the following text:

Testing 12V alternator current and voltage at idle

You will require a PicoScope to perform this test. A list of suitable accessories can be found at the bottom of this page.

For Smart Alternators test refer to the pre-set for Smart Charging, and the Smart Charging Help Topic. The purpose of this test is to assess the charging rate of the alternator in relation to the electrical load placed upon the battery. Any charge taken from the battery must be replaced by the alternator. The output of the alternator is regulated and must neither under- or over-charge.

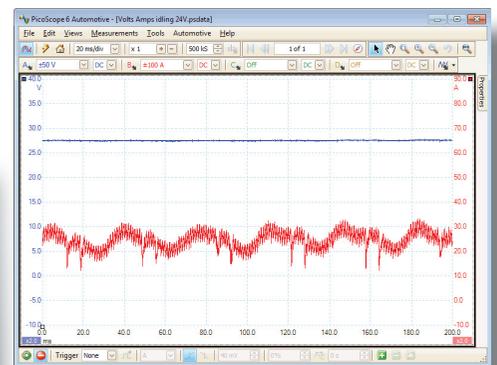
How to perform the test

PicoScope settings

- Channel A: ± 50 V DC
- Channel B: -100 A $+200$ A DC
- Timebase: 20 ms/div
- Current clamp to 200 A range

Connect the test cable to Channel A of your PicoScope. Connect the positive (+) lead of your test leads and connect across the battery terminals. Connect the negative (-) lead to the clamp. Connect the positive (+) lead of your test leads to the clamp. Connect the negative (-) lead of your test leads to the clamp. Connect the positive (+) lead of your test leads to the clamp. Connect the negative (-) lead of your test leads to the clamp.

Figure 1 - Battery and alternator



Diagnosis

Refer to vehicle technical data for specific test conditions and results.

Example: In the typical example to the right there should be a minimum of 20 amps output from the alternator when the engine is running and the headlights and heated rear screen are switched on:

Typical values

2 x headlights at 60 watts	120 watts
Heated rear screen	120 watts
Total	240 watts

240 watts divided by 12 volts = 20 amps.

Technical information

The alternator

The alternator, as the name implies, produces an alternating current (AC) output, which is rectified to direct current (DC) to provide the correct type of voltage to replenish the battery, keeping it at full charge.

The field current, approximately six to eight amps, energizes the rotor which then induces electric current in the stator as it rotates. The rating of the alternator tends to be vehicle-specific, as a base model has less electrical accessories such as electric front and rear heated mirrors, heated mirrors, additional lighting, heated and electrical adjusted seats etc.

An alternator stator has three internal windings wound 120 degrees between phases and requires nine diodes in a 'bridge' configuration to rectify the output. The voltage is regulated by a solid-state regulator that maintains the output in the range static to the requirement at the time. For example, a battery that has just been subject to a long cranking draws a higher output from the alternator than when the battery is fully charged.

Good charging system has the following characteristics:

- In battery voltage should be accompanied by an increase in charging current and vice versa.
- Regulated voltage can be measured on a multimeter, its reading can appear correct even if the alternator has a diode fault that reduces the output by 33%. The best way to monitor the alternator output is to capture the output voltage and current waveforms using PicoScope.

Figure 3 - Alternator wiring diagram with a nine-diode system

Figure 4 - Typical alternator

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I'd made some suggestions that he and his tech could check — things that are typical causes of the intermittent phenomena. The next day, in his second call to me, he elaborated on the test results for the suggestions I had made. I'd asked them if a complete electrical system test had been performed. I had also asked them to perform a vehicle-wide Diagnostic Trouble Code (DTC) check and to record the findings. In addition, I was curious if any aftermarket electrical devices were installed on or in the vehicle.

Their aftermarket scanner was able to access a majority of the modules on the network in this well-equipped Impala. Almost every module had stored codes, some relating to "Low Voltage" and most had DTCs that I like to call "Tattle-Tale" codes. Those are codes about module "State Of Health" messages.

Each module is supposed to identify itself on the network at some point. All modules are told to "keep a look out" for the other modules' report that they are on the network and that they are working properly. When a module does not receive an expected notification that another module was supposed to send, then this module stores a DTC that implies the other module is not healthy. It doesn't matter why that message didn't arrive — when a module expects the announcement on the network that the other module is "healthy" and it is not received, the code is stored.

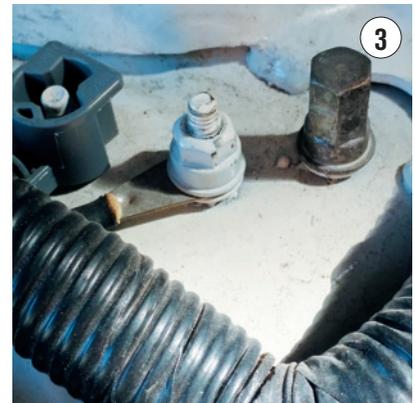
When Ken received the test results from his tech Jerry and saw how many DTCs were stored in every module, he asked Jerry to hold off on doing any more testing and made an executive decision. Jerry was well-versed in network diagnostics, but felt a bit intimidated by the number of codes set and also had some big jobs in the shop that needed to get done that week. So Ken asked me to take the job. It didn't hurt Jerry's feelings in the least when I showed up to relieve him!

General Motors' Global Diagnostic System version Two (GDS2) is the diagnostic software used on this car by the dealership technicians and is also available to the aftermarket repair shops. It is the diagnostic tool I chose to use in this case. I have numerous aftermarket scanners and PC-based diagnostic tools I could have selected from, but had I done so, I may not have gotten all the information the car had to offer.

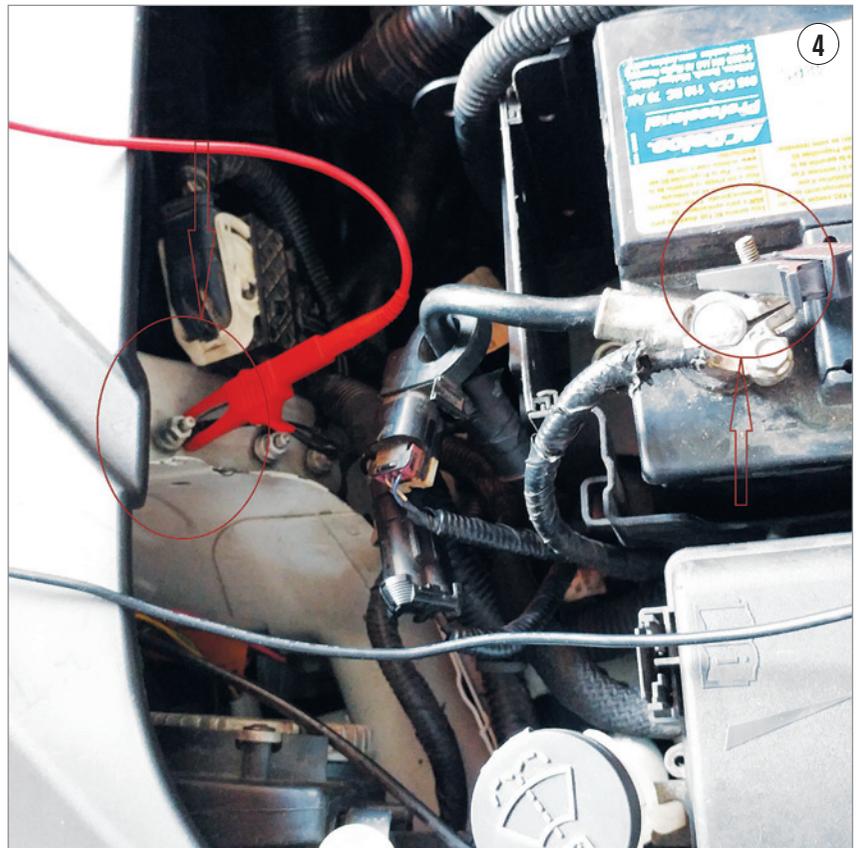
I started my diagnosis by reviewing with Ken and Jerry what I thought I'd heard them say. We all have been guilty of multitasking while conversing and not hearing everything correctly. I was driving at the time Ken made his first call to me, so distraction from my call could have occurred. Our chat confirmed we were all on the same page, so I proceeded to perform my diagnosis.

I began working on the car with a

verification of the electrical system integrity. This is where every (electrical fault-related) diagnostic sequence should begin. Since the battery is the starting and ending point of every circuit in the car, shouldn't we make sure there is nothing wrong with it? I tested the vehicle's battery with a conductance tester and a



GROUND ON A PAINTED SURFACE



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carbon pile load tester, and then I tested the alternator and the starter. All passed — Jerry’s test results had been the same.

Then I performed a vehicle-wide DTC and ID Information scan, which indicated numerous instances of “Low Voltage” problems (Figure 1) and network-wide communication faults (Figure 2). During this time I was closely monitoring the Data Link Communication (DLC) voltage displayed on the GDS2 screen. I saw it drop a few times to below 10 volts as modules were queried for their information one at a time.

It was during a visual inspection that ground wire terminals were found to be attached to painted surfaces rear of the left headlight and on the left strut tower (Figure 3). Here is where I say something’s wrong. Remember what I said about the car’s battery being the beginning and the ending point for all circuits? I haven’t had the privilege (in very many years) of inspecting brand-new Impalas as they were prepared for delivery, but it seems as if attaching ground wires to painted surfaces could potentially cause problems right from the start. So, I don’t know if that’s how they come from the factory — but I do know that once I cleaned the paint off one of the studs, I recorded a reduced amount of voltage drop — by a large amount! Looking closer I found evidence indicating this vehicle had been repaired after a frontal collision.

