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MAKE EACH CAR COUNT

When you change how you view car count, you can quickly change your bottom line. It starts here with the exclusive second piece of the two-part series by John "JB" Burkhauser, the director of training at BOLT ON TECHNOLOGY.

Keeping customers is the best way to build your car count and JB has the steps you can put into place now to make sure:

-Service recommendations are not lost
-Appointments are made - and kept
-Your service process is smooth and efficient

The second piece in this two-part series teaches you how your shop can take the vehicles you already have, make the most of them and get the car count number that really works for your business.

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RESEARCH

ASE SURVEY FINDS INDUSTRY ADAPTING TO BUSINESS CHANGE

MOTOR AGE WIRE REPORTS //

The National Institute for Automotive Service Excellence (ASE) conducted a comprehensive survey last month to better understand the impact of the COVID-19 pandemic on the automotive service industry and its workforce.

A key takeaway from the survey is that while 19 percent of those surveyed have seen an increase in business since the start of the pandemic, 56 percent reported a decrease in business.

The survey found that 34 percent of service facilities have reduced business hours, and the effect on technicians has come in the form of reduction of hours (34 percent), temporary furloughs (14 percent) and terminations (8 percent).

According to the survey, shops have been proactive in instituting safety measures for their employees and customers. Results show that nearly 70 percent of those surveyed are using protective equipment, while 63 percent have implemented social distancing measures and 62 percent have added supplemental sanitizing measures.

Participants were asked if they have been pursuing service training and credentialing since the start of the pandemic. Over 65 percent of those surveyed said they have done some type of self-study or enhanced training, while 46 percent participated in a webinar or

>> **ASE** CONTINUES ON PAGE 5

BREAKING NEWS

COLLABORATION

MERCEDES-BENZ, MICROSOFT PARTNER TO IMPROVE REPAIRS

Mercedes-Benz USA (MBUSA) collaborated with Microsoft to redefine automotive maintenance and the way technicians work, leading to an enhanced customer experience and greater efficiency in communication and safety.

As the first mixed reality automotive maintenance system, Mercedes-Benz Virtual Remote Support, powered by HoloLens 2 and Dynamics 365 Remote Assist, allows dealership technicians to work handsfree sharing real-time views and sounds of the vehicle while talking with Mercedes-Benz technical specialists. The remote MB specialists can provide insight and technological guidance to help complete complex maintenance issues in record time, without ever leaving their office.

"This is a massive shift in the way we do business — helping us to serve our customers more

>> **COLLAB** CONTINUES ON PAGE 5

TRENDING

AASA TECHNOLOGY CONFERENCE TO TACKLE BUSINESS SYSTEMS

The Automotive Aftermarket Suppliers Association will host a virtual AASA Technology Conference, focused on using technology to aid in future success.

MOTORAGE.COM/AASA20

REGISTER FOR THE YANG VIRTUAL MEETING

The Young Auto Care Network Group is accepting registrations for its first YANG virtual experience, set for Oct. 21, with a goal of sharing the best ideas and solutions for today's challenges.

MOTORAGE.COM/YANG20

MITCHELL 1, ELITE HOST WEBINAR SERIES

Shop owners and managers are invited to join Mitchell 1and Elite for a free webinar series to learn what customers think about the repair experience on Oct. 6, 13 and 20.

MOTORAGE.COM/OCTWEB

TUNE UP YOUR WEBSITE

During Fall Car Care Month this month, visit www.carcare.org to help your business tune up your website with valuable car care information. The Car Care Council has four quick and easy updates that will make a difference.

MOTORAGE.COM/SITETUNE

GARAGE GURUS, DOBBS PARTNER ON TRAINING

Garage Gurus and Dobbs Tire & Auto Centers have partnered to deliver mechanical training to their 41 locations that are looking to enhance and refine their technical skill sets.

MOTORAGE.COM/DOBBS

>> **COLLAB** CONTINUED FROM PAGE 4

quickly — and is especially timely with the new realities of COVID-19 and our desire to keep employees safe," said Christian Treiber, Vice President of Customer Services at MBUSA. "Today's vehicles feature more than 100 million lines of software code. Through our partnership with Microsoft, we have a new paradigm for technology support and communication that helps our dealers and technicians master the complexity of these vehicles while eliminating travel time and onsite visits. It's like having an expert on your shoulder."

The game changing Mercedes-Benz Virtual Remote Support:

- Enhances our customers' experience providing faster service turnaround
- Decreases the time it takes to resolve maintenance questions increasing the productivity and efficiency of dealer technicians
- Creates a remote work environment that dramatically improves employee safety so critical as a result of COVID-19, without eliminating the important collaboration between remote and onsite technical experts
- Reduces the environmental impact of service-related travel

With Mercedes-Benz Virtual Remote Support, the onsite technician puts on the HoloLens 2 headset and has immediate, real time support from Mercedes-Benz technical specialists anywhere in the United States. Leveraging Dynamics 365 Remote Assist, the remote specialist can see exactly what the technician is seeing at the dealership.

>> **ASE** CONTINUED FROM PAGE 4

online training course.

The use of social media by professional service providers also increased over the past several months. Over 42 percent of respondents said they have increased their usage of social media somewhat or significantly, with Facebook and YouTube named as the top platforms utilized.

"During these challenging times, we wanted to learn from service professionals about how their businesses have been affected and what ASE can do to best respond to their needs," said Tim Zilke, ASE president and CEO. "We were very pleased to learn how well they are adapting to the changing business climate and appreciate the positive feedback about ASE communications, weekly webinars and the extension of certifications until the end of the year."

Empower employees to get maximum performance

Learn the formula to getting your employees running on all cylinders

Relying on our vehicles for transportation is a must in today's world. Vehicles are best when they function properly on all cylinders, right? Well, our business and our employees are no different. Working on all cylinders together is a must to achieve the results and goals that you are working toward. This month let's listen to ATI Performance Coach LeAnne Williamson explain how she teaches this to shop owners.

Finding the RIGHT hire is difficult. So, when you have the RIGHT employees, you're in the best position to succeed. It's so much easier to achieve the business results you need with your current employees than to start over every 60 to 90 days with someone new.

Another challenge that shop owners face is letting go of day-to-day tasks that they did well in prior roles (technician, service writer, manager, etc.). Instead of working on the business, many shop owners continue to work in the business because they know it will be done right. If this is how you run your shop, you'll be handling every task and problem in your shop while your team of employees wait for their next assignment.

Your role as owner, manager or supervisor is to lead and manage your employees to do their work properly and efficiently and achieve the goals and results you have set for the business. As a performance coach for ATI, I help many shop owners shift their thinking to achieve their fullest potential. I'd like to share a formula and coaching process I use to assist you in getting your employees running on all cylinders toward achieving your business goals

The formula is: Expectations + Observation = Accountability

EMPLOYEES ARE MOST SUCCESSFUL WHEN THEY HAVE THE KNOWLEDGE AND THE ABILITY TO PERFORM THEIR JOBS.

Before we dive into this formula, let me first state that employees are most successful when they have the knowledge and ability to perform their jobs. They must also have the necessary tools, the confidence to complete their assignments and the desire to perform well and achieve the results you are seeking. Only when these factors are in place can you begin to set expectations.

As the owner, you are responsible for making sure employees know your expectations — the goals, behaviors and performance level you expect from them on the job. As they work to meet the expectations and performance level you desire, you must share your observations with them by providing feedback weekly, in 15-minute, one-on-one meetings. Through this communication process, you are then able to hold employees accountable for their performance and provide the guidance, correction or praise needed. Agreement between you and your employees on performance results is key to your business's success. Otherwise, they will set their own performance goals and behaviors.

The coaching process I share with shop owners is called G.R.O.W. The G.R.O.W. process will give you a framework to set the expectations, goals, behaviors, performance and follow-through with the feedback to hold your employees accountable for their work. Here's how it works:

1. G – Goals: Again, employees must know what you expect from them (goals, behaviors, performance). Job expectations must be communicated in one-on-one meetings, so that they are not open to interpretation. Be clear about your goals for them and make sure that they are S.M.A.R.T. (Specific, Measurable, At-

tainable, Realistic and Timebound). Work on 1-2 items at a time; too many will pull their focus in too many directions.

2. R – Reality: Have measurable data to share with them on what is happening right now with their work assignments, behavior or results. Have facts, examples, specific evidence on what you have observed; be objective, not subjective.

3. O – Options: Have your employees brainstorm on what improvements can be made to your shop's processes and services. What solutions can aid them in improving their performance, behaviors and goals? Your input may be necessary if they are unable to come up with ideas themselves. Have fun with this step — remember, work can be enjoyable.

4. W – Way Forward to Win: Make an agreement with your employees on how they plan to accomplish their goals. If both parties commit to the process, both will reap the rewards. Employees will improve their performance, behaviors and goals, and you will achieve better results for the business.

If you think that adopting and implementing these new processes are a lot of work, you're right. It's a big commitment to get the performance results you want. Once you develop the habit of communicating feedback weekly to your team of employees, they will feel like they are a part of the success of the business.

Making this mindset and operation shift can help your business. My first store manager assignment was to open a new repair shop from the ground up. I was so excited and just knew it would all go smoothly — and then I got a reality check. The day-to-day chaos took over and I was working IN the business and not working ON the business. I enrolled in a management class to assist me in being able to run my location more effectively. That's where I learned how to become a better leader.

Upon my return, I held a team meeting to share what I had learned and how I wanted to move forward with monthly team meetings and weekly one-on-one meetings. I stressed the importance of two-way dialogue and getting feedback. I thought they would all be excited, but they were not. They figured it was more work for them to do and there was nothing for them in return. I overcame their objections and we agreed on a plan to move forward and see how the meetings went for 90 days. The monthly meetings ran better than the one-on-ones in the beginning. It took time for the employees to become comfortable in one-on-ones and share feedback with me on how I was doing and how the business could improve. Sharing ideas did not come easily — they had to feel that it was OK to share the truth and not get in trouble for it. Having a flip chart for the meetings and allowing employees to be the authors of their ideas and plans, made it much more exciting. They felt they were a part of the solutions to improving the performance of the business. The one-on-one meetings rarely went past 10 to 15 minutes each week. Staying focused on the subject for discussion helped keep these meetings productive and efficient.

It took eight months to finally have the formula (Expectation + Observation = Accountability) and the coaching process in place and running smoothly — to the point where employees were running on all cylinders. Together we achieved the results we set for ourselves. Because of the two-way feedback dialogue — my employees aided me in becoming a better leader/manager and they became valued employees — we became a high-performing team together.

You can do the same with your business and team. Get started by going to ***www.ationlinetraining.com/2020-10*** to get ATI's "G.R.O.W. Coaching & Planning Form" for a limited time.

CHRIS "CHUBBY" FREDERICK is the CEO and founder of the Automotive Training Institute. ATI's 130 full-time associates train and coach more than 1,700 shop owners every week across North America to drive profits and dreams home to their families. Our 32 full-time Certified Performance coaches have helped our members earn over ONE BILLION DOLLARS in return on their coaching investment since ATI was founded. This month's article was written with the help of ATI Performance Coach LeAnne Williamson.
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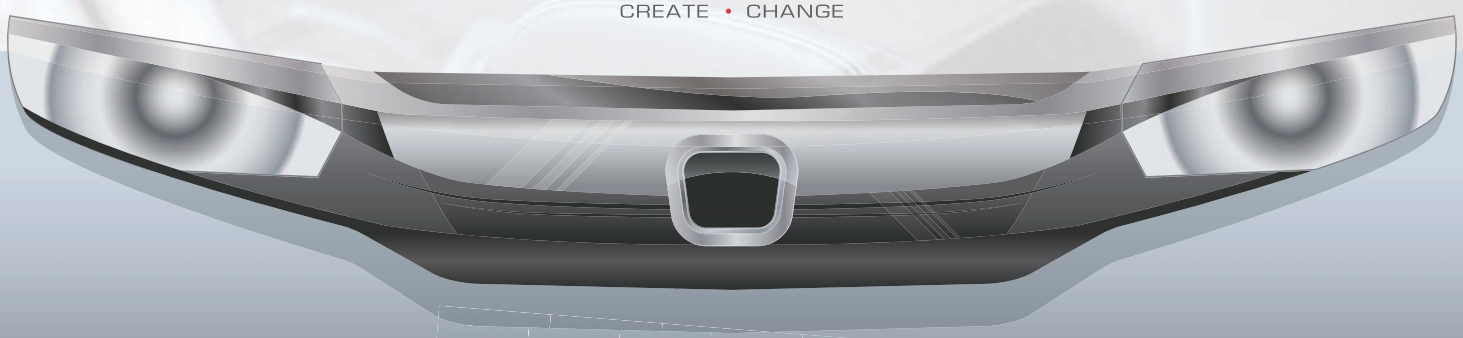

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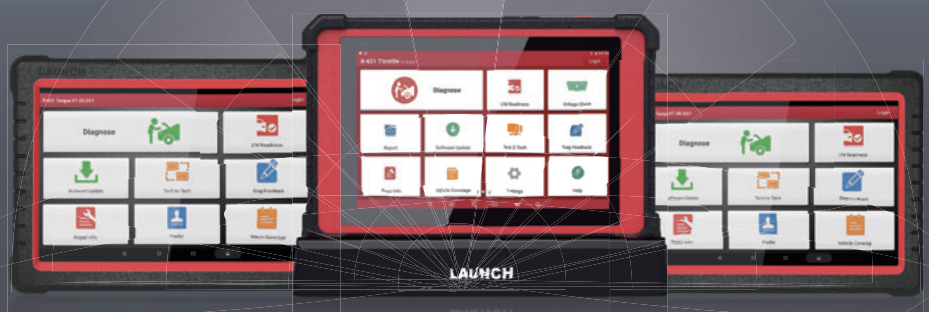

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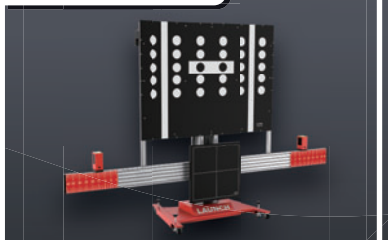

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ADAPTING TO THE FUTURE

The annual *Motor Age* roundtable delves into challenges, opportunities and what's to come

CHELSEA FREY // Senior Associate Editor

This year, *Motor Age* gathered four service repair industry professionals — three shop owners and a former technician-turned-trainer (see sidebar: "Who was at the table?") — for the annual roundtable. Panelists discussed challenges, opportunities and the future of the industry through topics such as the COVID-19 pandemic, the economic marketplace, the technician shortage and today's customers.

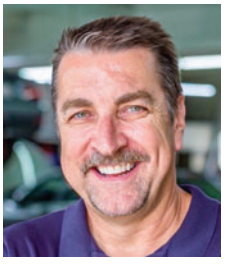
Here are some of the highlights from this year's *Motor Age* roundtable. Responses were edited for length and clarity.

How has your business adapted amid the COVID-19 pandemic, and what do you see as some of the longer-term changes for the industry due to it?

Brin Kline: We've already had to be creative and make adjustments with how we're doing business. With marketing, we've shifted the messaging from predominantly competence to talking about how we're keeping our team and our clients safe. We've gotten creative with how to do business remotely. Some of the shops that haven't adopted modern technology are going to struggle.

BRIN KLINE

Scott Brown: There's a lot of dynamics here. If you start thinking about people working remotely, they're not driving that much. But the other end of the spectrum is that people aren't spending their normal spend on things like Disneyland and going to movies. So those people who are still working and maintaining their regular income likely have more spending cash. For us, we use that as an opportunity to approach our customers that have had a lot of deferred maintenance. If I look at the last five years, there has been a ton of maintenance that has been put off. Every time a customer comes in, we're looking at that ticket closely; it's presenting a lot of opportunity. We are busier than ever right now. It's pretty cool to look back and think, "Wow, that didn't really affect us all that much."



SCOTT BROWN

It's definitely an opportunity for us to

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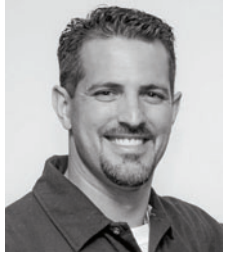
Brandon Steckler: I know quite a few technicians that are on the OEM side of the service industry at dealerships. Many of them have exhausted the vacation pay that they've had racked up over their tenure and were forced to seek out other means of earning an income. Some of them were on the fence about leaving the dealership to seek employment elsewhere either at another dealership or with a different manufacturer. Some have branched out to the independent repair shops and are doing quite well.


BRANDON STECKLER

Brin: Most of the shop owners that I've spoken to locally and on the national level have been doing well. But I heard that the dealerships were more negatively affected, at least in the beginning. In terms of dealership techs looking for jobs elsewhere, it opens up opportunities for independent shop owners to recruit them.

Terica Buckner: The aftermarket independent shops have been busy this summer. I would've expected the dealership repair centers to be busy, too. I wonder if they let go of their technicians too soon, so they're going to be hurting in the future when things pick back up.

What is the biggest challenging facing your business in the next 1-5 years? How are you addressing it?

Scott: If we look at the behavior of the economy, everybody is purchasing more and more from Amazon — even service parts. It's going to be tough to maintain a margin on parts, especially if customers are scrutinizing the cost of parts and are comparing. I think the way that we provide service needs to mirror the way a professional contractor delivers service. They don't usually itemize their ticket; they're delivering a service or a product for your home or what have you. That's going to be one of the challenges. You're going to need to look at the way that you conduct business.

Brin: In terms of pricing structures and local laws, in Florida we have to itemize parts vs labor. The shift does need to move toward the total solution as opposed to breaking it up in that way for the reasons Scott mentioned. In some areas that may not be possible, though.

The parts are the things that people can most compare. They don't know anything about how to fix a car or what it takes. That falls on us to make sure we're educating people. We are still always going to have more of a challenge on parts than labor. For those who are not able to focus on the total solution on their invoices, they may have to look at shifting the profit dollars to labor and less on parts. We've started to do that slowly at our location. The current model has been around for so long, so it's hard to get people to change that mindset.

The other challenge that has always been around for shops is the changing technology in vehicles. Our shop is pretty proactive with training, but we're still concerned about whether we'll be service ready for every vehicle that comes into our bays. We're probably going to look at narrowing our focus in order to be most prepared. Looking forward with vehicles advancing as rapidly as they are, most shops would benefit from specializing or focusing on specific brands.

Terica: One of our biggest challenges this year is going to be hiring another service advisor. The perfect service advisor has so many different skills. It can be very difficult to find the right person. The last one we hired knew nothing about cars but had great customer service skills. We've been teaching her about cars, and she's learned a lot and has learned fast. She's doing very well. It speaks to reaching out to people who are or were in the hospitality segment and then teaching them about the service industry. Since many people have been laid off from their hospitality jobs due to the pandemic, it provides an opportunity for our industry to reach out to those people.


TERICA BUCKNER

How should the industry be working together to solve the technician shortage?

Scott: My professional experience has been that this has not been a rewarding career for the majority of the marketplace. A lot of techs start to work at a shop at flat rate, and they're working in an environment with poor conditions that is not conducive to good performance. They have to supply their own tools and sometimes even their own uniforms. That's what has driven the talent out of the marketplace. If we look back over the past ten years, a lot of the tech trade schools have been a mining field for other industries — alternative energy, telecommunications, etc. They go through those institutions and start recruiting. When they can address a student and say, "Hey, you don't have to pay for your own tools. All you have to do is show up to work and bring your lunch. We'll provide you with a salary, paid vacation, and your training will be part of your workday," that's very appealing. In our industry, typically we have to work all day and then go to training at night. It's really frustrating. I'm in my 38th year in this industry and I'm fighting every day to try to raise the bar.

Terica: I completely agree. We need to get rid of the flat rate system, go to hourly and take care of employees — and their families. Most of these college programs are two years, so you get high school kids

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going into two-year programs. Then you put them in the shop at flat rate and they're expected to know everything. It's setting them up for failure. You get sub-par technicians because they're on flat rate and working really hard. They don't have time to learn more and do training.

One of the best solutions would be to partner more with local college programs and have an apprenticeship program even once the student graduates. There's so much to learn about all the different kinds of vehicles and all the different problems, so you can't expect students to immediately be able to diagnose vehicles — especially today's cars — given the little information they learned in the short course on that topics.

Growing your own technicians is really important. In our last apprenticeship through our local community college we paid for all of their schooling. We also have a tool bonus program, so we helped them get their tools. Then they came to work for us. If you find the right candidate, that setup can really work, but that's not the normal process for the industry. It's hard for people who have a love of cars and working on them to pursue a career the way it's set up right now.

Brin: Getting involved with tech programs is a must. Every company needs to have a PR person to represent the shop and get involved with the community — not only community colleges and tech schools but middle schools and high schools. Don't just focus on the tech side of the industry. Even if your local schools don't have an automotive program, you can focus on career days at primary schools and connect with the science teachers, because automotive repair is STEM. You can demonstrate how exciting and cool vehicle technology is and how rewarding it can be.

Scott: Growing your own employees is really where it's at. I've had guys work for me that had 20+ years of experience, but unfortunately, a lot of the experience was not correct. A lot of them had their own ways of doing things, and a lot of it did not align with what I felt should be done and in fact it wasn't the right thing. It's hard to break technicians from that.

Brandon: On the topic of education, perhaps we should be focusing more on teaching technicians how to learn. It's so important to learn the basics and know what you need to research in order to tackle the diagnostics of the vehicle. I don't think that's always being taught to new techs and students at trade schools. They're learning about specific systems or specific makes. I graduated from a GM ASEP [Automotive Service Educational Program] program. Of course, the focus was on GM vehicles and familiarizing yourself on a particular car or system. But it didn't help me much in the independent aftermarket, because I saw a lot more than just GM vehicles. If I had learned how to teach myself, what channels to follow to get the information I need, I would've been a lot more successful early on in my career.

Scott: I agree with that. What I would love to see schools start to teach is teaching the technician to think like an engineer. They're probably going to need some level of mechanical engineering, maybe electrical engineering, to understand what they need to do to make a system work. A lot of times you don't find that in service information. OEMs do not disclose a lot in service information anymore. If we start teaching the engineering side of things, how to think like an engineer, our industry and our techs will be well off for success.

Terica: I also want to point out the little things — we have different types of beverages and a freezer full of popsicles in the summer. The techs love that. It can be little changes to just say, "Thank you — have a cold drink." Once a week we have a barbeque lunch that we make here for the team. It cultivates that "work family" life. We show that it's a caring environment, that's it's not just "do your work and go home and do it faster." Higher benefit packages and tool money are great, but it's also the little things that can add up and make a big difference to the employees.

Brin: One more thing on the tech shortage is the importance of being encouraging. I've always been an advocate for women in the industry. Generally, they're more encouraging and supportive than the men in the industry. I think we as men often feel like we have to be super intelligent and prove ourselves. We're generally not as open to ideas that come from other people. I think it's also important to not bash and belittle the competition. And not be quick to criticize techs who might've gotten something wrong. Especially on social media and in Facebook groups — they can be really powerful and helpful networks, but it can also be toxic. Instead of putting other people down and spreading negativity, focus on being encouraging — that only helps to advance fellow technicians and our industry.

WHO WAS AT THE TABLE?

Brandon Steckler is the Technical Editor of *Motor Age* and Technical Training Instructor at Carquest.

Brin Kline is the owner of Assured Auto Works in Melbourne, Fla., and is Affiliate Director of ASA Florida.

Scott Brown is president of Connie & Dick's Auto Service Center Inc. in Claremont, Calif., and Diagnostic Tech columnist for *PTEN* magazine.

Terica Buckner is owner of Hawthorne Auto Clinic in Portland, Ore.

CHELSEA FREY is the Senior Associate Editor for *ABRN* and for its sister publication, *Motor Age*, in the service repair segment.
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Measure your client relationship progress

You should not sell to customers, but listen and counsel them in what is best

The most successful shops in our industry understand that in order to succeed in growing a profitable business, they must pay attention to the relationships they develop with the clients they choose to do business with. Notice the phrase "choose to do business with?" These shops are focused on the value proposition they want to bring to their client base and have defined the client base they want to attract and serve in growing their business.

Not everyone walking through their door qualifies as a potential client, usually because that "customer" perceives them too expensive rather than looking for the quality and value they get for what is paid in dealing with this shop. These shops know to whom they are selling; they understand the importance of earning the client's trust, which leads to capturing the client's business for life, not just for today. These shops slow the process down dramatically and council the client on the vehicle's maintenance requirements, drawing from the manufacturer's interval recommendations and tailoring their advice to the client's expectations with their vehicle for safety, reliability and efficiency based on "how" they use their vehicle. This value proposition obviously requires in-depth conversations with each client to truly understand the client's situation.

The key to this process is to recognize that their front counter people are no longer service advisors, but rather service consultants. This is a critical mind-set change for our industry, as they do not "sell" the client; they listen and then educate and counsel the client as to what is in the client's best interest. This service consultant's example is the old aftermarket in transition to the new aftermarket.

The progress of this relationship development can actually be measured each month. It is tracked by not measuring average sales per invoice but by calculating the average labor hours billed per invoice, which is a productivity measurement.

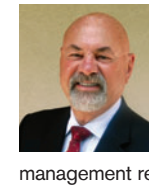
SUCCESSFUL SHOPS ARE NOT MEASURING THEIR BUSINESS ON JUST SALES, BUT RATHER ON PRODUCTIVITY, QUALITY AND THE VALUE THEY BRING CLIENTS.

To calculate average billed hours per RO, take the total labor dollars sold for the month and divide it by your current maintenance labor retail door rate. If you have multiple labor rates (which you should) then calculate the total hours for each category then add together to give you the total labor hours billed for that month. Next, subtract the opening invoice number on the first day of the month from the closing invoice number on the last day of the month.

This gives you the total number of invoices/ROs written for the month. Take the total labor hours billed and divide it by the number of invoices written. This will give you the average labor hours billed per invoice.

Unfortunately, the average shop in North America is billing between 1.4 to 1.7 hours per invoice. The goal of an automotive maintenance/repair shop should be to average a minimum of 2.5 hours per invoice. When a shop is consistently averaging 2.5 hours or more per invoice for basic consumer vehicles, we find that they are getting all the maintenance/repair business from the client, and they have earned and are maintaining the trust of their client base. Their clients do not shop around from one shop to another; the shop gets all the client's potential vehicle business. These shops are not measuring their business just on sales and car count, which is an "activity" measurement. Rather, they are measuring their shop based on their productivity, quality and the value they bring to each individual client, and they ensure they charge their services out at the right price, not the cheapest price. These are the shops that will remain, grow and be financially successful in this new aftermarket and its future.

Make sure you slow your process down, measure your relationships and then grow your relationships, as it is absolutely critical to your success. Remember, if you can't measure it, you can't manage it.



BOB GREENWOOD, AMAM, 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.
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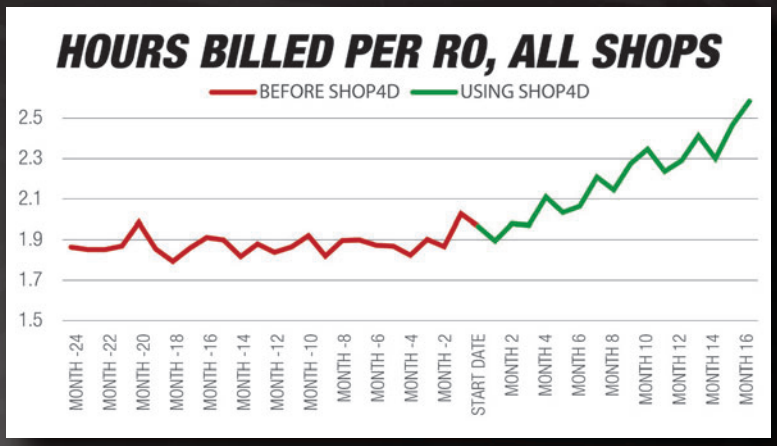

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DIAGNOSING NVH ON TODAY'S CARS

TODAY'S MECHANIZED WORLD REQUIRES POWER MOVEMENT FROM ONE SOURCE TO ANOTHER, AND WITH THAT COMES VIBRATION AND SOUND

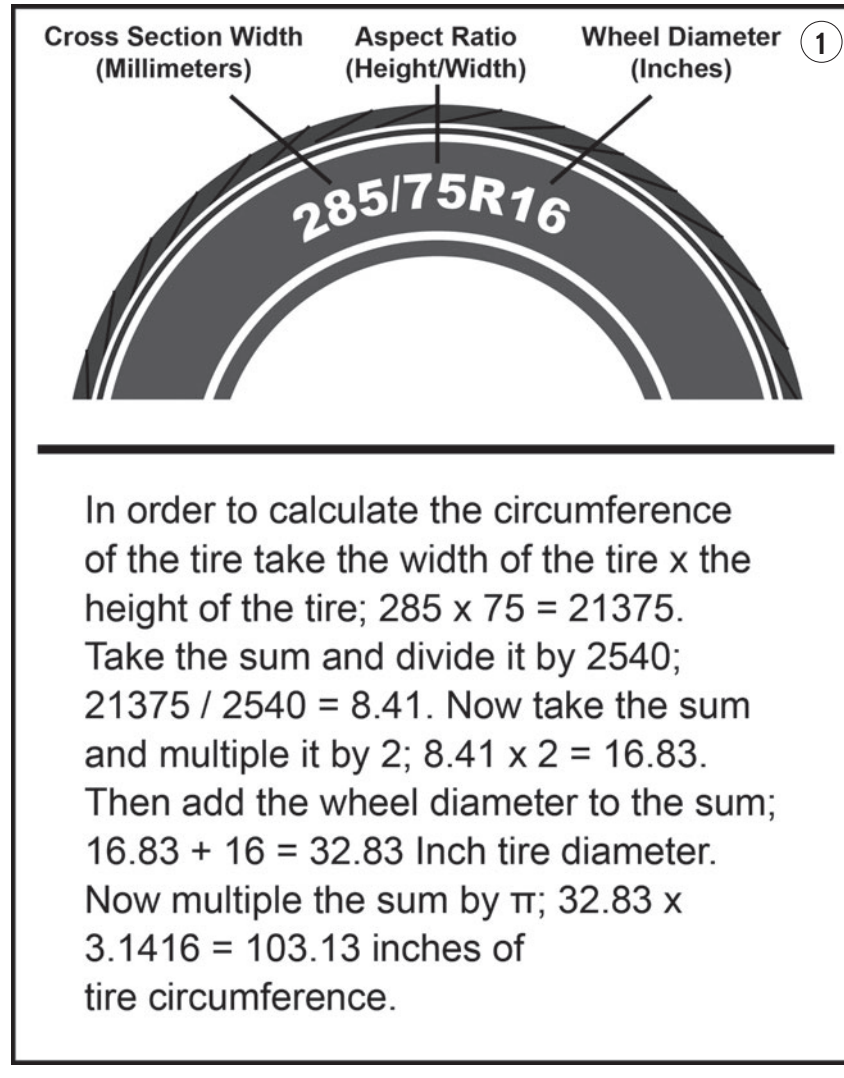
BERNIE THOMPSON //
Contributing Editor

Vibration and sound are the same in that they are both frequencies. When we consider vibration, it is a frequency that is moving through a mechanical means that produces mechanical force. When we consider sound, it is a vibrating frequency that is moving through air or another medium and can be heard when it reaches a person's ear or a sensing device (such as a microphone).