The voltage drop tests performed while cranking the engine showed no less than 216 mVDC (0.216 VDC) differences on any of the first four ground terminal eyelets tested (Figure 4). Could this amount of ground circuit “loss” cause all the modules to act as if they’ve lost their voltage supply (lost their minds)? Maybe.

You might ask, “what is this voltage drop test and why is it important?” Well, imagine a wire that has voltage running through it. The amount of voltage mea-



SOME OF THE NINE GROUNDS

sured at one end should be very close to the amount measured at the other. This would be true under most circumstances. Now, if there were to be something wrong with that wire, something that caused some sort of resistance, then the amount of voltage read at either end of that wire would be different from the other. That difference is what is called the “voltage drop.”

Resistance in a circuit can be in the form of corrosion (such as when the insulation on a wire is violated and the wire eventually turns green), looseness (such as when wire terminals aren’t tight or two aren’t mating correctly) and many other ways including the introduction of something between connections (like paint, which doesn’t conduct electricity very well). Yes, paint can interfere with the return of electrons to the battery, the amount which can be measured using the various techniques of performing voltage drop testing.

The Mitchell wiring diagram indicated there were (only) nine ground



BATTERY GROUND CABLE VOLTAGE DROP

points under the hood of this car. Some were grouped closely together and others were at each of the four corners in the engine compartment (Figure 5). I decided to measure the ground circuits beginning with the battery ground cable. Measuring from the battery post to the eyelet at the other end of the battery ground cable my DVOM (Digital Volt/Ohm Meter) displayed the drop as 0.212 Volts DC (Figure 6). I use this measure-



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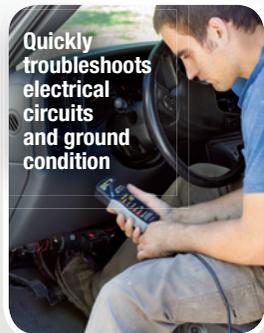


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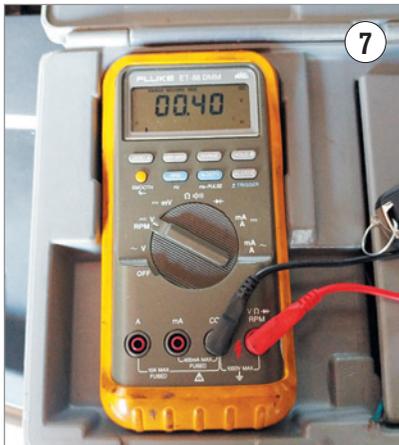
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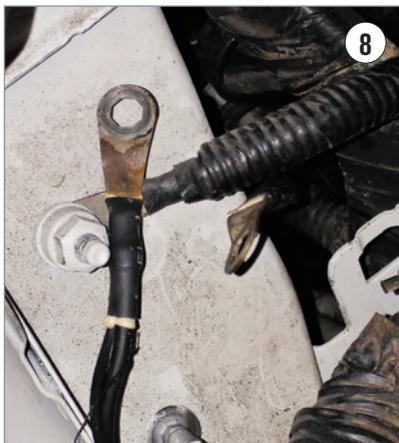


ment as a standard to go by because every test afterwards will include this drop. It's important to note that a voltage drop test should only be performed while loading the circuit. I did this by engaging the starter at the same time as recording it using the "Min/Max" function of my DVOM.

Once I have established the standard, then I can subtract that amount from future tests if I need to. I now know that amount of difference in voltage to the battery post is caused by how much resistance the battery ground cable has. If I test another ground circuit without attaching to the battery negative post, I can add the drop in the battery ground cable to get the TOTAL voltage drop in that circuit.



LARGEST VOLTAGE DROP RECORDED



ARCING EVIDENCE

Say I test a ground in the trunk by attaching my DVOM leads to a ground eyelet (for whatever system) and to a ground stud in the trunk. I will read the drop found in that area alone. But, to know the total voltage drop that that system is subject to, I have to add the drop of the battery's negative cable as well since that cable attaches the battery negative post to the rest of the car.

Once I had tested a few of the easy-to-get-to ground eyelets, I then moved my lead to the bell housing, near where another ground cable attaches. The readings changed every time I tried to record the maximum voltage drop! When the starter did engage, I read as low as 00.40 (400 mVDC, Figure 7) but sometimes, when the starter wouldn't respond to the push-button command I was giving it, I read over 10 VDC! Ten volts drop on the ground circuit is close enough for me to consider it an open circuit! It was a simple process of elimination at this point to locate the culprit. I worked my way back towards the battery.

Under the battery tray on this car are located numerous studs that are welded to the inner fender well. To each of these studs is attached a ground wire terminal (eyelet). I was able to reach each one and gave them a little "tug" to see if they were tight or not. Sure enough, the eyelet of the cable that attaches to the transmission bell housing was loose and easily moved with the slightest pressure. I removed the nut and while closely inspecting the terminal, found evidence of arcing (Figs. 8, 9). A lot of current was finding it difficult to complete its path to the battery through this loose connection!

The repair authorized by the vehicle owner was to combine the transmission bell housing ground cable on the same stud as the battery ground cable. I'd cleaned up the corrosion from the eyelets, removed the paint from the stud and nut, then I coated all compo-



LOOSE NUT — ARCING

nents with a liberal amount of dielectric silicone grease prior to reassembly. I cleaned and protected all other eyelets and studs under that hood just to make sure there would be no potential for failure in the future. I cleared all DTCs from every module, tested and re-tested many times for the customer complaint to reoccur, without incident.

It should be mentioned that all other aspects of the collision repair appeared to be done professionally. The owner had received the car unaware that any body damage had ever been repaired and had driven it for years before any repair-related incident ever showed up. I'm hoping the loose cable attachment was simply an oversight on the technician's part, one any of us could have made, but also hope collision repair specialists reading this would be extra careful with grounds in their future repairs.

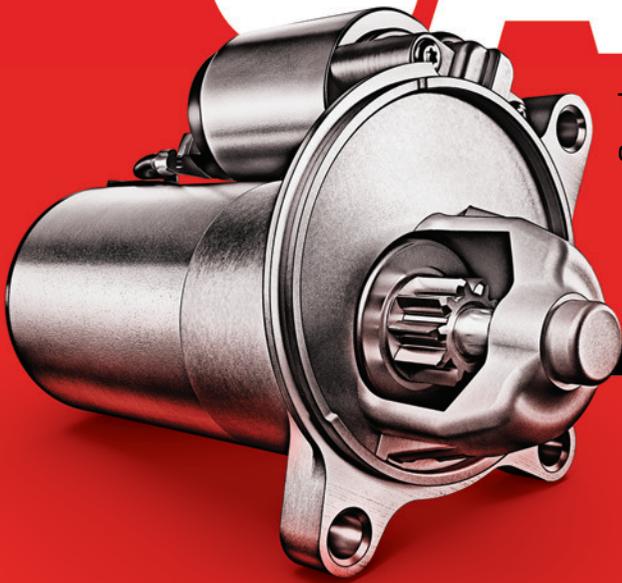
Please don't attach them to painted surfaces and expect them to be perfectly fine. No matter what you do, please perform voltage drop tests on them before returning the car to its rightful owner. This is a simple test and provides proof the connection made is what it should be (or not). *ML*



JAIME LAZARUS has regularly presented technical seminars since 1985. He recently taught instructors at the North American Council of Automotive Teachers conference and the

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AssistConnect is a centralized web-based system providing repair technicians direct access to the latest approved, licensed, original equipment manufacturer data immediately via Autologic's secure cloud server. AssistConnect is the only service that provides instantaneous access to vehicle manufacturers' licensed data without requiring multiple downloads. Since AssistConnect is cloud-based, Autologic automatically manages updates so customers are always assured they have the latest data.

AssistFix provides repair shops using any brand of scan tool direct support from Autologic's expert Fault2Fix team of nearly 100 master technicians. Each Fault2Fix team member is dealer-trained and brings — on average — 15-20 years of on-the-job, original equipment manufacturer (OEM), technical and specialty

automotive experience in European automotive brands to their roles. And, Autologic's "Try Before You Buy" program provides users the option to experience the AssistFix service on a trial basis for a brief period.

The **AssistPlus** device combines a deep diagnostic feature set with a range of applications, including a web browser, high resolution stills and video camera. It joins proven multi-brand European vehicle diagnostics capabilities with third-party information sources.

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Repair shops attend AAPEX to stay ahead of the curve

New programs and partners to address benefits and challenges of automotive technology

If you're like most shop owners and managers, there aren't enough hours in the day to take care of business, let alone stay up-to-date on the latest vehicle innovations and technologies. That's why AAPEX 2017 is expanding its focus on automotive technology, making it a one-stop source for everything you need to drive your business forward in today's high-tech world. AAPEX will take place Tuesday, Oct. 31, through Thursday, Nov. 2, at the Sands Expo in Las Vegas.

"AAPEX is a single venue where I can see all the products, services, technology and people that I need to keep abreast of new things that affect my business and profits," said attendee James Napier, Turbo Horsepower, Albuquerque, N.M.