All power or energy transmission through mechanical means produces vibration and sound. This fundamental principle will be important when dealing with vehicle vibration and sound issues. Now that we have established that all vehicles will produce vibration and sound, it is imperative to understand the difference between vibration and harshness, and the difference between sound and noise.

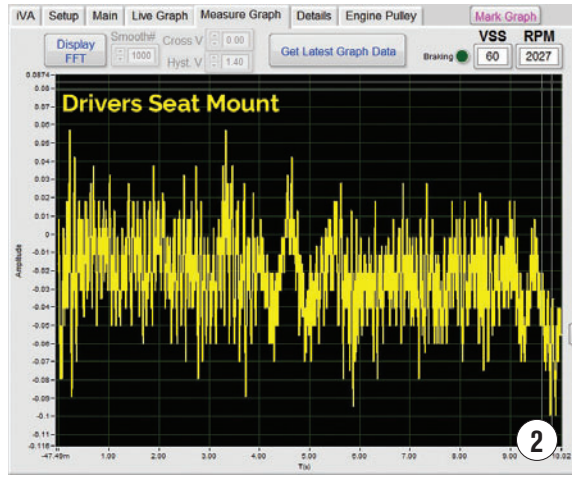
Noise, vibration and harshness (NVH) has become an ever-increasing problem for engineering teams on modern vehicles. The modern vehicle is designed and engineered to reduce vibration and sound within the vehicle. Therefore, any additional vibration and or noise is much easier for the vehicle occupants to recognize.

The modern vehicle comes in many sizes and weight categories. Therefore, the vibration and noise from each vehicle will be different. For example, a luxury sedan's vibration and/or noise concern would be much less than a 1-ton truck's vibration and/or noise concern. Each vehicle has a different design target for what vibration and noise level is acceptable. So first, one needs to know what is normal for the vehicle that is being diagnosed. That



PHOTOS: BERNIE THOMPSON

being said, most vehicles that are brought to you to diagnose have a definite vibration and/or noise issue.



It has long been known that rotating components can produce unwanted vibrations. When these vibrations are produced by components within a vehicle it can be very difficult to determine where the vibrations are emanating from. Vehicles contain many rotating components: tires, wheels, hubs, rotors, drums, axle shafts, driveshafts, transmissions, differentials, pumps, generators and engines, just to name a few. These components are balanced to assure that they will not create vibrations. However, from either imbalance, wear or poor design, vibrations can (and will) be present in vehicles. The question is how to locate the cause of the issue.

The scientific approach to vibration analysis

Perhaps the best method to locate these vibrations is to have an in-depth understanding of how these vibrations and/or noise issues are produced. To understand this, we need to understand what components on the vehicle are in rotation and the speed they are rotating at. So first let's take a look at the tire/wheel rotational speed. Tires have their size coded into the tire sidewall. For example, for a tire that is labeled as a 285/75R16 is 285 millimeters wide, 213.75 mm high (75 percent of its width) and is designed for a 16 inch rim. The circumference of this tire will need to be calculated to know the tire's rotational speed. The equations to calculate this are shown, but please don't get caught up in the math; just get the idea (**Figure 1**).

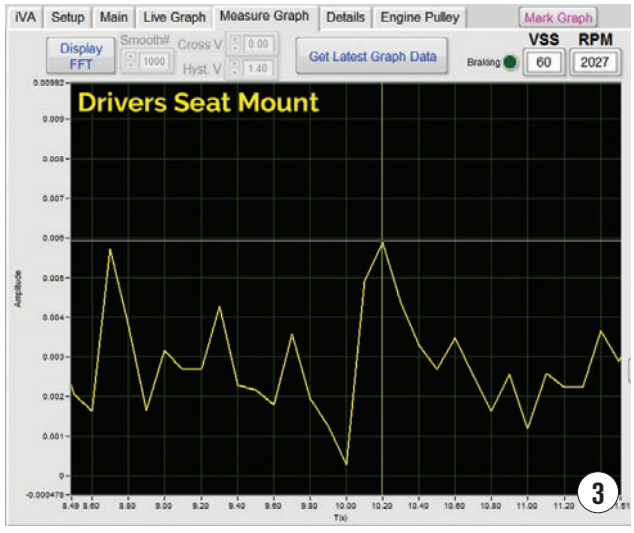
With the tire circumference known, you can calculate the tire/wheel rotation speed. There are 63,360 inches in a mile, so divide the inches in a mile by the tire circumference; 63,360/103.13 = 614.37. Take the sum and multiple it by the vehicle speed: tire's revolution per miles 614.37 x 60 MPH = 36862 revolution per hour. There are 3600 seconds in one hour, so divide the tire revolutions per hour by 3600; 36862/3600 = 10.23 tire rotations per second or 10.23 Hz of tire rotational rate. To calculate the tire's Revolution Per Minute (RPM): 10.23 Hz x 60 sec = 614 Tire RPM.

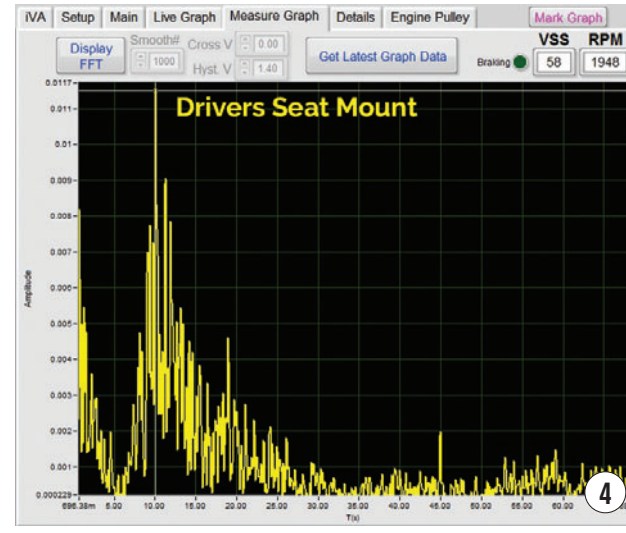
Now that you have a rate of a rotating component (the tire and wheel), how would you use this? At 60 MPH the tire and wheel produced 10.23 rotations per second. Now that this quantity is known, you will need a way of measuring the vibration. Vibration is the amount that a frequency is moving through a mechanical means that produces mechanical force.

The frequency of the tire at 60 MPH is 10.23 Hz, so the measurement will need to test the force that is present at this frequency.

Vibration is mechanical force-creating frequency

To test the force, we will need a sensor that can provide such a measurement.





Accelerometers are one such sensor that can read mechanical force. An accelerometer is a very sensitive device that can measure proper acceleration. Proper acceleration is the acceleration or the rate that an object changed its velocity. For example, an accelerometer at rest on the surface of the Earth will measure an acceleration due to the Earth's gravity.

Typical accelerometers are made up of multiple axes (two to determine most two-dimensional movement with the option of a third for three-dimensional [3D] positioning). Accelerometers used for NVH are 3D and can read force in three planes of movement (X, Y and Z). With an X-Y-Z coordinate system, the X axis would go from front to back, the Y axis would go from left to right, and the Z axis would go from up to down.

With an accelerometer mounted to the vehicle, and a way in which to monitor the X-Y-Z planes, the tire/wheel forces can be calculated. The accelerometer will read the forces that are present from where the device is mounted. Let's say the accelerometer is mounted on the driver seat mounting bracket. In this position, the sensor would read the forces that a driver might feel (**Figure 2**). This data is being monitored with a personal computer (PC) and an Analog to Digital Converter (ADC). An ADC is what a multimeter, and/or oscilloscope uses to read the voltage levels with.

The accelerometer data is showing the movement of the sensor and since it is attached to the vehicle, this shows each movement of the vehicle. More to the point, in this configuration, the data shows the repetitious movement of the vehicle. So if a tire/wheel assembly is out of balance, it will produce a repetitious movement at the rate of the tire/wheel's rotational speed. Which, in this example, is 10.23 Hz.

Decoding the secret message

When analyzing this waveform, it becomes clear that it is very hard, if not impossible, for us to determine what the frequency of the movement would be. Therefore, we will need an algorithm to unlock the frequency from this accelerometer's output data. This algorithm is referred to as "Fast Fourier Transform" (FFT). Fourier analysis converts a signal from its original domain, which in this case is the mechanical movement in time, to a representation in the frequency domain in Hz. Since in this example we know the tire/wheel assembly is rotating at 10.23 Hz, if we convert this accelerometer data to find the repetitious movement we can compare this data's output at 10.23 Hz, as shown (**Figures 3, 4**). In **Figure 3**, the tires are in balance. In **Figure 4**, a tire is out of balance.

This vehicle is moving at 60 MPH in both **Figures 3** and **4**. The lower horizontal scale indicates the Hz, the vertical scale to the left indicates the amplitude. So we need to locate the 10

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The world of NVH diagnostics can be interesting. Over the years, many pieces of equipment have been used to point the technician in the right direction when tackling noise and vibration complaints.

For those who have done NVH work for a while, I can safely say that there is no one part that vibrates the same way, or makes the same noise when it fails. Take for instance a wheel bearing; I have heard them squeak, growl, moan or not even make a noise when they fail. Having a tool to give a good direction to NVH is a way cool tool to have. Keep reading at **MotorAge.com/NVH**.

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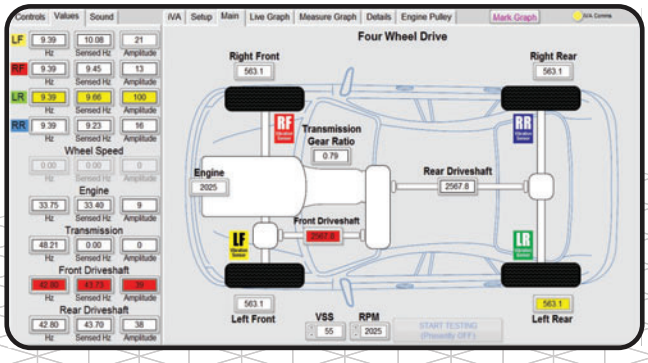

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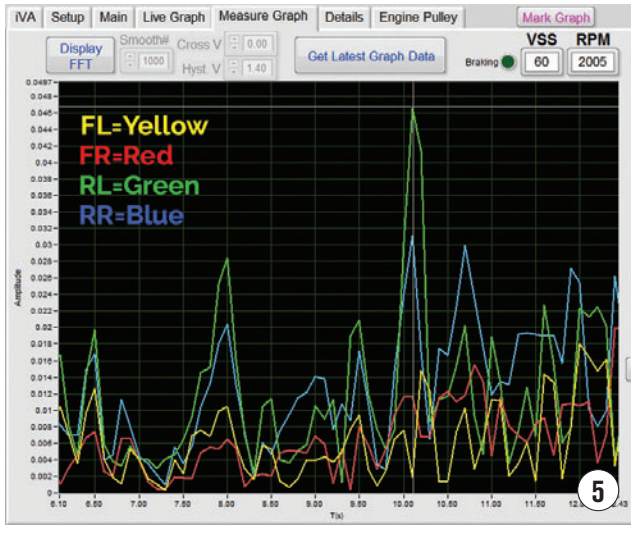

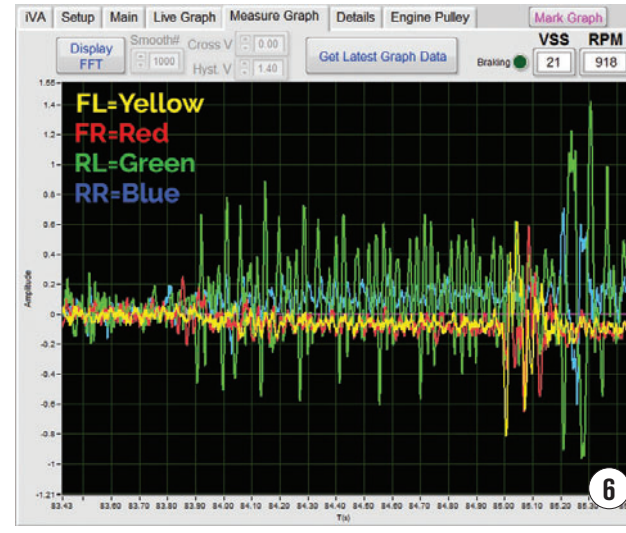

Hz position on the lower scale. Now find the amplitude on the scale to the left. It is clear the amplitude in **Figure 4** is much higher than the amplitude in **Figure 3**. This is the difference between vibration and harshness. **Figure** 3 shows vibration (remember that all vehicles produce vibration). But **Figure 4** shows harshness. This is a vibration that has exceeded the manufacturer's design threshold. This is excessive vibration that is recognized by the vehicle's occupants.

The problem with this accelerometer's location is that we now know that a tire/wheel assembly is exhibiting a harshness problem, but which wheel? So basically this is no better than a good technician, for a good technician can feel this vibration's frequency and determine if it is at the tire/wheel rotational speed. What one needs to know is which tire/wheel assembly is creating the vibration. For this to occur, we will need to change where the accelerometer is mounted. If we mount the accelerometer at each suspension component for each tire/wheel assembly, we can quickly determine which tire/wheel assemblies are creating the vibration and harshness problem. The RL (green trace) has a higher amplitude than the other traces, this indicates that the RL is creating the vibration (**Figure 5**).

In this example, there are four accelerometers in place (one at each tire/wheel suspension component). The data is acquired simultaneously. This is important because during a harshness problem the entire vehicle is vibrating. All the vibration sensors will need to be monitored at the same time and compared to each other. If only one sensor is used at a time it will be very hard to determine which tire/wheel assembly is creating the vibration. For example, on a solid axle assembly, a vibration on either side creates the entire solid axle to vibrate. You will need a sensor on each end of the axle to determine which sensor has the greatest amplitude. This in turn allows you to determine which of the tire/wheel assemblies are creating the vibration. Therefore, to analyze where the vibration is being emitted from on a vehicle, one will need an accelerometer on each of the suspension corners; Front Left (FL), Front Right (FR), Rear Left (RL) and Rear Right (RR).

With this accelerometer configuration, brake vibrations can also be isolated to the brake component that created it. When the vehicle is braking and the vibration is felt, capture the data. You will find the brake that is creating the vibration will have an amplitude greater than the other brakes. The RL (green) brake is the one creating the vibration during a brake application (**Figure 6**).

To find driveshaft vibration, one will need to calculate the driveshaft rotational speed. To accomplish this, one will need to know the ring and pinion ratio. Since the tire/wheel assembly is connected mechanically to the ring gear carrier, the ring gear is rotating at the same speed as the tire/wheel assembly. Therefore, if the ring and pinion ratio is known, and the tire/wheel speed is known, then one would simply multiply the tire speed by the ring and pinion ratio.

So if the tire speed is 10.23 Hz and the ring and pinion ratio is 4.56 to 1, 10.23 Hz x 4.56 = 46.64 Hz driveshaft rotational speed. This shows that on this vehicle the driveshaft rotates 4.56 times for each tire/wheel rotation.

Now that we have the drive shaft rotational speed in "Hz," we can check the data acquired from the accelerometer, with the FFT (**Figures 7, 8**). This vehicle is moving at 60 MPH in both **Figures 8** and **9**. The lower horizontal scale indicates the Hz, the vertical scale to the left indicates the amplitude. So we need to locate the 47 Hz position on the lower horizontal

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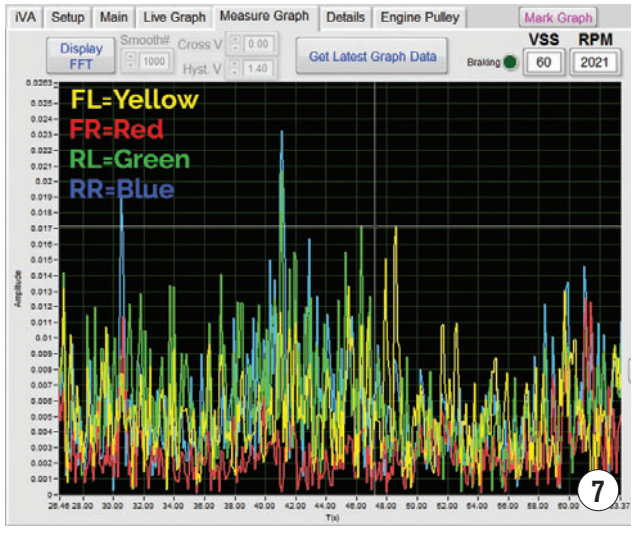

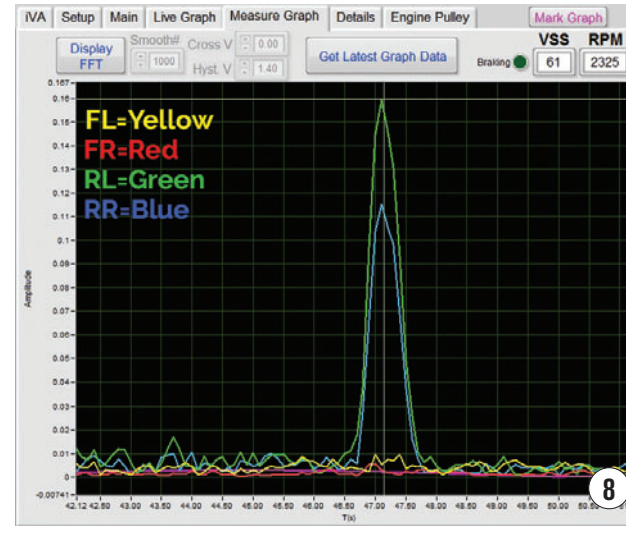

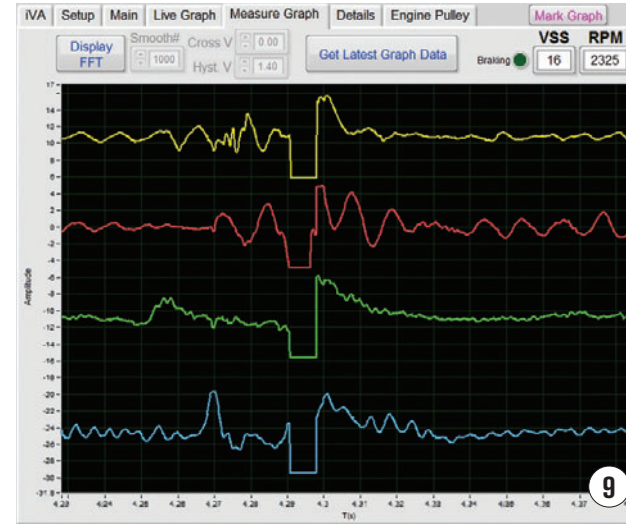

scale. Now, find the amplitude on the vertical scale to the left. It is clear the amplitude in **Figure 8** is much higher than the amplitude in **Figure 7.** This is the difference between vibration and harshness. **Figure 7** shows vibration; remember that all vehicles produce vibration. **Figure 8** shows harshness; this is a vibration that has exceeded the manufacturer's design threshold. This is excessive vibration that is recognized by the vehicle's occupants.

The data in **Figure 7** and **8** was taken on a 4-wheel drive with two drive shafts: one to the front differential and one to the rear differential. When analyzing the data, note that the accelerometers on the RL and RR are much greater in amplitude than the accelerometers on the FL and FR. This indicates that the rear driveshaft is the cause of the vibration. Be aware: if only one accelerometer were used on the driver seat mounting rail, you would be unable to determine which driveshaft was causing the vibration and harshness problem, only that the vibration was at driveshaft speed.

To determine an engine vibration problem, the RPM will need to be converted to revolution per second. This is done by dividing the RPM by 60 seconds. So if the RPM is 800, then 800 RPM/60 seconds = 13.33 Hz. If an accelerometer is placed on the engine and other accelerometers are placed next to each engine mount on the frame or supporting structure, a bad mount can be determined. The engine mounts are designed to absorb vibration from the engine. For example, if the engine vibration has an amplitude of 16 (at 13 Hz), then the other accelerometers should read less than half of the engine amplitude, or about the amplitude of 8. This would show that the engine mounts are absorbing the engine's vibration. If the accelerometer next to the mount is reading about the same as the engine, the mount is bad or is in a bind where it cannot work correctly. To determine if the engine has excessive vibration or a misfire, raise the RPM of the engine. If the vibration goes away, suspect a misfire. If the vibration gets worse when revving the engine, suspect a balance problem.

Additionally, one of the driven components on the engine can cause a vibration. If the diameter of the pulleys is known, then one can calculate the rotational speed of each pulley. With the accelerometer mounted on the engine, the output data from the accelerometer can be processed with the FFT. Now each component can be monitored at its rotational speed. If there is a problem, the amplitude at the pulley's Hz-output is the component that is creating the vibration. If the engine is creating the vibration, the rotational speed of the engine (in Hz) will produce the greatest amplitude at that Hz reading.

Like the sound of this so far?

Sounds are part of a vehicle's normal operation. When these sounds become loud enough that the occupants can distinguish them from the normal operation, then this is noise. The origin of this noise can be very difficult to locate. Perhaps one of the most difficult sounds to isolate is a suspension chassis pop. For instance, this can occur when hitting road bumps or when the vehicle is pulling into a driveway. When the pop occurs the sound travels throughout the vehicle. When listening for this noise it can usually be isolated to a corner of the suspension, but it seems as though all the components on the suspension corner are making the same popping noise.

When these popping noises occur, it is much easier to find the origin of the popping sound by using microphones. However, if one was to listen to these microphones, one would still be unable to determine the origin of the noise. For when this popping noise occurs, it emanates through all the components. This is due to all the components being connected, and sound travels through metal easier than it does through air. Metal is denser than air, which allows the sound vibration to travel at a faster rate through metals or solids. However, if one were to graph the microphone's output, it becomes much easier to identify the origin of the pop (**Figure 9**). There are four microphones attached to the vehicle's suspension system. The yellow trace is connected to the lower ball joint, the red trace is connected to the strut, the green trace is connected to the tie rod, the blue trace is connected to the strut top. The sound is emitting from the component that rings out like a bell. This can be seen on the red trace and indicates that the strut is creating the popping sound.

NVH systems will automatically do the calculations for you, so don't worry — you won't have to be a mathematician. If you can enter basic information (such as the tire size) you can become proficient in quickly finding vibration and noise issues. The vehicles that have these type problems are "money makers" for your shop, so,don't pass these jobs up. With the right NVH system, these problems are quite easy to solve.

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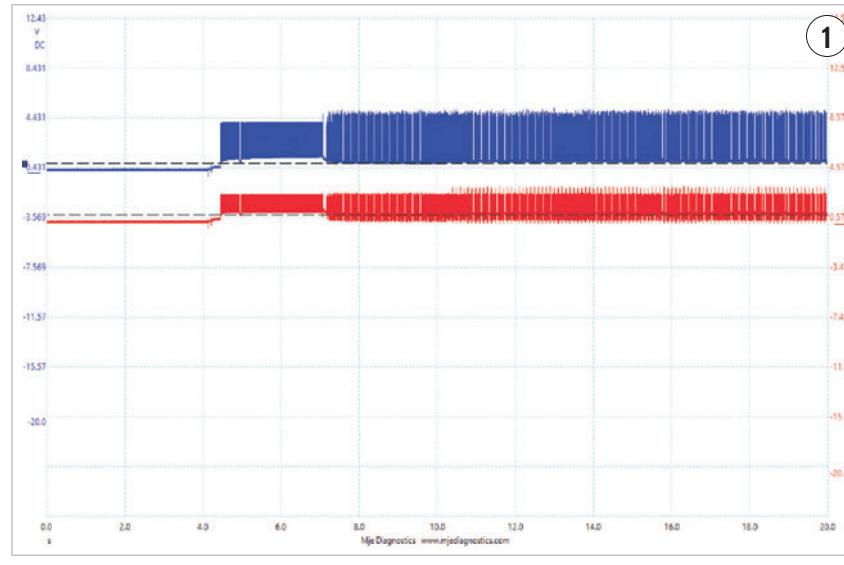
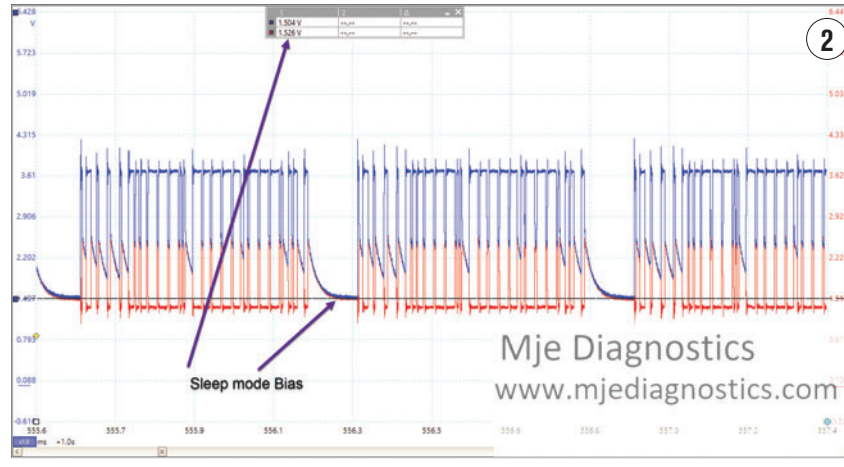
ALLISON HYBRID EP 40/50 NO START

SEE HOW THIS BREAKDOWN IN COMMUNICATION WAS SYSTEMATICALLY APPROACHED IN A SEEMINGLY ENDLESS NET OF POSSIBLE FAULTS

MICHAEL EILBRACHT //
Contributing Editor

It can be very taxing sometimes finding faults on the such heavily networked busses of today. On an Allison Hybrid, many messages are sent from the Gateway module so it can start. There must also be valid messages from the Dual Power Inverter Module, Energy Storage System, Transmission Control Module and the Vehicle Control Module, too. So, if one of these components malfunctions, how do you figure out which? And how do you do so efficiently? In this article, I am going to show you how I logically approached this problem using scan data and oscilloscope captures.





Scan tool data

I entered the vehicle and noticed that the Shifter is not powered up. After seeing this, I decided to use the Allison Doc (the OE scan tool) to see if I can communicate with any of the modules within the hybrid system. The laptop software is telling me that it cannot communicate with any of the modules on the network that pertain to Allison. So after seeing this (and also noticing that my dash is not booting up either), I used my Picoscope (PC-based 4-channel oscilloscope) and sampled from CAN HI and LO at the J1939 Powertrain Data Link Connector to see if I have any activity on the bus. Getting to the connector took hardly any time at all. That is the reason I chose to measure at this location. It was a quick and easy location to access to see bus activity. I captured the information and see that I have an issue on my communication lines. Just by a glance, I see that my CAN LO is not pulling down past 1.5 Volts. So I do have an issue present. Let's zoom in on the

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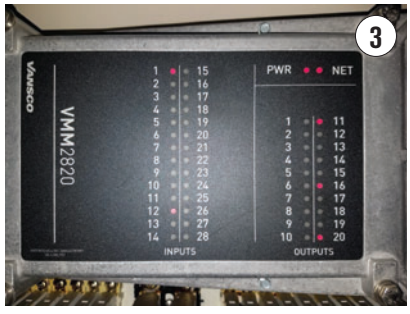
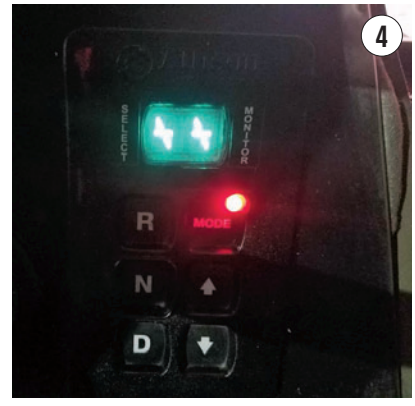
capture and see if we can see anything else noticeable. As we look at the capture (zoomed in) we see that the bias voltages are low for both CAN HI and CAN LO. Respectively, they should be at 2.5 and 2.4 Volts Bias. Something is loading the CAN bus and causing this issue (**Figure 1**). Now, we do see pulses on the bus, but unfortunately (since the CAN bus is loaded), the TCM, VCM, the Cummins ECU and Meritor ECU cannot output or receive proper data.