To keep you ahead of the curve, the 2017 AAPEXedu will include sessions on telematics, connected vehicles, Advanced Driver Assistance Systems (ADAS), vehicle data access, alternate fuel and drive train options, and Vehicle-to-Vehicle (V2V) communication and new mobility models. The information-packed "Aftermarket Outlook" and "Five Trends in Five

Minutes" sessions will return with the latest market intelligence and research to help you identify opportunities to diversify and grow your business.

This year's enhanced Service Professionals Program will feature under-the-hood training by AVI and a special Advanced Vehicle Training session by the Automotive Service Association (ASA). An all-new Service Professionals Summit will take place on Nov. 2, with a reception to follow. Carm Capriotto, founder and host of Remarkable Results Radio, will moderate the panel of industry experts as they discuss emerging technologies facing the service and repair segment of the industry.

For the first time, Northwood University will offer sessions as part of the AAPEXedu, while ASA and AVI will provide technical training sessions. The Auto Care Association and the Automotive Aftermarket Suppliers Association (AASA) also will host sessions tailored to each of the communities within AAPEX. NARSA — the International Heat Transfer Association — joins the education lineup this year with a program on the latest trends and technologies in heating and cooling systems.

A day-long REMANedu Conference, which also is part of AAPEXedu, will take place on Monday, Oct. 30.

On the show floor, watch for more than 2,200 exhibiting companies and don't miss the all-new area, AAPEX Technology Intersection. This section will be



filled with excitement as exhibitors use an interactive interface, such as virtual reality or simulators, to demo innovative automotive technology that is not currently available in the aftermarket.

For even more technology, Let's Tech returns to AAPEX 2017 with a new lineup of short, 20-minute or less presentations.

All Let's Tech presentations and AAPEXedu sessions are included in the \$40 (U.S.) online attendee registration fee. To register, visit www.aapexshow.com/adv.

"AAPEX 2016 was an amazing event. I bring some of my team members every year to see how massive and awesome the automotive aftermarket industry is. There is no other show that can give you the ability to get education, network, see new products and learn the direction of the industry," said Dwayne Myers, co-owner, Dynamic Automotive, Frederick, Md.

AAPEX represents the \$740 billion global automotive aftermarket industry and is co-owned by the Auto Care Association and the Automotive Aftermarket Suppliers Association (AASA), the light vehicle aftermarket division of the Motor & Equipment Manufacturers Association (MEMA). For more information, visit the AAPEX website, www.aapexshow.com or e-mail: info@aapexshow.com. On social media, follow AAPEX at #AAPEX17.

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Playing the diagnostic game

Without a doubt, diagnosing automotive vehicle problems is a complex issue and the most difficult service to profit from. The tidal wave of technological complexity installed in today's vehicles make it even more difficult to consistently profit while satisfying our customers. Your shop needs talented technicians and service advisors with great attitudes towards serving your customers to be successful. Your team should constantly seek knowledge to stay abreast of new technologies and your shop must commit to a solid diagnostic workflow process that includes investment in tools, equipment and continuing education. Many shops have struggled to keep up and are now using a mobile diagnostic technician. While this is a solid solution, it does not always serve the customer's immediate needs in respect to timing and convenience. Here are a few tips that may help you get your shop's diagnostic house sorted.

First let's define diagnostics. Most shop owners define diagnostics as the techs' work to determine the root cause of a customer's concern. It is the information you stand on when making a service recommendation. And, of course, diagnostics is the least profitable service you provide. There are no parts involved (and thus no parts margin) – to the point that some have resorted to giving diagnostic services away if a customer buys the repair.

To your customers, diagnostics is viewed as inconvenience that costs money; money that they don't think they need to spend. Many customers don't understand or accept the value, because they feel you should know what's wrong with their car.

An all-encompassing definition of diagnostics is 'Identification of a condi-

tion or problem by systematic analysis of the background or history, examination of the signs of symptoms, evaluation of the research or test results, and investigation of the assumed or probable causes.'

Systematic means process. This service isn't just an approach using experience-based diagnostic web sites. It requires a plan of action that is followed every time.

Analysis is different that diagnose. Analysis is taking all the information gathered and considering how it relates to the problem. Diagnosis has the perception of a solution while analysis is the process of getting to that point. Background and history consider all that has happened with the specific vehicle prior to the point in time a customer brings it into your shop.

Examination relates to running a se-

ries of tests based on the analysis of the vehicle history and symptoms. Test Results implies you actually ran tests and the results are included in the analysis. Investigation is focused on determining if the results of the analysis are logical and make sense as a solution.

Customers don't simply want a diagnosis. They want you to 'just solve the problem!' when they walk into your shop. This discussion of the way we define diagnostics should prompt you to think about your own best practices from a different points of view.

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CHRIS CHESNEY has more than 40 years of technical training experience in the automotive aftermarket and currently serves as Senior Director of Customer Training for Carquest Technical Institute (CTI) and Advance Professional. Chesney received his ASE certifications in 1972 and has led thousands of technician trainings across North America for Advance Auto Parts.

Understanding multiple ground electrode spark plugs and the benefits of iridium spark plug technology

One of the most misunderstood spark plugs in the automotive industry is the Multiple Ground Electrode Spark Plug. It has been used as Original Equipment (OE) in rotary engines by Mazda since 1971 and has since been adopted by many other automotive manufacturers (European and Japanese). Some Original Equipment Supplier (OES) manufacturers still offer them to feed the mentality that OE is the best replacement.

A few manufacturers still offer designs with 2, 3, and 4 ground electrodes. Some originally thought that multiple ground electrode spark plugs would help to avoid fouling, but the effect is short lived. These product designs are now considered to be obsolete.

Other OE manufacturers use multiple ground electrode spark plugs as a way to extend durability so as one wears out, you'll have additional functional electrodes to last 2-3 times longer than a single electrode made of the same metallurgy.

One of the myths about multiple ground electrode spark plugs is that they fire more than one spark at a time.

However, the physics of electricity doesn't allow this to happen.

The multiple ground spark plug was the answer to increase the durability of spark plugs during the 1970s. However, it came at the cost of ignitability, most noticeable with rotary engines during cold starts, and on higher mileage engines with lower compression or poorly maintained engines. Electrodes would get in the way and interfere with the flame kernel by absorbing the heat energy, essentially extinguishing the flame. This is also prevalent with more recent spark plug designs that have a massive ground electrode that absorbs the kernel energy.

Because of these problems, OE manufacturers needed to have better ignitability to comply with emissions standards. And as misfire detection began with on-board diagnostics, most professional technicians have switched to Iridium Spark Plug technology as it has proved to be an all-around better performing technology, making



the multiple ground electrode spark plugs obsolete. The durability of Autolite's Iridium XP Enhanced Alloy Technology Spark Plug is attained through rare metal alloy that performs through the duration of manufacturer maintenance intervals. The spark plug features a finewire Iridium center electrode and a platinum tip in the single, V-trimmed ground electrode. The innovative design also features an anti-fouling ceramic. Autolite's Iridium XP provides ultimate ignitability and is the top choice to work with any ignition system.

With an iridium-enhanced 0.6 mm finewire design and patented platinum ground electrode technology, the innovative product delivers optimum performance and is an excellent replacement for multiple ground electrode spark plugs. Autolite is also the first spark plug manufacturer to introduce a Lifetime Limited Warranty.

For more information on Autolite Iridium XP Enhanced Alloy Technology Spark Plugs, please visit www.autolite.com.

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EVAP system testing on late-model vehicles

The impact of Mode 10 on your emission diagnostic testing

Many late-model vehicles use a natural vacuum leak detection system to alert drivers of emissions problems. Using your scan tool, you can diagnose those issues by reading codes and testing the various components within the EVAP system. These include the vent solenoid and purge valve.

After you plug in your scan tool and pull codes, perform an all-systems scan to look for freeze frame data. This information will show you what happened when the code was set, allowing you to repeat those conditions and isolate the issue.

The next step is using maintenance or special tests specifically for the EVAP system. In here you'll be able to test the vent-purge solenoid and purge valve to check the impact it has on fuel tank pressure. As you increase the purge, fuel tank pressure should drop. If you decrease purge, fuel tank pressure will rise as vapors are not being allowed to vent.

MODE 10 REQUIRES NEWER VEHICLES TO SELF-VALIDATE EVAP ISSUES.

If increasing or decreasing purge does not change fuel pressure, you may have a failed solenoid that is not opening or closing the purge valve.

If the EVAP purge test fails, grab a voltmeter and go under the hood. From there you'll test voltage at the connector for the purge solenoid. Using your scan tool, increase purge percentage. If voltage changes, you've confirmed the



wiring is good and the purge solenoid needs to be replaced.

Once you've identified the problem and replaced the failed part, run your tests again to confirm the fix. Go back into your EVAP special tests and increase purge. As you purge vapors from the fuel tank, pressure will drop, confirming your solenoid is operating properly. You're now pulling engine vacuum into the fuel system, allowing fuel tank pressure to be released.

After fixing the vehicle you may be tempted to clear the codes, but you might not be able to. Mode 10 requires newer vehicles to self-validate EVAP issues, requiring a specific number of drive cycles to self-test and clear the codes.

So if you're fixing a vehicle with an EVAP issue, remember to run all your EVAP / emissions special tests, do an all systems check to view freeze frame data and that Mode 10 may not let you clear codes. You may have to let the vehicle decide when to turn off the DTC light.

To help in your next EVAP diagnosis, remember there are three main criteria for when a vehicle will

perform its tests and turn off a DTC light. Those criteria are:

- The PCM turns off the malfunction indicator lamp (MIL) after three consecutive ignition cycles that the diagnostic runs and does not fail
- A last test failed, or current DTC, clears when the diagnostic runs and does not fail
- Ode 10 DTC clears after 40 consecutive warm-up cycles if no failures are reported by this or any other emission-related diagnostic

OTC TOOLS

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Never install less than you remove.

In today's competitive service environment, you can't side step the issue of OE quality because, if you do, the 'Check Engine' will get you. This is especially true when you're working on an engine management issue or servicing a fuel system. There's only one right way to do this kind of work, and that's with the right parts. This means replacing failed or worn components with OEM parts you can trust.

Engine management and fuel supply components can directly affect overall drivability, power response, efficiency, fuel economy...and in some cases, even warranty. You don't question the quality of your work, and you shouldn't have to question the quality of the parts you use either.

We're talking about parts that are essential to a vehicle performing properly, such as mass air flow and manifold absolute pressure sensors, electronic throttle valves, air actuators, fuel injectors and fuel modules. The big problem is that these parts typically only come at a steep price. Of course, you can find aftermarket parts out there that cost less, but they may not deliver the OE quality and performance your customers need. While these non-OE parts may look and fit the same, they may not work the same.

Genuine OEM parts

Continental's VDO OEM Direct Parts Program gives you and your shop an unbeatable solution. They offer an exceptional range of premium, but competitively priced, VDO branded OE replacement parts.

Continental's VDO parts are genuine original equipment parts – we're not talking 'like OE' or 'meets OE spec'. We're talking the real



McCoy. So, there's never any question of quality or performance. VDO OEM Direct Parts are made to deliver trouble-free, labor saving fit and function that you would expect from OE parts. They are vehicle-specific with OE connectors and install right, the first time, every time. You won't see any pigtails or universal fits in this line.

The VDO OEM Direct Parts Program includes Air Actuators, Electronic Throttle Valves, Electric Temperature Controlling Water Pumps, Flex Fuel Sensors,

Fuel Injectors, Fuel Modules, and MAF and MAP Sensors. European, domestic and Asian coverage is exceptional for popular and high volume vehicles, as well as hard to find applications.

Remember, not all aftermarket parts are created equal. So, when you're working on your customers' vehicles, do it right, the first time with VDO OEM Direct Parts.

For more information, visit: vdo.com/usa or contact: salessupport-us@vdo.com.

VDO

VDO – A Trademark of the Continental Corporation

Clean the tank before replacing the pump

A safe and effective fuel pump repair job begins with cleaning the fuel tank. Did you know that most replacement pumps that fail often do so due to contamination in the fuel tank?

Debris in the gas tank will damage a new fuel pump. Contaminants collected over time inside the tank can clog the strainer, forcing the pump to pull more current and amperage which leads to burnout. The time it takes to clean out this debris – about an hour – is nothing compared to the time it takes to redo the entire job.

Fuel tank cleaning kit

Whether you're a Do-It-Yourselfer or a technician replacing a fuel pump, cleaning and inspecting the fuel tank before installing the pump should be a priority. As part of our commitment to do the job right the first time, Delphi offers a fuel tank cleaning kit (FC01) designed to make a safe and effective tank clean easier. The low-suds cleaning solution is specifically designed to easily treat and rinse up to a 40 gallon capacity fuel tank.

Delphi's fuel tank cleaning kit removes microbial growth in the tank, breaks down varnish and gel from ethanol and minimizes sludge and other fuel contaminants. Using the fuel cleaning kit to remove harm-causing debris can extend the life of your new fuel sending unit.

The original pump went into a clean tank. To ensure the same level of performance, the new pump should go into a clean tank, too.

For more information, visit delphiautoparts.com/en/clean-tank.



10 steps to clean your fuel tank

Before you begin cleaning your fuel tank, be sure you're considering safety first. This includes wearing safety goggles and gloves, storing fuel in an approved container and having a fire extinguisher on hand.

1. Drain the fuel tank into an approved container.
2. Clean rust and debris from the top of the fuel tank.
3. Remove the old fuel pump from the fuel tank.
4. Swirl the gas tank and pour out remaining gas and debris.
5. Clean the tank interior with a low-suds soap and water mixture.
6. Swirl the cleaning solution inside the tank.
7. Drain the tank and dry it with compressed air.
8. Wipe out the tank with a lint-free towel
9. Visually inspect the tank for damage. Replace the tank if there is any damage.
10. Let the tank sit for approximately 30 minutes until you are sure it is completely dry.

DELPHI

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Technical bulletin: Fluid reservoirs and water outlets

Fluid Reservoirs

The hottest days of Summer are quickly approaching, and with the higher temperatures, radiators will be steaming, engines might start overheating, and cooling systems could be failing. As your cooling service business heats up, be sure to check Dorman Product's full line of coolant reservoirs to save time and money now.

Cracked, damaged, or leaking reservoirs are some of the most common causes of overheated engines. Dorman's coolant reservoirs are made from premium materials and tested to rigorous quality standards to ensure the highest quality product for your customers. Included in the testing of each reservoir is a 300-hour heat-aging process that simulates over 200,000 vehicle miles. Every reservoir is a direct-fit replacement to the OE bottle and ships complete with a cap to save you installation time and money.

When you are troubleshooting and diagnosing issues related to the coolant reservoir, be sure to remember these simple quick tips.

- For Pressurized Coolant Reservoirs:
 - o Always ensure fluid has cooled before opening reservoir cap.
 - o Check to make sure any level sensors present are operating properly.
 - o Inspect the reservoir, fittings, and hoses for leaks or other damage.
- For Non-Pressurized Overflow Bottles
 - o Ensure the radiator is operating properly.
 - o Check fluid is only filled to the cold level.
 - o Remind customer that the use of fluid other than coolant can lead to costly failures and engine damage.

With over 450 reservoirs covering

more than 200 million vehicles on the road, Dorman offers the most comprehensive line of fluid reservoirs in the aftermarket. Coolant reservoirs, windshield washer reservoirs, and power steering reservoirs are just the start of the value Dorman can bring to your business.

Water Outlets

Closed System and Increased Complexity
A vehicle's cooling system is a closed system designed to optimize the engine's efficiency. A properly maintained system will extend the life of your vehicle's engine, reduce emissions, and also increase fuel economy. The complexity of this sealed system increases every year as vehicle manufacturers are hard-pressed to attain more stringent emissions regulations and consumer demands for improved fuel economy.

Effects of time and temperature

The integrity of a closed coolant system is challenged throughout the lifetime of the vehicle due to constant temperature fluctuations of a heating or cooling engine. Typically, one of the more failure prone components within the coolant system is the thermostat housing or water outlet. Five of the most common failure modes are:

- Vibration Welds — heat and pressure of coolant cause seam welds to fail prematurely
- O-rings / Gaskets — coolant wears away material causing poor performance and leakage
- Plastic Housings — plastic housing become brittle over time, leading to cracking
- Integrated Thermostats — thermostats are worn out causing poor timing on opening or closing



WATER OUTLET - part number 902-033



FLUID RESERVOIRS - part number 603-487

- Integrated Sensors — sensors corrode causing poor communication to thermostats

All of the failures listed above could lead to failure of the entire coolant system that, if not repaired, may leave you stranded on the side of the road.

Need a quality replacement? Look for the Dorman wings!

If you're looking for a replacement water outlet or thermostat housing, Dorman has over 500 SKUs, covering all of the vehicle applications that you would need!



DORMAN PRODUCTS

3400 East Walnut Street
Colmar, PA 18915

www.DormanProducts.com

Downstream O₂ Data Analysis

Have you ever been challenged to find the cause of an engine misfire? Perhaps you invested a lot of time on the job only to discover the cause wasn't as buried as you had believed. Or maybe you missed the root cause the first time and had to tackle the job again on your own dime.

Federal Mogul Motorparts' Garage Gurus training network (www.FMgaragegurus.com) offers advanced training focused on streamlining all diagnostic processes. We're committed to arming techs with the latest information to keep pace with emerging vehicle technologies.

One quick tip relates to the use of downstream O₂ sensor PID value in diagnosing a misfire. Obvious suspects include ignition faults, air:fuel issues and engine mechanical concerns.

Misfire analysis can often lead to additional analyses requiring use of a digital storage oscilloscope, secondary ignition wand, inductive clamps, pressure transducer testing, variable valve timing bi-directional scan tool tests, injector balance testing, and even measurement of exhaust backpressure. But the process typically begins by retrieving the diagnostic trouble code(s), followed by a data scan. Paying attention to all clues is key.

Misfire counters, coil driver PIDs and fuel trims provide invaluable diagnostic insight, but there are other clues available. For example, switches on conventional O₂ sensors are driven by short-term fuel trim commands. In many cases when a vehicle experiences a Type A misfire, fuel control will go into open loop, zeroing-out fuel trim values. The sensors are still alive, however. Many technicians use the downstream sensor only as a catalyst efficiency indicator when, in fact, it can offer additional insight. Here's an example:

The screen capture in Fig. 1, taken from a known-good vehicle, indicates effective fuel control with no misfires. When the catalytic converter is functioning correctly, you will typically see a downstream sensor value of around 700mV at road load, cruise conditions in a fully warmed-up state. This indicates both a healthy catalyst and proper fuel control.