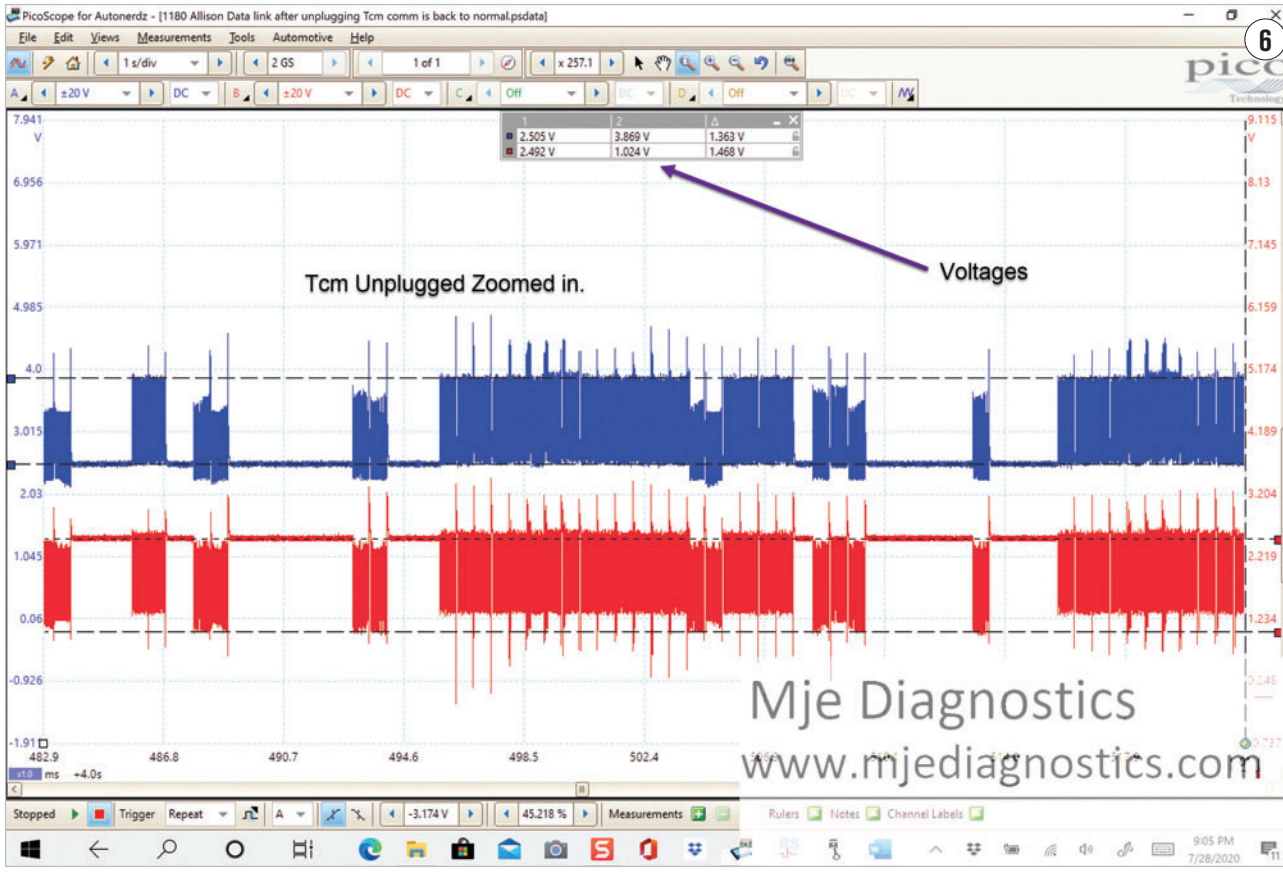
So what is our next step? I decided to pull the paneling out (at the TCM and VCM) inside the bus first. Pulling this panel is very easy compared to trying to pull connectors at either the Cummins ECM Connectors or ABS unit. Another reason why I wanted to go here first was because there was no wake-up signal available at the shifter. If you do not have a wake-up signal to the shifter, and also notice that you have no wait-to-start lamp function, this leans towards a few potential faults:

- A low voltage input to the TCM (and thus, nothing is powering-up)
- A voltage or ground issue with the shifter.

As indicated by my CAN bus trace, the system is being pulled down. If it was just a power or ground issue, the CAN bus bias would be more elevated (in an accessory or a dormant mode) as it is here. This is a known-good capture of the Allison CAN bus in a dormant sleep mode (**Figure 2**).







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I had a hypothesis to follow up on. I saw that there was no output from the multiplex module to the shifter. If the TCM had awakened, it would have signaled the multiplex to energize the shifter. To prove this, you can see that the multiplex output LED # 6 is not illuminated (**Figure 3**). I then energized the ignition-supply wire for the shifter (with a PowerProbe) and the red LED of the shifter illuminated, indicating it is functional (**Figure 4**). The display on the shifter, however, shows a set of dash lines crossing each other on the display (which means no communication). Thus, this information directed me to investigate the TCM's functionality.

What were my findings?

I pulled the paneling off of the road side of the bus to gain access to both the TCM and VCM. I removed the connectors, for inspection. The connector to the TCM was wet, and both the ignition and the ground wire terminals were green with corrosion (**Figure 5**). With the TCM disconnected (which removed it from the communication bus) the scope trace resembled a normal communication waveform (**Figure 6**).

After I cleaned the corrosion from the TCM and its connector, I also checked for water intrusion at the VCM. None was found. I re-mated all the connectors and the dash, as well as the shift selector were awake, but the vehicle still would not start. I was finally able to communicate with the TCM and VCM, via scan tool, and there were 20 codes stored.

What are these codes telling us?

All of these codes stored pointed us to a communication stop, with the TCM. Either by a fault in the bus circuitry, loss of power or ground supplying the TCM, or perhaps the codes are indicating the TCM is not supplying a wake-up signal. I started looking at the freeze frame data (for all the codes) and the only codes that clued me into the problem being with the TCM were codes 17-14 and 17-15 (Inverter A and B Hardware Enable mismatch). As seen by the freeze-frame, it indicated low TCM voltage (for both codes). Since the TCM had low voltage, it could not communicate with any of the modules on the network. This resulted in a no-start, because it was not receiving signals from the TCM. The water intrusion caused the low voltage and also made the CAN bus voltage go down (resistively shorting the circuit to ground).

So after seeing this data, I was 100 percent sure that the TCM was damaged by the water intrusion and was no longer able to communicate properly with any of the modules on the Powertrain Network. After replacing the TCM, the bus came back to life and no more diagnostic trouble codes (from Allison) were present.

Communication problems can be quite tasking, but if you have a plan of attack and use the info in front of you, these issues can be solved efficiently. An oscilloscope wasn't a necessity. But choosing to utilize it helped me see the deficient CAN bias voltage. It would have taken me much longer to isolate the cause otherwise. These are the tools and the testing techniques that are not found in the service information and flow charts published. They are developed over time and come from an understanding of the vehicle I'm working with and the tools used to capture the faults.

MICHAEL EILBRACHT is a transit bus technician for the Champaign and Urbana Mass Transit District in Urbana, Ill., and is the owner of Mje Diagnostics, a heavy-duty mobile diagnostic and training business. He is also an ASE Certified Master Transit Bus Technician and also holds an Advanced L2 Certification.

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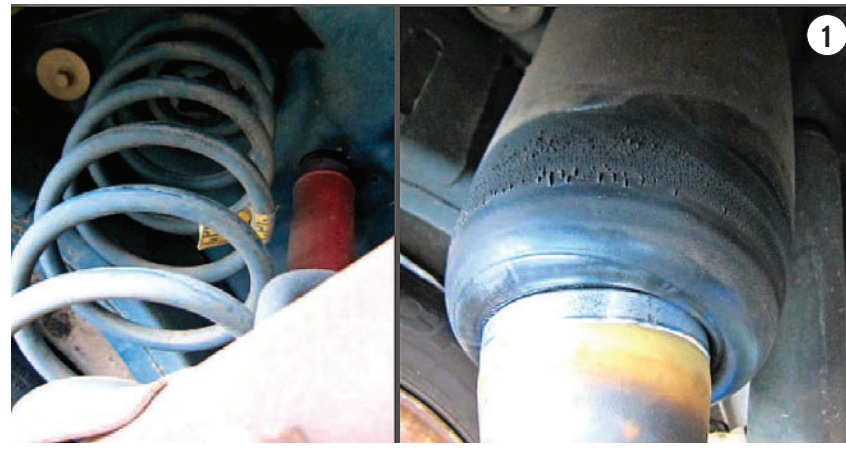
SUSPENSION 101

EVERY CUSTOMER DESERVES A SMOOTH, SAFE RIDE

RICHARD MCCUISTIAN //
Contributing Editor

Suspension is as old as wheeled vehicles, and some higher priced buckboard wagons had seats mounted on leaf springs to prevent the driver and passengers from having sore backs. Any part of a vehicle that is being carried by the springs is sprung weight (like the seat on the wagon). And anything not being carried by the springs is un-sprung weight (like the rest of the wagon). Un-sprung weight on a vehicle would be the lower control arms, axles and the tire and wheel assemblies.

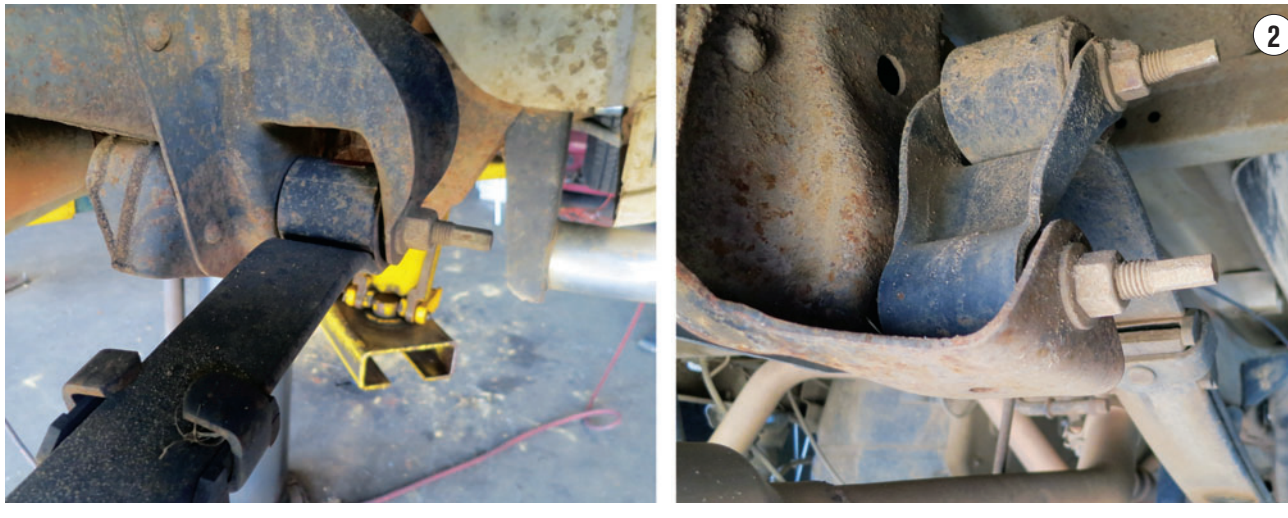
Most vehicles have steel springs, but some have air suspension rather than the metal springs (**Figure 1**). Air suspension requires electronics, piping, a pump and a height sensor. Air suspension systems tend to be problematic on high mileage vehicles and there are kits for sale to replace the air springs with coils.



AIR SPRING SUSPENSION ISN'T NEW, but it can be problematic on units like this. There are $200 kits to replace the airbags with springs; I've made that modification quite a few times on Lincolns and Fords.

Leaf springs are usually on the rear of pickup trucks and since leaf springs change shape (getting longer as they're compressed), one end of a leaf spring will have a hinged portion that allows the springs to lengthen and shorten as the vehicle is loaded and unloaded (**Figure 2**). Any spring can break, and springs can be dangerous. So be careful.

Four-wheel drive vehicles usually have torsion bars because the axles driving the front wheels pass through the place where the springs would normally be (**Figure 3**). Torsion bars are thick spring-steel rods designed to twist when the vehicle is loaded and reverse that twist when there's less loading. This provides suspension support.



UNLIKE THE WAGON SEAT SPRINGS IN FIGURE 1 with upper and lower leaves, pickup trucks have only a lower leaf that needs a hinge link to allow the spring to lengthen and shorten with suspension movement.

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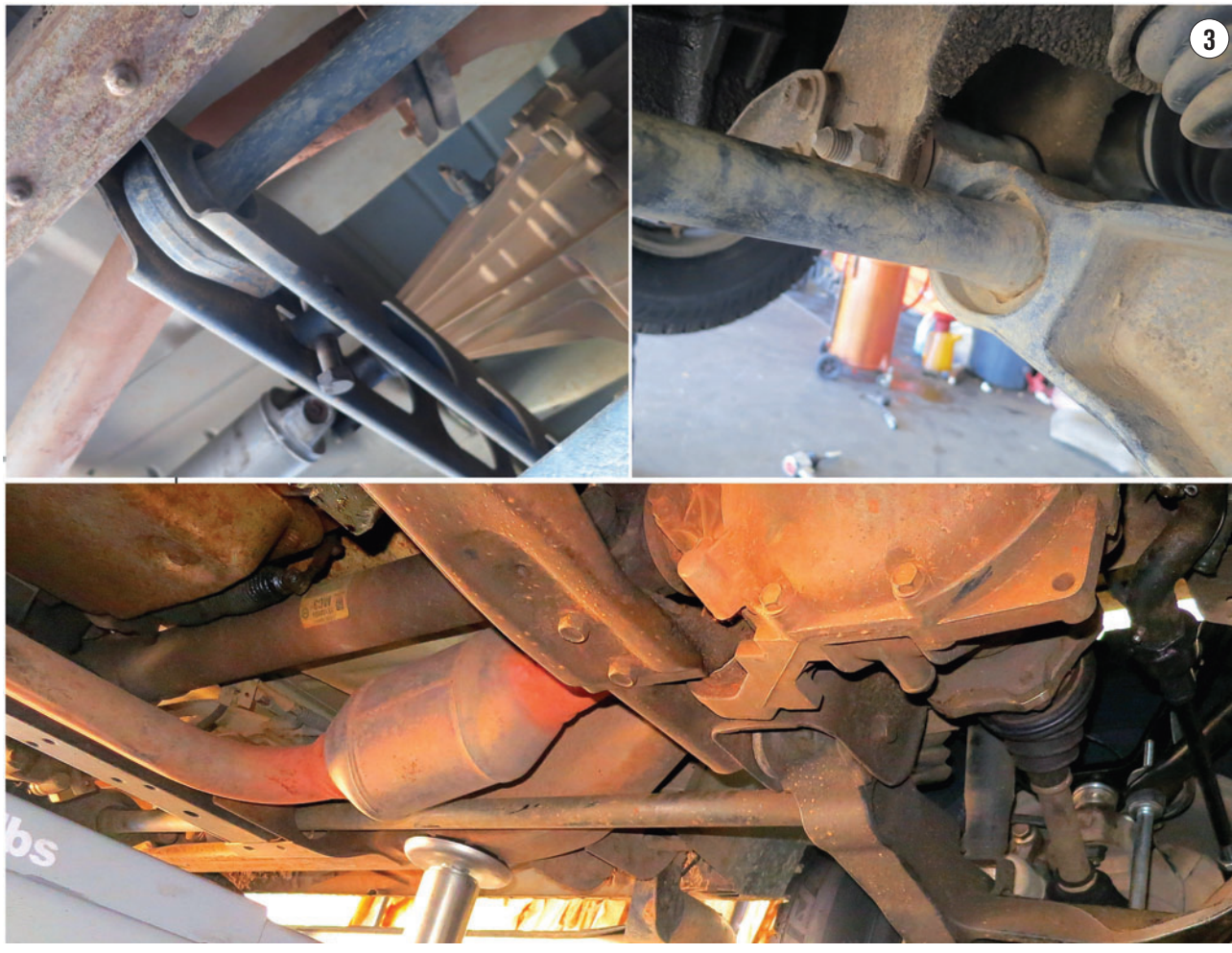

TORSION BARS WERE USED IN THE 30S ON HUDSON AUTOMOBILES and appeared on Eldorados and Toronados in the 1960s because with a drive axle passing through the place where a spring usually goes, a different kind of spring is necessary. This is a 4WD Silverado.

Torsion bars are six-sided (like the head of a bolt) on each end with the front end inserted in a six-sided matching hole, located in the front control arm. The rear end of the bar is inserted in a heavy, wrench-like lever with a six-sided hole. That lever sits on a heavy bolt so it can be adjusted.

The cool thing about torsion bars is that they're easily adjustable (**Figure 4**). To determine adjustment, measure ride height from the bottom of the wheel to the fender well. Remember to mark the bars whenever they have to be removed. And make sure to put them back exactly as they were — left and right are NOT interchangeable. Also, make sure you know the front from the rear on each bar. Reinstalling torsion bars the wrong way (backward, or on the wrong side of the vehicle) ruins the ride quality of the vehicle (GM and some other manufacturers will put L and R marks and arrows on the ends of their torsion bars).