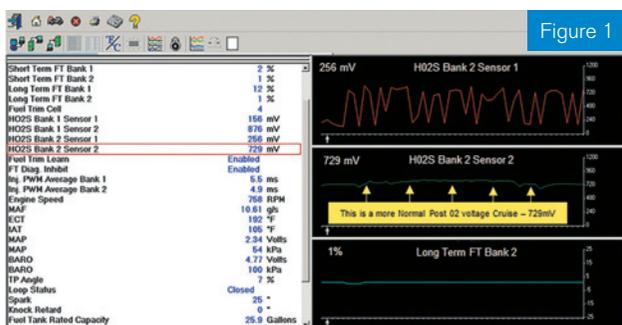
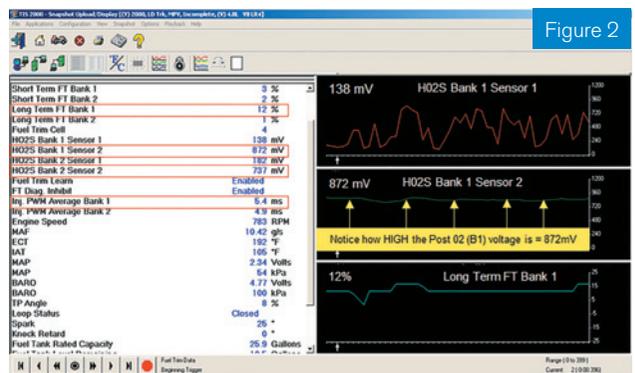
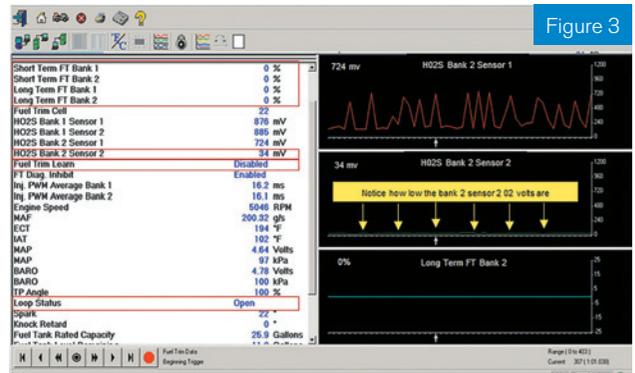


Fig. 2 shows the same vehicle experiencing a single cylinder misfire due to loss of ignition. Let's compare the downstream sensor value with that in Fig. 1. The elevated voltage (870mV) indicates the injector for that cylinder is active (some vehicles will disable the injector after a Type A misfire). As a result, the catalyst is being fed an overly rich mixture and cannot oxidize all of the hydrocarbons. Our takeaway is that the misfire is being caused by lack of ignition rather than lack of fuel (loss of injector).



In Fig. 3, the engine is misfiring due to lack of fuel. Downstream Average sensor voltage is extremely low (34mV). In this case, the injector was actually unplugged, but the result is similar to what we would see with a clogged or dirty injector.



Our ultimate takeaway is to always use the downstream O₂ sensor to aid in diagnosing an engine misfire. This approach is simple and easy during your initial diagnostic steps, such as in a road test.

For more diagnostic insight and information regarding the Garage Gurus training curriculum, please visit www.FMgaragegurus.com.



Accessory belt noise — Is the belt *REALLY* to blame?

DREW CONKLING //

Belt Product Manager, Gates Corporation

Belt technology has changed significantly over the last two decades, and as a result, techniques for inspecting belts and correctly diagnosing belt noise need to change as well. In the past, accessory belts would wear quickly, resulting in common visual cues such as cracking, chunk-out and pilling. This would often result in belt noise, especially under high loads, that was easily traced back to the worn belt. But as belt technology has progressed, root cause analysis of belt noise has become more important than ever. This is because more often than not, belt noise on today's vehicles is **NOT** caused by the belt itself.

Think wear, not cracks.

Before diving into the diagnosis, let's start with proper belt inspection methods. Unbeknownst to many, accessory belts are now manufactured with a synthetic rubber called EPDM. They wear much slower than previous generation belts, which were made from actual rubber. A byproduct of this is that modern belts do not show the same telltale wear signs that older belts did and a simple visual inspection will no longer do. Rather, one must rely on a belt wear measurement tool which actually measures the amount of material loss on a belt (similar to a tread depth gauge). These easy-to-use tools are available free of charge through most major belt manufacturers.

If not the belt, then what is the cause?

When it comes to the commonly re-

ported symptom of belt noise, it is important to remember that the underlying cause most likely lies with another component in the system and not with the belt itself. The good news is identifying the root cause of belt noise is a fairly simple diagnosis. First, perform an inspection of the belt; check for excessive wear with a wear gauge, and also for signs of fluid contamination. If these pass, then either misalignment in the drive or improper belt tension is to blame.

To determine which, fill a spray bottle with nothing but water, start the vehicle, and spray water on the ribbed side of the belt as it is emitting noise. If the noise temporarily dissipates or goes away entirely, misalignment is present in the drive. This is because the water is temporarily lubricating the belt, thereby masking the misalignment. Further diagnosis is required to determine the misaligned component, and can be performed with a straight edge or a laser alignment tool. Since the crankshaft pulley is least likely to be the cause, it is recommended to check all other components against it for misalignment.

Alternatively, if the noise becomes more audible or is unaffected by the water, improper tension is at fault. Since the belt is already slipping due to the improper tension, the water once again acts as a lubricant, thereby causing the belt to slip even more. The underlying cause of the improper tension is either



an excessively worn tensioner or a belt that is too long for the drive. If the correct length belt is being used, the tensioner is worn and needs to be replaced.

So the next time a vehicle with belt noise pulls into the shop, remember that although belt noise is the symptom, the belt is probably not to blame. Performing these simple inspection and diagnosis techniques will ensure you fix it right the first time, thereby avoiding costly comebacks and angry customers. Also, remember to Be System Smart. If you are replacing the accessory belt, don't forget to recommend replacement of the tensioner and idler pulleys as well, as they are manufactured to wear at the same rate.



GATES CORPORATION

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The Disc Brake System Analyzer: If You Don't Have One You're Just Guessing!

If a customer comes to you with uneven brake wear and you just assume it is a bad caliper and replace it, you may be guessing. Imploded brake hoses and stuck proportioning valves produce hidden symptoms that are not easily diagnosed.

Symptoms of an imploded brake hose occur when the inner nitrile tube of the brake hose ruptures. Using vice grips to crimp off a brake hose when changing calipers is a bad practice since many times, it will break the inner nitrile tube, setting the stage for a hose rupture and implosion. Some manufactures clamp the brake hose to the fender wall. Over time, there is a warring effect between the point where the hose is held tight in the clamp and where it flexes. Over time, the inner tube will rupture again, setting the stage for an implosion of the inner tube.

Once the tube rupture occurs and the brakes are applied, the brake fluid is pushed past the rupture, actuating the caliper. However, when you release the brake, the implosion acts like a one-way valve, not allowing the fluid to find its way back to the master cylinder or the caliper to release. This has all the indications of a stuck slide or frozen piston, but it is only the hose that needs replacement. It is a hard lesson to learn when the car comes back with the same symptoms after replacing all the brake hardware, i.e., rotor calipers and brakes.

Uneven brake wear can also be misdiagnosed very easily because there are no tools to detect its hidden cause. Here is a very common scenario that

shop owners face because of uneven brake wear. A customer comes in with one side brake pads worn down to the metal and the other side in good shape. The first reaction is to replace the calipers, rotors and brakes. Then test drive the car and return it to the customer.

Two weeks later, the customer comes back and describes the same noise and problem as before, but this time, they're not so nice! As soon as you pull the car into the shop and hear the metal scraping again, you will immediately know what the problem is, but may not know why it's happening again. At this point, some techs will install a second set of parts hoping the first caliper was bad; maybe replace the proportioning valve, the master cylinder, or the brake hose.



This is where IPA's Disc Brake System Analyzer can save the day. It can accurately detect exactly where the problem is and allow the tech to fix it the first time, saving time, energy, guess work and embarrassment when the customer comes back.

The Disc Brake System Analyzer is a must have for the professional brake technician. It is the only tool that can quickly identify an imploded brake hose and quickly diagnose a proportioning valve imbalance.

For more information on the #7884 and other IPA products, contact your professional tool distributor or visit www.ipatools.com

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IPA
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Changing radiator fittings

The only question is which fitting is right for your radiator application—Jiffy-tite's Basic Quick-Connect (BQC) or the company's Integral Quick-Connect (IQC)?

Locating replacement nuts, bolts and related fasteners when working on a vehicle can be trying at times. But when it comes to finding new fluid fittings, the process is easy: simply replace the original Jiffy-tite with a new Jiffy-tite!

More than two dozen manufacturers around the world use Jiffy-tite fluid fittings as original equipment on their automatic transmissions and heat exchange applications. And even if it didn't come with one from the factory, there's a Jiffy-tite solution that makes nearly any replacement a snap—literally! So, if you're going for a foolproof, leak-proof repair, the answer is always a Jiffy-tite quick-connect fitting.

Basic Quick-Connect (BQC)

Jiffy-tite's BQC fittings are used for standard metal radiators. When installing a Jiffy-tite quick-connect, it's important to understand the function of the fitting you're using.

With standard metal radiators, the

cooler is retained in the radiator tank independently of the quick-connect fitting. The BQC threads into the bung of the cooler and allows the transmission line to snap into the radiator.

Integral Quick-Connect (IQC)?

Meanwhile, the company's IQC fittings are designed for use in plastic radiators. IQC fittings will always have an external washer on the threaded end of the quick-connect.

For plastic radiator tanks, Jiffy-tite designed the IQC fittings to replace the retention mechanism that attaches the cooler to the tank. The IQC fitting threads directly through the plastic tank to the cooler.

When torqued properly, the Belleville-style spring washer creates tension, pulling the cooler against the plastic tank. This seals and retains the cooler in the plastic radiator, while also providing a quick-connect port for the

tube insertion and retention.

Note: When replacing Jiffy-tite quick-connect fittings on a plastic radiator, always remember to remove and re-install one fitting at a time. If both Jiffy-tite IQC fittings are removed at the same time, there is nothing holding



BASIC QUICK-CONNECT FITTING

the cooler in place, and it can drop into the tank. This can lead to a contamination of fluids, damage to the cooler or tank, or possibly even having to buy a replacement radiator. Therefore, when replacing a Jiffy-tite IQC fitting, be sure to remove and replace one at a time.

All of Jiffy-tite's connectors are 100-percent leak-tested and feature a simple, ergonomic design, so when the fittings are snapped into place, you know they're in place for good.



INTEGRAL QUICK-CONNECT FITTING



2017 PurolatorTECH™ Professional Automotive Filter Catalog

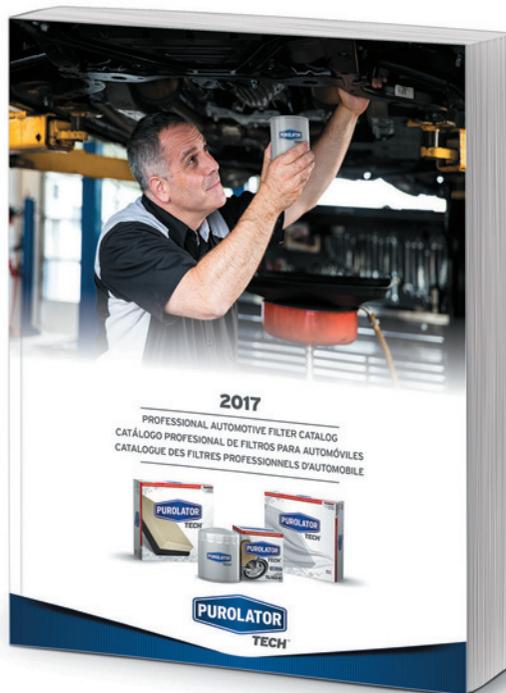
The 2017 PurolatorTECH® Filter Catalog is a one-stop-shop for all the product information you need. Designed specifically for automotive technicians, the catalog is organized in a way that allows users to quickly and easily look up filter options for all product applications by vehicle year, make and model.

The catalog provides an extensive listing of filters covering the last 20 years, available for markets in the U.S., Canada and Mexico. It is offered in tri-lingual print and online versions, and includes a buyer's guide, competitive interchange and a hotline directory.

To request a printed copy of the 2017 PurolatorTECH Professional Automotive Filter Catalog, contact your local Purolator sales representative. You can also explore the digital version of this catalog or experience the complete PurolatorTECH product line with cross-references and search capabilities at www.pureoil.com.

About PurolatorTECH

PurolatorTECH is Purolator's latest professional grade filter product line offering designed specifically for the vehicle service professional. The program



is focused on providing top OE-quality products at competitive pricing with comprehensive coverage within the oil, air and cabin air filter lines.

PurolatorTECH oil filters offer 96.5 percent Dirt Removal Power™ and cover 99 percent of the vehicles in operation (VIO). Engineered to meet or exceed manufacturers' performance requirements, these filters feature rugged internal construction and an anti-drainback valve to protect against dry starts.

PurolatorTECH air and cabin air filters are engineered to provide reliable and optimal performance. The new, expanded line of air filters is designed to ensure maximum airflow, high efficiency and increased engine performance, offering more than 97 percent of VIO coverage. PurolatorTECH cabin air filters are available in particulate or carbon depending on OE configuration, with more than 95 percent VIO coverage.

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Fleet brakes that work as hard as you do.

When it comes to keeping fleet vehicles on the road, time, money and even lives are at stake. That's why we created NAPA Fleet brakes from the ground up — designed to last longer and perform better on more than 90 percent of fleet vehicles.

More longevity. More performance.

As a rule, the longer a part lasts, the better. But longevity isn't the only marker of a good product. There's also performance to consider.

The truth is, NAPA Fleet brakes hit longevity and performance right in the sweet spot.

According to industry-standard SAE Safety Testing, NAPA Fleet brake pads and rotors last an average of two times longer than the competition. All thanks to special pad and rotor formulations that, when used together, stand up to the intense heat and friction service vehicles endure day in and day out. As a result, technicians experience more time between maintenance intervals and drivers benefit from more uptime — making project managers, accounts and business owners especially happy.

More safety qualifications than any other brand.

Imagine you're behind the wheel hauling a massive backhoe from a construction site, driving the morning rounds in a school bus or taking a police cruiser in pursuit from 80 mph to zero in a matter of seconds. You wouldn't want your vehicle equipped with just any normal brakes.

According to the tests, NAPA Fleet brakes are anything but normal.

After submitting NAPA Fleet brakes to rigorous research and development processes and safety tests, we've collected more safety qualifications than any other aftermarket brand. Our brakes even exceed the requirements of the Emergency Vehicle Operations Course — an industry benchmarking test where NAPA Fleet brakes passed with flying colors on performance and longevity, wear, and noise reduction.

Support you need to get the job done.

When it comes time to switch to NAPA Fleet brakes, we know you can't be left with a vehicle sitting on the lot waiting for parts. Time is money. That's why NAPA offers world-class training and technical support to all our fleet customers. And with more than 6,000 NAPA AUTO PARTS Stores and 16,000 NAPA Au-



toCare Centers nationwide, the parts and advice you need are never far away.

Don't settle for anything less.

When your business or organization depends on a well-maintained fleet, there's no better choice than the performance, longevity and service that come with NAPA Fleet brakes. Because while keeping a fleet of vehicles running longer and stronger is your job, it's our business.

NAPA AUTO PARTS
1-800-LET-NAPA | NAPAOOnline.com

3 Tips to Increase Diagnostic Efficiency

When a vehicle arrives in your auto shop for repair, you know the questions to ask your customer before you get started. Once you've had that initial conversation, you'll have an understanding of the nature of the problem, when it occurs, and how long it has persisted.

Those details are the first steps toward a diagnosis. But the real diagnosing begins when you apply your skill and experience to the problem. A quick look at your auto repair information resource can help set you on the right path right away.

For instance, ProDemand* from Mitchell 1 gives you a variety of features you can check to validate your gut instinct before you get under the hood. The goal is to help you quickly arrive at the correct solution to solve the customer's main concern, as well as determine whether there are additional issues with the vehicle that need to be addressed.

Here are three things to check before you start a repair, to save you time and improve diagnostic accuracy:

1. Technical Service Bulletins, Campaigns and Recalls

One of the most important first steps is to check to see if there is a technical service bulletin (TSB), campaign or recall on the year/make/model of the vehicle in your bay. If so, that may not only solve the problem, but it might also help you uncover other issues that could require immediate attention.

ProDemand puts TSBs, recalls and campaign information front and center in a "Quick Links" ribbon that shows

The Top 10 Repair List for a 2009 Toyota Camry in ProDemand

Commonly Replaced COMPONENTS		Common DTCs		Common SYMPTOMS		Top Search LOOKUPS
1. Cabin Air Filter	7,182	1. P1423	39	1. Noise Heard From Brakes	315	1. Drive Belt
2. Disc Brake Pad	4,479	2. P0301: Cylinder 4 Misfire	37	2. Coolant Leaks From Vehicle	189	2. Engine Oil Monitor
3. Brake Rotor	3,361	3. P0a80	36	3. Engine Does Not Start	138	3. Engine
4. Engine Water Pump	1,923	4. P0138	34	4. Air Conditioning Inoperative	128	4. Engine Water Pump
5. Tires	1,722	5. P2195	31	5. Fluid Leaks From Vehicle	128	5. Hvac System
6. Wheels	1,331	6. P0304:Cylinder 4 Misfire	23	6. Noise Heard	123	6. Alternator
7. Headlight Bulb	1,310	7. P0136: O2 Sensor Circu...	22	7. Tpms Light On	73	7. Engine Timing Belt
8. Spark Plug	1,247	8. P0300: Random/Multipl...	16	8. Headlights Inoperative	61	8. Throttle Body
9. Battery	1,063	9. P0303: Cylinder 3 Misfire	16	9. Noise Heard When Drivi...	52	9. Brake Rotor
10. Headlight	935	10. P0302: Cylinder 2 Misfire	14	10. Engine Runs Rough	51	10. Fuel Tank Module

up on the first screen after you have selected a vehicle in the program. This information is one of the first things you see, so it's easy to make TSBs the starting point for your initial research.

2. Common Repairs for the Vehicle

Without any information beyond the customer's description of the problem, it can take some time to diagnose the root cause, and identify the components to replace to solve the issue.

Luckily, you can quickly gain insight into how to repair your customer's car by drawing on the experiences of other auto repair technicians. The Top 10 Repairs list in ProDemand is generated from the real-world SureTrack content in ProDemand, based on millions of actual auto repairs performed by professional technicians throughout North America. This is an excellent resource to check when developing a repair or maintenance plan for a vehicle.