Shock absorbers

Since springs tend to keep on bouncing after their cushioning action, shock absorbers — dampers, as it were — became the order of things early on. A traditional shock absorber is mounted almost vertical, with a polished plunging shaft bolted to the frame, and that shaft slides vertically through a seal into a pressurized chamber. On the bottom end of the shaft, there is an attached plate that slides in a sealed tube. The tube is bolted to the lower control arm, which moves in response to bumps, dips, cornering, etc.

The plate affixed to the shaft has a seal, where it slides in the tube and has small holes in it. This is the heart of the shock/damper. When shock absorber action is happening, the polished shaft (connected to the frame) slides in to shove the plate down within its polished tube (which, by the way, is partially filled with oil) (**Figure 5**). The action of the suspension spring strives to return the rod (and its plate) to their original position. This usually overshoots a bit and is why damping happens. The oil in the shock tube is forced to make its "sluggish" way through the holes as the

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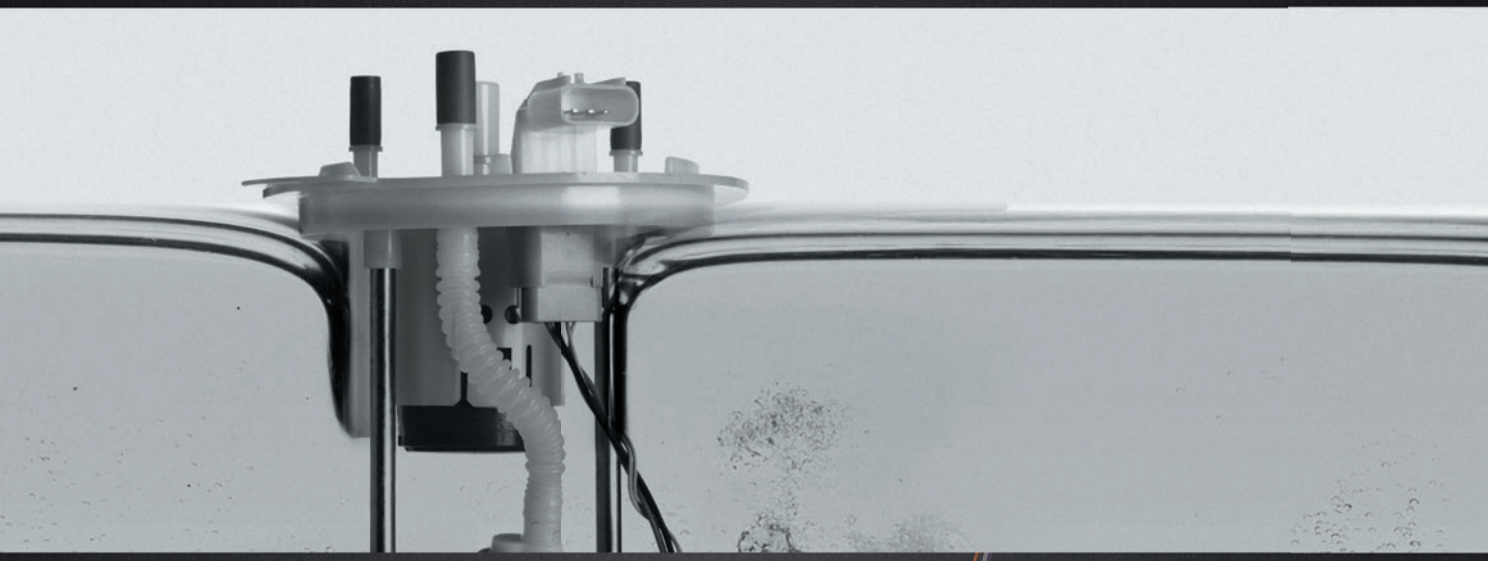

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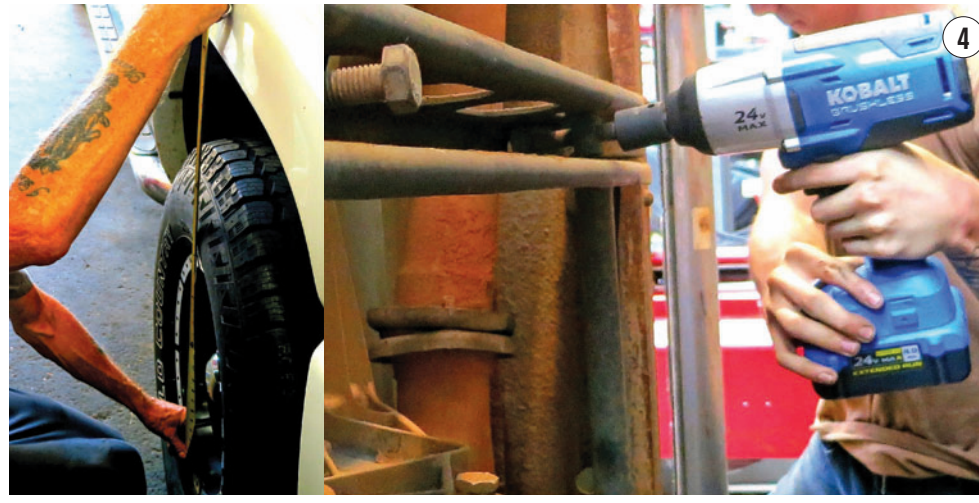
plate reciprocates. This action effectively stops the vehicle from bouncing after going over a bump (or through a dip) and prevents the wheels from beginning a resonant bouncing that leads to worn tires. Some vehicles have small, shock-like steering dampers mounted laterally and connected to the steering mechanism. This prevents front wheel shimmy. Old VW beetles had these, as do many four-wheel-drive vehicles.



MEASURE FROM THE BOTTOM OF THE RIM (NOT THE FLOOR) to the fender on both sides of the vehicle with the weight on the wheels, then adjust the torsion bar to achieve even front ride height.

Variably damping shocks on some performance vehicles have an electronic mechanism that adjusts instantly to restrict the oil flow through the plate holes. This stiffens the suspension when cornering, panic-stopping or when the customer selects "firm" with a switch on the dash. There are several ways this variable damping can be done, but most shocks don't work that way.

Just about all newer shock absorbers are nitrogen gas-charged, along with the oil, and provide some support for vehicle weight in addition to their dampening function. They come "loaded" and must be "unloaded" before installation. You either turn the polish rod or remove a strap. They want to remain extended when at rest and will try to. Older shocks didn't work this way. If you shoved one halfway down, it'd stay there. On an aging shock absorber (or one that has been damaged), the oil will begin to leak out. Usually, we catch the oil leaking out of the shock when we have it on the lift and see a wet shock housing. If the shocks leak enough of their oil, the car will develop a noticeable bounce while driving, because the damping effect of the shock absorbers has been lost. It's best to replace shocks in pairs. Some shocks are easily replaced, and others are surprisingly difficult. When you're handling a worn-out shock, you can compress and extend it easily with your hands. New shocks are very stiff and are practically impossible to manipulate by hand if you're not a He-Man.

Struts

My dad ran a VW shop for 30 years, and when VW came out with their Super Beetle in 1972, he expressed a dislike for the new bug because, in his words: "They have a Mickey Mouse front end under them." Dad was referring to MacPherson Strut front suspension, which eventually found its way to the rear.

Rather than a coil spring (riding between a frame-welded truss and a lower control arm), the stamped steel body of the vehicle has an upside-down reinforced well or "bucket" (I call it a strut tower). It nearly goes to the underside of the hood, and that's where the strut carries the sprung weight. This makes the vehicle's center of gravity a lot lower, giving it a lot more stability during turns and evasive maneuvers (**Figure 6**). Struts are a shock and a spring assembled as a unit. The struts are available as an assembled unit (that's the smartest way), or in two pieces. By using a special heavy-duty spring squeezer, the strut can be replaced, independent from the spring. But, be careful — that spring is strong enough to take your head off.

On vehicles where the strut provides the steering axis, there is a special bearing at the top of the strut unit that enables the strut to turn (with the wheels) while it carries the weight of the vehicle. These bearings are of varying designs and can wear out or dry out so that the customer hears funky noises while turning. If the bearing is the problem, the noise will be consistent while turning the wheels and can be felt with your hand. If you kneel by the tire and put your fingers on the spring while the wheels are turned with the car sitting still, the wear will be evident.

This steering-axis type strut suspension doesn't have an upper ball joint or an upper control arm. It just has a lower control arm and a ball joint. The bottom of the strut is attached to the steering knuckle and plays an important part in vehicle alignment adjustments. They are available with either eccentric bolts (where the strut attaches to the knuckle for camber adjustments) or camber may be adjusted by slotting the mounting holes in the strut tower and moving the upper part of the strut

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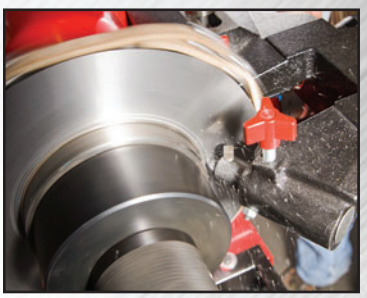

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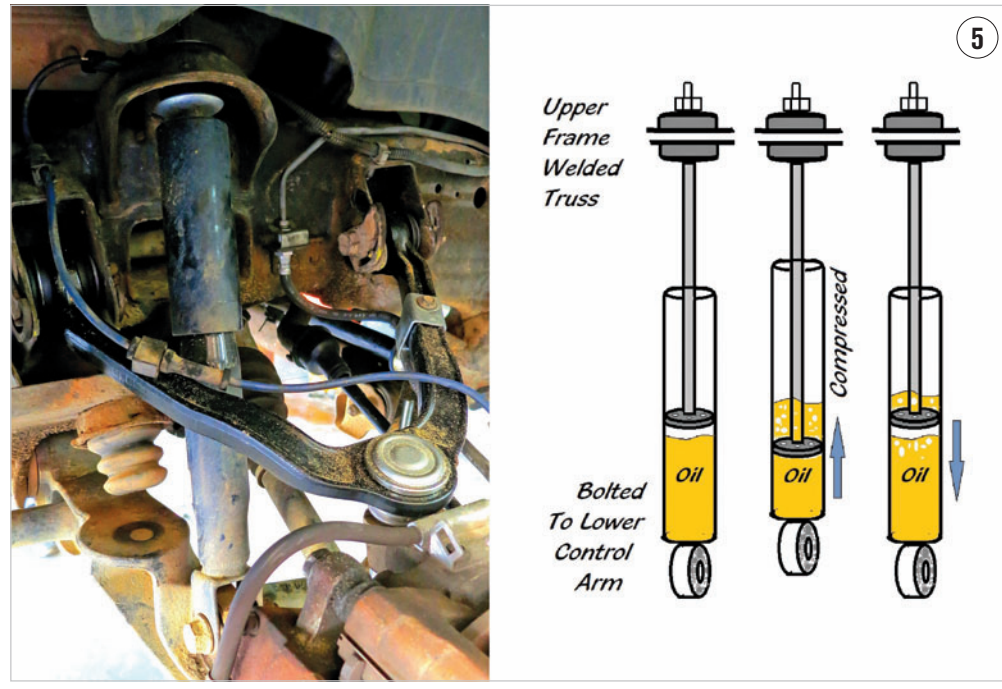
housing in the top of the tower, for caster and camber adjustments. This style can be a pain with a capital "P."

Hondas and some other vehicles — including early Ford Fusions — have both upper and lower control arms with ball joints but still have strut suspension. On these, the strut assembly is attached to the lower control arm (just inboard of the lower ball joint), using what I like to call a "wishbone." The upper part of the strut assembly is bolted high in the car's body (like a conventional strut) but without the bearing. The steering axis on this kind of suspension passes through the upper and lower ball joints, rather than through the center of the strut.



I DREW THIS SIMPLE DIAGRAM OF HOW SHOCK ABSORBERS WORK. The oil moves sluggishly through the holes in the plunger plate to dampen movement and mitigate bouncing.

Short story — working at the VW dealer back in 1983, I encountered a Rabbit with a rattling noise when going over bumps. It was coming from the left-rear strut. I removed and disassembled the strut (which was very easy) and checked everything, finding no witness marks or any reason for the rattle. I reassembled it and reinstalled it, but it still rattled going over bumps. Finally, I had Sam (the parts guy) order me all the composite pieces to build a new replacement strut and that took care of the rattle. I have no idea what was going on with the original strut.

Alignment issues

Aside from old-school Short-Long-Arm (SLA) suspension vehicles, weak front-springs sometimes need replacing to restore in-spec camber setting. But you need to make sure you get the right ones for the vehicle. Some pickups (for example) may have three different spring sizes, and using the wrong springs can cause ride issues. I found that out the hard way, working on a Dodge truck.

Alignments are, on most vehicles, a four-wheel affair nowadays. But the adjustments on newer-model cars are getting more sensible. The eccentrics for front caster and camber on a growing number of vehicles have been moved to the lower control arms, where it's very easy to do. Fiddling with control arm shims (typical, on older vehicles) to set caster and camber was a drag, unless you were accustomed to it.

The toe alignment on the rear wheels is typically done with eccentrics, but sometimes the rear toe adjustments will be done with adjustment sleeves (like the front tie rods), which is a lot better. That being said, adjustment eccentrics in the rear (particularly in high-salt areas) can become so rusty and seized that the adjustments become impossible without doing some torch-work. There's nothing like going into (what you think will be) a simple alignment only to have it turn into a monster.

Sway bar links

No suspension run-down would be complete without a discussion of sway bars. I found out just how necessary this component is when (as a teenager) I took a '58 VW my dad had traded for, shoved an engine in it, and took it for a drive on a nearby dirt road. It was an awful ride; when I swerved right the body would sway sluggishly to the left and vice versa. It was dreadfully disappointing how bad this bug handled, and I had not experienced this before. When I drove back up to Dad's shop, I told him how awful it was. I then asked what could be done about it. He explained that the '58 VW was built without a sway bar — only I had no idea what a sway bar was at the time. The sway bar was part of the front axle assembly (on bugs that came with it).