With every vehicle search in ProDemand, the Top 10 Repairs list gives detailed information about the most common component failures, diagnostic trouble codes (DTCs), symptoms and lookups for the vehicle selected. This allows you to learn from the collective wisdom of many other auto care professionals, and gives you a starting point to start your diagnostic process.

3. Real-world Repair Information

You're likely not the first technician to face the issue with the vehicle in your bay. Being able to access the records of how other professional technicians solved the same issue can be a huge time-saver. ProDemand calls these Real Fixes — and there are over 35 million of them available in the software.

Enter the vehicle information and problem (a symptom, DTC or component) and you can compare it with the most likely causes based on documented repairs and community discussions. To help narrow the search, ProDemand ranks the Real Fixes by "probable component," with the most common fixes at the top.

With just a little research up front, you will have a wealth of information at your fingertips to feel confident in your diagnosis and begin the repair. Complete OEM information, like wiring diagrams, specifications and procedures, is also close at hand to help you complete the repair with maximum efficiency.

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In your shop, at your side

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Sync for success

Tablet-based digital vehicle inspections were just the start of an automotive service-repair shop digital revolution.

Here's how NAPA AutoCare Centers, large and small, can benefit from new integrated DVI tools – SmartCheck and SmartFlow, provided by AutoVitals.

- **Increase repair order averages;** improve service quality; boost shop productivity and employee performance. Here are some recent examples of ARO increases at AutoCare Centers across the country. A shop in Vancouver, WA's ARO went from \$161.00 to \$376.00; another in Des Moines, IA, had their ARO go up from \$501.75 to \$726.87; and a shop in San Diego, CA saw their ARO climb from around \$375.00 to around \$475.00.

- **Educating shop customers** – “Do I really need a brake job right now?” – is time consuming. Tablet-based vehicle inspection reports reaffirm the need for a repair with photos of the customer's vehicle as well as test results, technician diagnostic notes and educational videos.

- **Faster Approvals:** Integration with your Shop Management System allows for a seamless connection from the technician to the customer's device. Unlike paper reports, tablet-generated inspection reports can be quickly sent to any electronic device. Creating work orders from the approved inspection makes it easier to keep the techs productive and the revenues coming in.

- Technicians are able to **complete thorough inspections on every vehicle with ease**, and have more power to increase their pay. Owners can easily track technician proficiency.

- **Integrates with NAPA TRACS and other major shop management systems** to sync the front counter with



the back shop. Technicians and service advisors have virtually all the information they need right at their fingertips – from work orders to up-to-the-moment technician recommendations.

- **Increase Tech Productivity:** Interruptions break concentration and decrease tech productivity; walking back and forth between the front counter and the back shop wastes time. In a digital shop, techs can focus on vehicle repairs and billable hours, while service advisors focus on customers and dispatching work orders.

- **No more VIN scanning.** Technicians are alerted to repair order changes and can access work orders, service history, OEM recommendations, recalls and technical service bulletins – all on their tablets.

- **Devote more time to customers:** Service advisors are able to dispatch repair orders with just a click; they're also able to monitor work progress and tech availability, and they receive instant alerts from techs about unexpected events. This frees service advisors to spend more time focusing on building the relationship and trust with their customers.

- Technicians and service advisors

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Guided Test: Parking Sensors

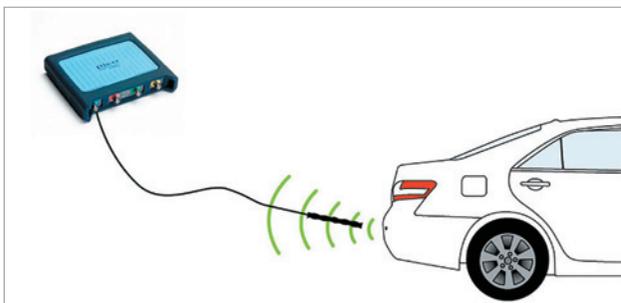
The purpose of this test is to evaluate the operation of Ultrasonic Proximity Sensors (Parking Sensors) with Pico technology's Ultrasonic parking sensor detector.

Safety notice

To test the proximity sensors, you may have to have the engine running with a gear selected in the transmission (e.g. Reverse). Under no circumstances must these conditions be met without a qualified driver in control of the vehicle at all times. Testing of proximity sensors, therefore, requires two operators; one to control the vehicle and one to acquire the relevant signal.

Note: The correct operation of parking sensors is dependent upon their position/orientation (aftermarket fitment), wiring harness connectivity, surface contamination or degradation, control unit functionality, and their operational environment being removed from sources of intense telecommunication and ultrasonic activity

How to perform the test



Accessories

- TA329 Ultrasonic parking sensor detector

PicoScope settings

Channel A:

- DC coupled
- Input range ± 50 mV

- Timebase 1 ms/div (optional timebase 100 ms/div)
- Sample count 1 MS

Trigger:

- Channel A, Auto
- Rising edge approximately 10 mV
- 30% Pre-trigger setting

How to connect PicoScope

1. Connect the detector to Channel A on the PicoScope
2. Run your scope.
3. Activate the vehicle's parking sensors.
4. Hold the detector close (approximately 1 in) to the parking sensor.
5. Aim the detector at the parking sensor and move it in a circular fashion.
6. Stop the scope.
7. Park the vehicle (engine off).
8. Scroll through your captured waveforms to assess the parking sensors.

Diagnosis

The output from the parking sensor can be measured to confirm activity in the parking sensor under test. In general, the frequency of the signal generated by a parking sensor is around 40,000 Hz (40 kHz). The detector is tuned to detect high-frequency signals like these in the immediate vicinity of the parking sensor. The high frequency will excite the pick-up inside the detector to produce a voltage that can be displayed on the screen.

High-Frequency signal

Use the windowed zoom feature to draw a box around the peak amplitude point of the captured signal. This will

zoom in on and reveal each cycle of the captured waveform.

Use the time rulers to measure the frequency of one cycle at the approximate peak amplitude. The frequency value is displayed in the frequency legend.

Our parking sensor had an operational frequency of 45.93 kHz.

Peak-to-peak measurement

Click on the Measurements tab to reveal the Add Measurement option. Select the channel you wish to add a measurement to, select Peak To Peak as the type of measurement and Whole trace as the area of the waveform you would like to measure. Click on OK and your selections will add the peak-to-peak voltage of your captured waveform as a numerical value. Typical values can vary from 50 mV to 200 mV depending on the location and distance of the detector in relation to the parking sensor. Alternatively, you can use the signal rulers. Drag both signal rulers to align with specific areas of the waveform. Compare the peak amplitudes of each parking sensor. This will let you judge their respective serviceability

To read the full Guided Test go to: <https://picoauto.com/us999>

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When do I need a hub kit?

As the number of types of vehicles on the road today proliferates, so, too, does the number of different types of wheel bearings.

One common type is called a Generation 1 wheel bearing, which features a double row angular contact ball or taper bearing.

Like all bearings, these are subject to wear and damage over time that might eventually require replacement.

Before a bearing is replaced, take a close look at the wheel flange and the related components. A bent or damaged wheel flange is often the cause of wheel bearing failure, but is frequently overlooked.

Visual inspection is the first step in checking the wheel flange; also note any excessive wear along the shaft. A dial indicator can be used to check the wheel flange for excessive run out.

If a wheel flange is cracked at its base, the damage is usually severe, so it should be replaced. If replacement is needed, SKF offers a variety of hub kits that include the wheel flange, Generation 1 bearing and additional components.

Nearly 90 million vehicles worldwide ride on SKF wheel bearings and hub units, which is more than all other brands combined. All SKF hub bearings are premium-quality parts manufactured using high-quality steel and surface finishes, premium seals, OE grade sensors, precision manufacturing techniques and precise assembly tolerances. Each is tested to original OE specifications for fit, form and function.

In servicing these types of wheel bearings, care should be taken during the installation process, as proper installation will help promote longer life of the replacement bearing.

Make sure to incorporate additional wheel-bearing grease if needed.

Press the bearing into the steering knuckle by use of proper tools, then press the bearing on the outer ring.

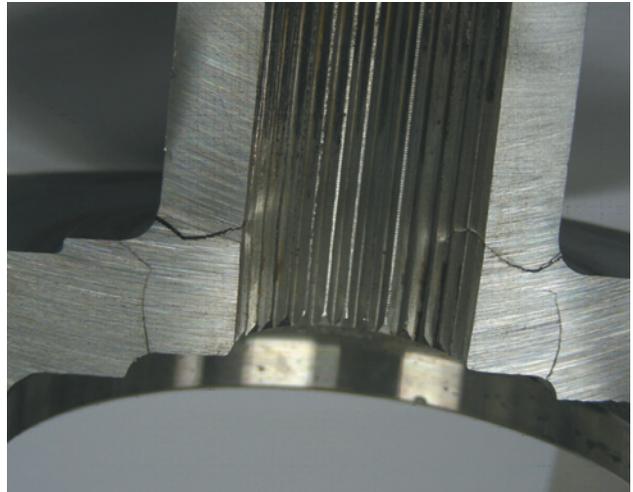
Next press the wheel flange, again using the proper tools.

Finally, follow the recommended axle nut torque specification.

While this article focuses on Generation 1 wheel bearings, SKF also offers a variety of other common wheel bearings.