"Take the front axle assembly off that '64 model bug," he told me, pointing at a vehicle in his boneyard "and put it on the '58." When I did that (no small feat for a 15-year-old), I was shocked at how

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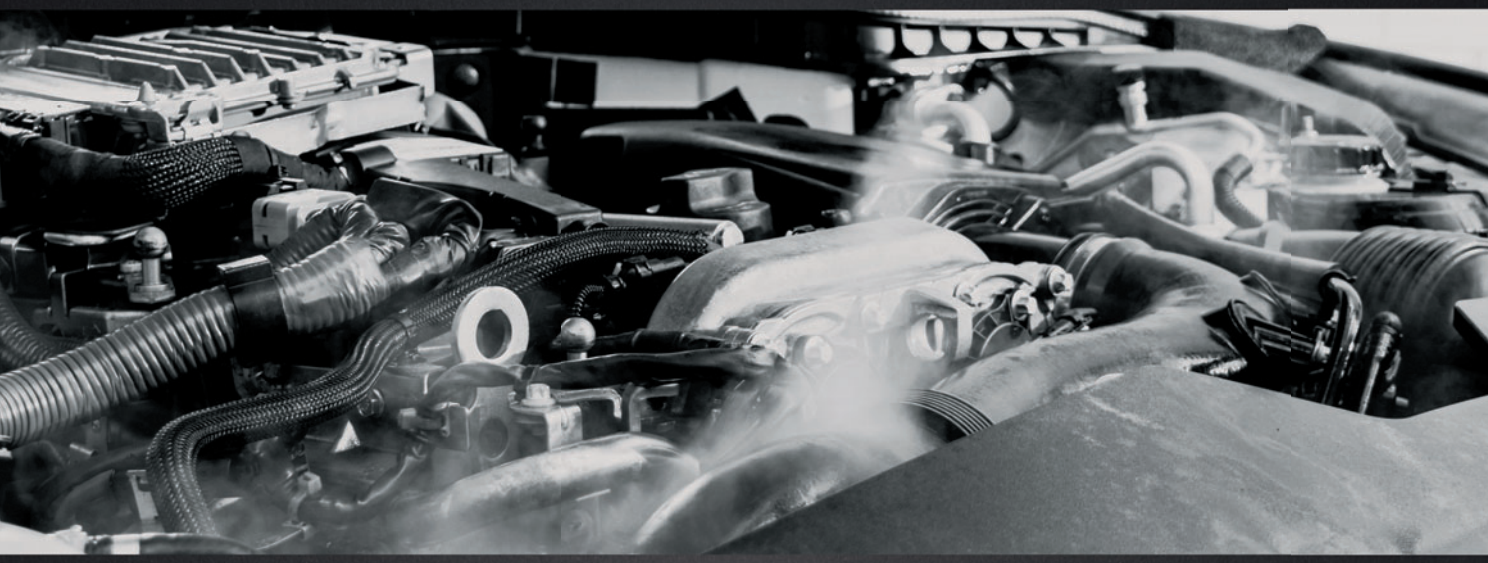

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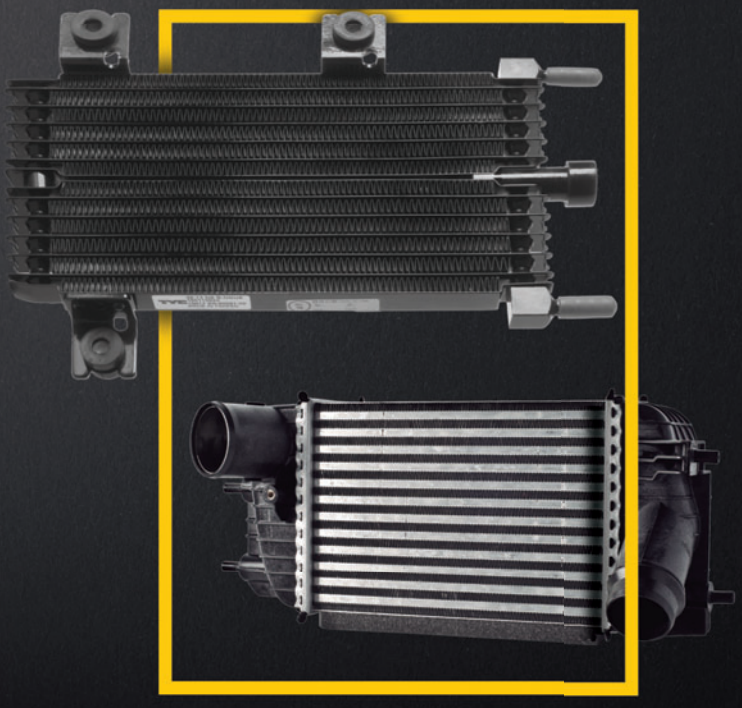

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much better that '58 bug handled doing slalom drift runs on the dirt road. It now handled like a Porsche. No vehicle since the early '60s (that I know about) has been built without at least one sway bar. These are so effective and so important to vehicle handling that many SUVs started including rear sway bars over 20 years ago to help prevent rollover.

A sway bar is a piece of spring steel that is clamped to the frame (in rubber grommets) with steel straps, and at each end of this crooked piece of steel there is a sway bar link attaching it to the lower control arm. When the vehicle corners, the sway bar acts in such a way that (since it is attached to both control arms) it keeps the car's body from tilting as much.

Sway bar links are probably some of the cheapest components you can buy, and they need replacing on higher mileage cars when their rubber wears out and they begin to make popping sounds. It's a good upsell to have a look at them and typically easy money when it comes to replacing them. But make sure you know how to stack the washers, bushings and spacers when installing them — newbies can find a lot of ways to do it wrong. Replacing sway bar links doesn't require additional tasks like alignment adjustments and it's fairly easy to do.

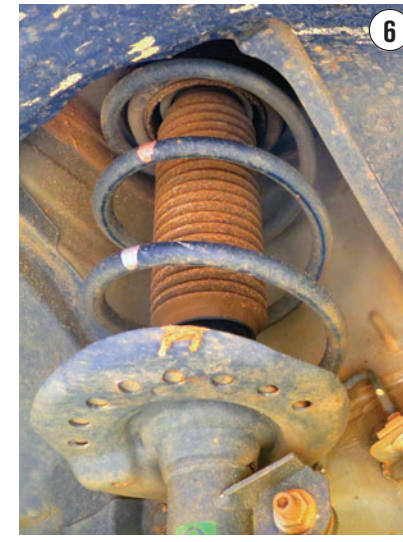
Sudden failures

There's nothing more unsettling than the front-end or suspension parts (the really important ones) that die without warning "catastrophically." When I was doing fleet maintenance down on the Texas coast, in the late '70s, we transitioned from mid-70s Chevy pickups to late-70s Dodge pickups. That very rapidly racked up some pretty serious (and grueling) miles. We had half-hour lunches and we shop guys would sometimes make that mile-long run to Sabine Pass to have lunch at one of the cafes at the intersection. The road to town was rough and bumpy, and we drove one of the Dodge pickups down there and back — a cab full of happy-go-lucky guys.

When we got back, the guy who greased the cranes took that same truck out on the dockyard for the rest of the day to do his work. In the evening, when he was pulling the '78 Dodge back into the shop, the left-lower ball joint broke and the bumper of that truck hit the floor like ton of bricks. It sounded like a bomb going off.

The next day we jacked the truck up, right there where it was parked, to replace that ball joint and saw (from the bi-color cross-section), looking at the "break," that the ball joint had been cracked about halfway through for a pretty good while, before it finally broke. If that failure had happened during our 60-mph drive to the café earlier that day, I probably wouldn't be sitting here typing these words right now. The ball port of the joint wasn't worn, either, and the boot was still intact. It was a stealth failure that could have been fatal. A sister-truck to that one (another '78 Dodge) had a tie rod end separate at highway speed. I was following the truck, and I had noticed that the right front wheel started whipping back and forth like a shopping-cart caster. I was behind the truck when it happened, and that truck crossed the oncoming lane and onto the shoulder. It then crossed that lane again and finally came to a stop on the right side of the road, about three feet off the shoulder. I've seen ball joints and tie rod ends fail on other vehicles, too — a ball joint on a 2001 F150 and a tie rod end on a 1987 F250, but both of those happened at very slow speeds. Ball joints usually fail while turning.

Finally, it bears mentioning that some shops will try to sell customers hundreds of dollars' worth of front-end work that isn't even necessary. As a second-opinion guy, I saw it repeatedly when I was instructing. A friend of mine who owns a tire shop told me he gets vehicles in for second opinions just about every week with the same circumstances. This shop or that one would try to fear-monger the customer into letting them replace all the ball joints and tie rod ends. When they came for a second opinion I couldn't find so much as a busted boot anywhere, and all the joints would be tight and safe. Let me conclude by saying that there's plenty of suspension work out there that needs doing, without trying to sell work that isn't needed. Just a thought.



THIS KIND OF STRUT HAS TWO BOLTS SECURING IT TO THE SPINDLE AT THE BOTTOM, and eccentric bolts or slotted holes can be used to set camber on these. The steering axis passes from the lower ball joint through the top of the strut, which has a bearing that carries the weight of the vehicle as the strut turns with the steering. When these bearings get dry or fail, they'll make odd noises that can be felt by putting your hand on the spring as the wheels are turned.

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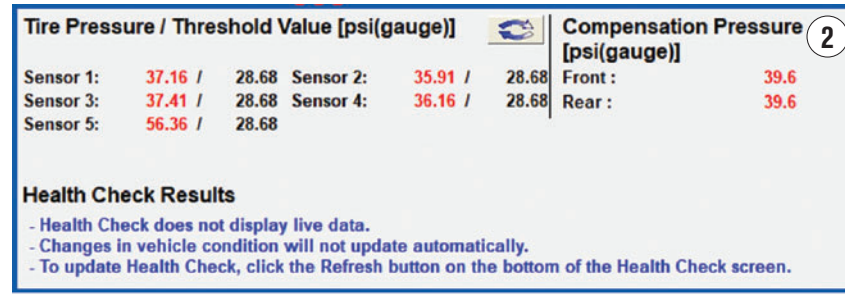
DETERMINING IF THE TIRE SHOULD RETIRE

LEARN HOW TO PROPERLY EVALUATE A DAMAGED TIRE

BRANDON STECKLER //
Contributing Editor



Of the wear items found on vehicles, I could think of nothing more crucial to the safety and well-being of everyone on the road than a vehicle's tires. Carrying a vehicle down the highways of the world at more than 65 mph with thousands of pounds upon them and navigating and cornering under temperature ranges far below freezing and well above 120 degrees F, the tire has to endure a lot of punishment. And if properly maintained, can do so sufficiently for tens of thousands of miles. But proper tire maintenance and thorough inspection are equally as crucial to ensuring the safety of the tire. Learning how to properly evaluate a damaged tire for potential repair is taken for granted all too often and could be the difference between life and death. I'd like to clear up any misconceptions.

The tech's task at hand

According to the National Highway Traffic Safety Administration (NHTSA), in 2017 alone, 3.2 trillion miles were driven in the United States. Each one of those miles was driven atop a set of tires. I know that is a silly statement to make, but think of the potential danger each time a set of tires carries that vehicle (more importantly, its passengers) down the crowded streets and highways. In 2017, there was more than 730 traffic-related fatalities associated with tire failures. This information is indicated by the Fatality Analysis Reporting System (FARS), a nationwide census that supplies the NHTSA with data. There is a lot at stake and we as technicians are offering our input as to the safety and reliability of the tires. We are the ones who determine if they are up to the task. We had better know what we are doing or someone could get hurt. A tire is only as sound as the inspection process used to evaluate its condition.

One of the most important aspects of an inspection is to verify and maintain the proper pressure for the tire (this may be found on the tire placard, or in an owner's manual). The pressure indicated on the tire itself is an indication of maximum allowable pressure.

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This is not necessarily what the vehicle manufacturer recommends. Always follow the recommended specifications for the vehicle. Although the tire pressure monitoring system (TPMS) had been implemented more than 10 years ago, they typically don't exhibit a warning unless a tire pressure is significantly out of range. To operate a vehicle with a significantly out-of-range tire pressure can lead to blow-outs (**Figure 1**). A tire blowout is a rapid loss of tire air pressure that can cause your vehicle to lose control. Although it's not always possible to prevent blowouts, maintaining proper tire pressure can certainly help you avoid them. Pressure not only affects the safety and longevity of the tire, but also has a large impact on fuel economy. In fact, instructing a vehicle owner to have the tire pressure maintained monthly (including the spare tire) can extend the life of the tire upwards of 4,700 miles. The specifications for tire pressure are recommended for "cold." This means the tire should have been stationary for at least three hours. To get an accurate tire pressure reading, you must measure tire pressure when the tires are cold or compensate for the extra pressure in warm tires. A helpful tip comes from an example involving a Toyota. Displayed is a capture of the Toyota TechStream scan tool (**Figure 2**). It has a feature called Tire Pressure Utility that compensates for ambient temperature and the effect on tire pressure accuracy. The compensating factor of the utility allows the tech to inflate the tire at a pressure different then what is designated on the placard. In this example, it's recommended that the tires be inflated to a gauge pressure of 39.6 psi. Sensor #5 is showing that a tire's pressure is too high (in this case, it's the spare tire). This allows for a higher setting under warmer conditions and a lower setting under cooler conditions. It just goes to demonstrate that accurate and correct tire pressure is crucial to the longevity and safety of a tire.

The next aspect to consider is the amount of safe and useable tread left to the tire's surface. Of course, this tread provides the necessary friction, maintaining a firm grip on the road, even under not-so-ideal conditions. Without the proper amount of useable tread, the tire simply can't maintain traction

safely. The tread is not only designed to improve friction between the tire and the road surface. It has to also manage water and direct it away from the contact area in between the tire and road surfaces. This is to limit the effect of hydroplaning. Hydroplaning is an uncontrollable slide of the vehicle that occurs when friction is lost between the surface of the tire and the road it is operating on. This happens when the water between the tire and the road can't be displaced fast enough. The tire begins to float on the surface of the water and lifts the tire from the road (**Figure 3**). Hydroplaning is possible whenever water accumulates to a depth of one-

tenth of an inch (0.3 centimeters) or more for at least 30 feet (9.14 meters) and a vehicle moves through it at 50 miles per hour (22.35 meters per hour) or more [source: Crash Forensics]. Hydroplaning is caused by a combination of standing water on the road, car speed and under-inflated or worn-out tires.

It is advised that tire tread be inspected about once monthly (ideally at the time the pressure is being checked and/or adjusted). The treadwear indicators can be found in between the tire treads and are raised sections of rubber. These tread wear indicators represent the minimum safe amount of useable tread remaining and, once in contact with the tires rolling surface, are an indication that tire replacement is necessary.

Another trick is to use a penny as a measurement indicator. Simply place the penny (Lincoln's head upside-down) within the tire tread. If the top of his head is invisible, it's time for new tires (**Figure 4**).

Some states in the U.S. still adhere to a motor vehicle safety inspection program. Typically, the boundaries of tire wear are a lot more stringent in these programs than what the vehicle manufacturers are stating. With that said, local mandates trump all others to legally operate the vehicle within that state's borders and with that state's inspection certification. In my experience, I find that most tires don't last long enough for the tread wear indicators to serve their purpose, though. Other determining factors that limit the tire's longevity come into play. These factors can be avoided if proper inspection and maintenance are followed diligently. We'll cover them later.

Age is NOT a beauty

You may tend to notice this on the older vehicles that don't have many miles accumulated. Although the paint and interior seem to be in fantastic shape, it's the tires that are the age-revealer. Age is a very real factor when it comes to evaluating a tire's ability to perform properly. As tires age, they are more prone to failure. Some vehicle and tire manufacturers recommend replacing tires that are six to 10 years old, regardless of treadwear. You can determine how old your tire is by looking at the sidewall for your DOT Tire Identification Number (TIN). The last four digits of the TIN indicate the week and year the tire was made. If the TIN reads 0308, it was made in the third week of 2008. Look on both sides of the tire. The TIN may not be on both sides (**Figure 5**).