Generation 2 hub bearings have an outer ring with an integral flange, replacing the function of a separate hub. The flanged outer ring serves as a lightweight structural component and incorporates threaded holes or studs to center and mount both brake and wheel. They are most commonly found on non-driven front or rear wheels.

Meantime, Generation 3 hub bearings have a flange for wheel and brake attachment, while a second flange fixes the unit to the suspension. They are typically used for both driven and non-driven wheel applications. Torque is transmitted to the inner ring



CRACKED WHEEL FLANGE



via an included spline in driven-wheel applications.

And there are X-Tracker hub bearings, a patented and exclusive design Generation 3 hub bearing. These consist of a double row angular contact ball bearing arrangement, in which the outboard row is at a higher diameter and contains more balls than the inner row. This increases the bearing's capacity, while improving hub stiffness 50 percent over a traditional tapered bearing unit.

For more information about SKF hub bearing units and kits, visit www.vsm.skf.com.



Changes in brakes

The automobile has gone through many changes over the years. Some are very noticeable, such as carburetors, fuel injection and electronic ignition. Other changes are not so noticeable, but play a big part in the way technicians service those systems. Brake pads, rotors, drums and shoes may look similar to how they did 20 years ago, but they are really quite different.

Friction Material

Changes to friction material are probably the biggest reason why technicians service brakes on today's vehicles the way they do. Brake pads and shoes used to be made with asbestos, which was a great material for brake pads because it was easy on the rotor, could be used on many weight platforms and was a low-cost option.

However, as we all know, asbestos is not good for the technician's health. Today's pads and shoes are classified into three categories – metallic, ceramic and non-asbestos organic (NAO). Each category has its advantages and drawbacks.

Metallic style pads are great for work trucks, performance vehicles and vehicles that tax their brakes, such as overloaded minivans. Ceramics are great for light duty trucks, everyday drivers and drivers that love clean wheels. NAOs are inexpensive alternatives.

For those wondering how friction materials have changed the way technicians do brake jobs, it has to do with the way the friction stops the vehicle.

Metallic lining uses abrasion to stop and it's very hard on rotors. In fact, the rotor is being worn down every time the pad touches the rotor.

Ceramic brakes stop with adhesion. The brake pad leaves an ultra-thin layer of ceramic material on the rotor every time they make contact. This is called

“material transfer” (fig. 1). The braking process consists of the ceramic brake pad rubbing against the ceramic transfer material on the rotor, causing an adhesion of the two. This process does not wear down the rotor. In fact, the thickness of the rotor increases every time the driver steps on the brake. This is also the reason ceramic brakes keep wheels cleaner. Since the rotor is not being worn down like it is with metallic pads, there is no rotor dust on the wheels.

Checking Runout

The biggest change when servicing brakes today is checking total rotor and hub runout when replacing brake rotors. This step was not really needed with asbestos brake pads because even if the pad contacted the rotor every revolution, the rotor did not wear down on that one spot. That is the reason rotor runout specs were .008” and greater.

But now, with metallic wearing the rotor surface and ceramics adding material to rotor surfaces, technicians have to make sure the rotor runs true and doesn't touch the pad unless the driver is applying the brakes.

The average allowable runout on vehicles built after 2001 is .002”, which is the thickness of a piece of paper. The wheel turns about 800 times a mile. That adds up to 1.6 million revolutions in 2,000 miles. If the installed rotor has .007” lateral runout when all torqued down, the pad will contact a portion of that rotor with every revolution. If metallic pads were installed, they're wearing



Figure 1



Figure 2

the rotor thinner in that one spot.

Ceramic pads are applying material in that spot (fig 2). As soon as the thickness variation exceeds .001, the driver may start to feel a slight pulsation in the brake pedal. This is the reason customers come back with warped rotors two to three months after the brake service. Take the extra two to three minutes and clean the hub and check the runout when servicing brakes.

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Dan-Am Air is lightweight, aircraft grade, powder coated aluminum, which provides clean, dry air up to 232 psi. The reinforced composite Nylon fittings have dual seals, which rest on un-scraped pipe, providing a leak free guarantee. Our Press-to-Connect fittings feature a full bore design for turbulence free air delivery. This quick, instant connection eliminates the need to thread, solder or glue, accounting for far less installation times than traditional copper or black pipe.

We also stock a large array of threaded connectors and adapters, allowing Dan-Am Air to be integrated into existing systems without compromising performance, making DAA perfect for upgrade or expansion projects.

Designed with simplicity in mind, DAA allows you to do-it-yourself. Measure, cut, de-burr, then simply Press-to-Connect, equaling lower installation times and cost. All fittings arrive pre-torqued for immediate assembly and pressurization, as well as being interchangeable, allowing for ease of future addition or expansion. "This "Press-to-Connect" subject tends to be the most misunderstood instructions in the DAA system. We have all been taught since

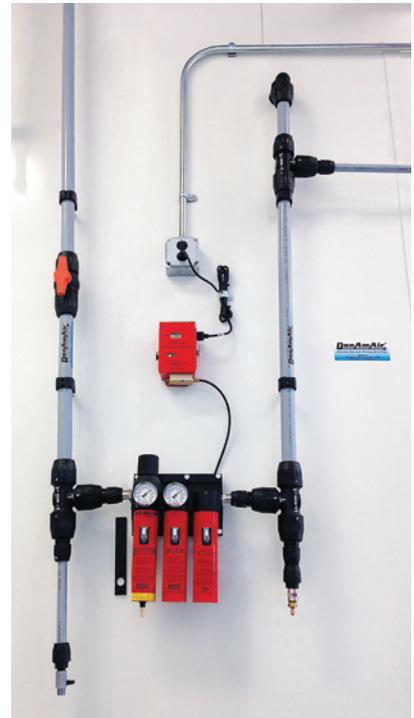
we were young, to loosen a given item, put it together, then tighten it back up, right? That is wrong with Dan-Am Air. DO NOT loosen fitting caps before installation. It really is as simple as push the fitting onto the pipe until it bottoms out. Done. Stop. Move on. The only reason to loosen a fitting cap, is to remove the fitting from the pipe. Loosening the cap relieves the pressure on the grip ring, allowing you to gently back out the pipe. To reuse any given fitting, simply re-torque the fitting cap to factory specs (line the arrows up, see figure 1), and "Press-to-Connect. As each cap is individual to its fitting, the arrows are either solid, or hollow respectively. Fitting caps are NOT interchangeable.

DAA also allows you to take your investment with you in the case of relocation, as all components are reusable.

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Watch our video to learn more about our easy-to-install system

customers to understand exactly what can be accomplished with SATA and Dan-Am Air combined.



BRAD GRAVENHOF has been in the automotive industry for over 30 years and serves as DanAm Company's Sales and Technical DanAm Air Specialist.

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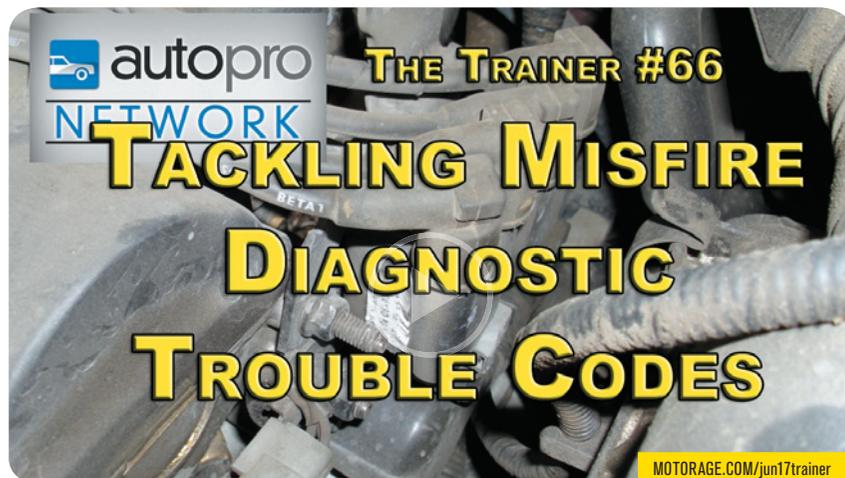
TACKLING MISFIRE CONCERNS

LEARN HOW TO TACKLE THIS ISSUE FROM START TO FIX

PETE MEIER // Technical Editor

Depending on the severity of the misfire and the strategy used by the manufacturer for testing the engine for a misfire, the Check Engine light may be off, on or flashing angrily at us. This is one indication of just how severe the miss is, but I think most of us can tell that without the CEL's help — you can feel it. Well, if you're an experienced technician you can. And I'm sure most of you reading this can remember more than one instance where you knew a miss was occurring but the ECM didn't have a clue — at least, one you knew about.

Technicians have been chasing down the cause of an engine miss since the first automobile. After all, any condition that impacts the normal combustion process will result in a cylinder event that isn't as strong as it should be — and that's a "miss!" Even with our longtime experience with this particular concern, I still see



techs head straight for the spark plugs rather than perform a few simple diagnostics. Maybe it's the terminology? Miss-FIRE?

Anyway, no matter. In this edition of The Trainer, I'll take you through my process for misfire troubleshooting and show you how to quickly isolate the cause. We'll start with some scan tool information (that you may or may not know existed), and then move on to

some general tests I use to narrow down the culprit. And it will all build on all that we've learned so far.

While you're checking out this series, have you watched our newest "How2?" You can find these series and a whole lot more in our AutoPro Network and on our YouTube channel. Be sure to let us know what you think and what you'd like to see us include. After all, we do it for you! **TZ**

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