As tires age, the effect of heat from the sun and heat from the road (and other environmental conditions) create a breeding ground for dry rot. The rubber of the tire starts to discolor as it deteriorates and becomes rigid or brittle and begins to fracture (**Figure 6**). Once dry rot appears in a tire, you only have a short time to attempt to repair the damage before the tires become unsafe for driving. Minor dry rot can be addressed by a using a tire sealant, similar to ArmorAll. Tires with advanced dry rot must be replaced. Dry rot allows air to escape the tire, making it difficult or even impossible to keep the tire properly inflated. Dry rot can also cause unnatural rubber expansion while driving that breaks the tire apart. Tires with dry rot are much more likely to develop leaks, holes and blowouts. In extreme cases, the tread may separate from the rest of the tire entirely. As the name suggests, the tires will dry and

crack. Below are some characteristics to keep your eyes open for:

- **Brittleness** — Dry rot dries out your tires. As essential oils leech out of your tires, you may notice that they appear and feel more brittle. You may even observe small pieces of rubber breaking away from the tire.
- **Cracks on the tread** — Advanced dry rot can cause small cracks on the outside edges of your tire tread. These cracks can affect your car's handling, even if your tread still has adequate depth overall.
- **Cracks on the sidewall** — Even in minor cases of tire dry rot, you may notice cracks on the sidewall of your tire. These cracks may appear in an isolated area or extend around large portions of your hubcap.
- **Faded color** — If your tire begins to look more gray than black, it may be developing dry rot. Fading may appear before or in tandem with cracking.

Inspect tires for signs of dry rot at least once a year. Inform your customers of the importance of inspecting tires in the early spring or early fall, since winter and summer conditions can contribute to the development of dry rot. Below is a list of things to avoid that you can advise your customers of, too:

- Abrasive or corrosive chemicals, such as pool treatment chemicals, motor oil and industrial cleaning solutions
- Excessive or direct sunlight that exposes the tires to harmful UV rays
- Extremely low temperatures
- High temperatures
- Long periods of disuse
- Ozone generated by electrical equipment
- Underinflation, especially when the car is driven regularly

Getting to the root of the problem

Discovering that a tire (or a pair, or even a full set of tires) requires replacement is just the first step of the process. Like any other approach, a good technician should take to a problem the realization that the tire has worn out for a reason is what is important. Getting to the root cause of the wear issue is what needs to be discovered. Otherwise, we have customer dissatisfaction, and nobody wishes for that. Like any other fault that occurs within an automobile, it does so for a specific reason. So, too, does premature tire wear, whether the wear occurs due to age, lack of maintenance or some other underlying cause. It's up to us as automotive technicians to uncover it. Learning to read the treads as well as we do our scan tool or lab scopes will help keep us efficient, our customers happy and generate some profitable supplemental work for us to perform.

As I mentioned, being able to read the tire treads to determine what an underlying cause of premature wear is will certainly serve you well. The treadwear in the following areas is an indication, if you know what to look for:

- **Wear on outside edges** — Underinflated tires wear on the shoulders or outside edges. There is excessive contact with the outer edges of the tire and

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the road surface as the vehicle travels down the road

- **Worn center of tire** — Overinflated tires wear in the center. There is excessive contact with the center of the tire and the road surface. Always use a tire air pressure gauge when inflating tires and be sure to set them to the OE recommended specification. Advise your customer to do the same. Be sure to verify the accuracy of the gauge, too!
- **Wear on one of the edges** — When the tire is worn on one side, but not the other, the camber angle is likely not within specification.
- **Cupping** — Resembles the surface of a rough lake. When cupping occurs, it usually leads to poor shock/strut performance. It can also be caused by improperly balanced tires. Both conditions can allow the tire to "hop." Jounce the vehicle and look for excessive oscillation.
- **Feathering** — Looks like the end of a bird's wing across the tread of the tire. Could be an indication of worn tie rod ends. The wear is typically caused by the tire excessively toeing in/out as the vehicle is driven down the road.

All of the above are just some examples of what can be learned by reading the tire tread wear. These are all visual indicators that can lead to faults found through physical inspection and wheel alignment. Carrying out this process can save you a lot of grief and your customers a lot of money in the long run.

Repairing a serviceable tire

For a tire to be labeled as serviceable, it must be able to fulfill its function adequately. Although a tire can be worn, it still may be serviceable. We will find ourselves as technicians faced with a punctured, yet serviceable tire. When the tire has been deemed safe for repair, only then should we proceed to do so.

For starters, I've seen many tires arrive at the shop damaged with multiple punctures. This usually occurs after a drive near the scene of a home having its roof replaced. If multiple punctures are present, those punctures should be no closer than 16" apart. Otherwise, the structural integrity of the tire is compromised and the tire should be replaced. If the tire has sustained serious damage in a crash (such as big cuts or treads separation), it should be replaced, not repaired (**Figure 7**). The maximum repairable injury size for passenger and light truck tires through load range E is 1/4 inch or 6mm in diameter. If the puncture in your tire is larger than the allowable repair size, the tire must be taken out of service.


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If the situation arises when a tire is to be repaired, it cannot have a puncture in the area closest to the edge of the tread (**Figure 8**). A tire plug does not offer a permanent seal and neither does a patch. I've been in many shops and a common practice is to eliminate the use of patches or plugs and to only use a patch/plug combination. This offers the best of both options simultaneously, and also serves as redundant. Once the tire is removed from the wheel, a thorough inspection from within must be carried out.

As a tire rotates in an underinflated condition, the tire sidewalls flex in and out as the tire meets and leaves the road's surface. This creates heat and causes the internal surface of the tire to breakdown. This can typically be seen as handfuls of pulverized rubber (resembling pencil eraser shavings) are found throughout the inside of the tire. This is a sure sign the tire is need of replacement, as it is no longer structurally sound (**Figure 9**).

If a punctured tire is found to be in a serviceable condition and multiple punctures are neither too close to one another nor exceed the maximum safe diameter, the tire can be repaired. Although repairing a tire is not a difficult task to carry out, it must be done so properly and with great care. Learn the proper way to repair a tire by watching https://youtu.be/sx1p2bOaIU0. Follow all directions that occupy the contents of the repair solutions your facility provides. And always remember what is at stake and what is riding on those tires. Safe rather than sorry is definitely the way to travel.

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INQUIRING MINDS WANT TO KNOW

IT ISN'T ALWAYS TALENT, BUT RATHER THE DIAGNOSTIC GAME PLAN THAT LEADS TO REPAIR SUCCESS

BRANDON STECKLER //
Contributing Editor

Does it ever cross your mind how some shops seem to struggle with complicated and many times hard-to-reproduce faults? Yet, others seem to "specialize" in such situations and remain profitable? No, it's not magic or that the successful shops have more talented technicians, necessarily. It has to do with the ever-so-important "diagnostic game plan" that we mention so frequently here on the pages of *Motor Age*. And to be more specific, the interrogation process.

Turn up the heat

As I visit shops for the request of diagnostic support and a second set of eyes, there is typically a common trait among all of my mobile calls. There is almost always a missing piece of data. Sometimes this data simply cannot be obtained, like vehicles that don't come with known service history (ie: vehicles acquired from an auto auction). But, more often than not, this critical data can be obtained quite easily. We just have to step up and ask for it.

The man who taught me everything I know about the diagnostic approach was the same guy who pounded this interrogation process into my brain. He ran a diagnostic/drivability shop in the Philadelphia area of Pennsylvania and (as the description denotes) specialized in deciphering hard-to-find drivability and electrical faults. His process was clear and repeatable, which made it easy to carry out.

The process began with a conversation that initiated before the vehicle even arrived. As the customer called the shop to arrange an appointment, the conversation led to the customer being allowed to drop the vehicle off ONLY if he/she could invest in a 20-minute conversation in the quiet atmosphere of the shop's interrogation room. If the customer couldn't invest that time, the appointment for analysis would be refused. The second and probably most important aspect of this customer interrogation process was a requirement for the complainant to be present for interrogation. What we sometimes fail to realize is that the person leaving the vehicle at the time of the appointment isn't the one experiencing the "symptom."

This reasoning may not seem obvious, but I distinctly recall a vehicle being dropped off for evaluation, with the complaint of brake failure. This occurred only hours after servicing of the evaporative emissions system (a leak between the induction system and the purge valve was repaired earlier that day). The concerned mother of the vehicle's driver was irate as she experienced what she described as "brake failure." The vehicle's entire brake system was thoroughly inspected and

PHOTO: BRANDON STECKLER

extensive road-tests were carried out by multiple technicians. In the end, only after speaking directly with the "complainant," it was discovered the vehicle's brake system was performing as designed. I recall the statement from the concernedmother that the vehicle's brake performance is "nothing like her high-end European sports car." Thinking back, a well-conducted interrogation would've saved a lot of grief and embarrassment as well as time. The customer was simply comparing apples to oranges and was not comfortable with the brake performance of her daughter's economy-class vehicle.

The point is, it's the questions that don't get asked that — many times — hold the key to the puzzle.

Understand that this diagnostic-specialty shop not only handled the "un-fixable" that the local area struggled with. It operated with only three technicians, a well-trained office staff (of two), and was handling, on average, 28 of these seemingly "impossible-to-solve" puzzles daily! To do that meant

to have a game plan and that simply can't occur (at the rate of 28-daily) without this "interrogation process," to streamline the approach.

Beauty lies within the cup holder

Another situation existed when a thorough interrogation process could've saved a lot of time, headache, and in this case, a poor performance review. It was when a customer left the vehicle for routine service and upon retrieval, promptly returned the following morning for drop-off. It was accompanied by the complaint of "noise, anytime the vehicle is driven." Of course, a thorough road test was conducted and the fault was not duplicable. The customer returned several times that week with the same complaint, but this time, much more frustrated. It was only on this final visit that a technician rode-along with the customer present. It was noted that the customer emptied the contents of her hip pocket, to the cupholder of the door panel, each time she entered. She retrieved the contents each time she exited. Included was a tube of lipstick and mascara. During the test drive, the annoying "rattle noise" the customer complained of was easily exhibited. It took no longer than 10 seconds to demonstrate the fault and prove to the customer the source of the noise. This was a lesson learned. No…she didn't alter her review. Ouch!

The 8-hour road test

This final example was one from my archives. The subject vehicle was a 1988 Ford Thunderbird that was experiencing a very intermittent engine stall/restart with no other symptoms whatsoever. What made this lesson very hard learned is that I accepted this challenge and drove 85 miles (one-way) just to evaluate it!

As noted above, the fault was very intermittent. Due to the age of the vehicle, data was not very robust, so it was even more important to gain as much information that I could before I performed an evaluation. It was explained to me that the vehicle was not a regular customer of the shop I was assisting. It

WHAT IS YOUR GAME PLAN FOR VEHICLE DIAGNOSTICS?

This process is like a building with a roof that's sagging — you don't replace the roof without first checking the foundation. If the foundation was sagging and you didn't repair or replace it, the new roof would only sag again. It's the same on a vehicle, we need to start at the battery and go on to the mechanical, then move on from there in a process that I call a game plan.

The first place to start is by interrogating the driver of the vehicle. That may lead you to investigate an area that you may have not checked. The next step is to use the best tools you own: your brain, eyes, ears, nose and hands to check out the problem. Over years of working on vehicles, I have seen, heard or smelled something that helped me identify a problem. That step should be followed by researching Technical Service Bulletins (TSBs) that may be related to the issue. You should also check other service information (SI) sources like ALLDATA, Identifix, Motologic or ProDemand. Use these sources to read up on the system so you understand how it works so you can properly diagnose it.

A game plan is a needed mindset when working on today's complex vehicles. Your game plan for a problem vehicle is just as important as a professional sports team's game plan. The sports team cannot win a game if they don't have a plan on how they can beat their opponent. Don't forget what Benjamin Franklin said, "If you fail to plan, you plan to fail."

With your preliminary homework done and having an idea of how the other "team" operates, it's time to get hands on. Start your diagnostic procedure by testing from the basics up, finding out what's right and what's wrong, just like the big box scope analyzers did in years gone past. The good thing about the old big-box analyzers was that they forced us to start testing at the battery, starter, alternator, then moved us on to checking the engine's mechanical condition, taking emission gas readings, verifying ignition, then fuel, and scan data.

The battery is the first place to start since it's the heart of the vehicle's electrical system. If the battery is not the correct one for the vehicle, you may encounter problems that will not be resolved until it is replaced with the recommended one. Just because the battery is the same physical size does not mean it's the correct one for the application. Always make sure the battery that is installed has the correct CCA (cold cranking amp – at 0 degrees) rating. Installing a battery with a different rating will affect the battery's Reserve Capacity rating, which is the number of minutes a fully charged battery at 80°F will discharge 25 amps until the battery drops below 10.5 volts. The wrong battery in a modern vehicle can cause many issues including Readiness Monitor or Check Engine light problems. Keep reading at **MotorAge.com/gameplan**.

was a problem vehicle that had been through the ringer. The vehicle would stall on occasion for no apparent reason. I recall the vehicle stalling only once the entire day. Because of my long drive I was committed, so I stayed until I could reproduce that fault and hopefully capture it. Unfortunately, the fault didn't occur for me that day. I had no choice but to abandon the challenge or return the following weekend — I chose the latter.

Upon my return, I chose instead to interrogate the customer. I asked the customer questions about the frequency of the stall. Questions about the weather and how long the car was running before the stall occurred came about. He mentioned that this didn't occur until the engine was replaced a few months prior. I then inquired about rough roads, and his eyes lit up! He recalled the car stalling frequently on a particular road that was very bumpy. I performed a subsequent road test and quickly recreated the fault over a speed bump. I discovered that a connector, securing the wired harness to the ignition control unit was damaged and secured only with a zip-tie. I could wiggle the connector gently and the engine would stall each and every time!

Those experiences and stories (although hard to swallow) were career-changing for me. It's these not-so-desirable experiences that allow us to grow as technicians. I hope to help you grow as well while avoiding the pitfalls and the wasted time I've encountered in my experiences growing up as a diagnostician. Developing a well-thought-out diagnostic game plan involves a logical thought process. But we can't carry out our process with the blinders on. Always be aware of your surroundings and interrogate those customers. The difference between your success and another shop's failure likely lies with what the customer knows but is not telling you!

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HONEY, I SHRUNK THE FRAME

A BLIND SPOT CAMERA CALIBRATION GOES AWRY THANKS TO A MISMEASUREMENT

JOHN ANELLO // Contributing Editor

Developing a reputation as a solid and reliable source of technical solutions definitely means knowing what you are doing. Familiarity with procedure and using the tools you have (properly) is definitely a must! But spotting deficiencies in tooling or procedure as well as being willing to adapt and evolve is what it takes to keep your business moving forward in a positive direction. When faced with adversity, you can pack it in and head home, defeated, or you can step up to the challenge and overcome it. I chose the latter!

I was called to a body shop for a 2019 Honda HRV (**Figure 1**) that recently had the right passenger side mirror replaced. This mirror had a blind spot camera incorporated into it and needed the camera calibrated. This was an easy task for me because I had the proper target and knew the exact procedures needed to perform the task. I also noticed there was an icon on the dash relating to an error with the front LKAS camera system. I asked the shop if the front windshield was replaced or the camera was disturbed. The shop was honest enough to tell me that he hired someone else to come out to calibrate the blind spot side camera and the guy he hired was unable to perform the task. After the guy left, he noticed more errors on the dash, but did not think much of it.

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Preliminary evaluation

I proceeded to scan the vehicle to see what it would take to resolve the current issues this vehicle had. It turns out that the prior guy was unaware that the blind spot side camera calibration was all performed by the center dash panel electronics. He used his scan tool and went into the menu for the camera system that controlled the Lane Keep Assist System. He started the procedure and found out (a little too late) that he was working on the wrong system. What he did not realize was that once you initiate the procedure to start, there is no backing out without leaving a message that now said, "Static Camera Aiming Incomplete." The problems were now compounded, and two separate procedures had to be done on the same vehicle.

The blind spot side camera calibration went well, but the real challenge was the LKAS calibration, because this vehicle would require both a static cali-

PHOTOS: JOHN ANELLO

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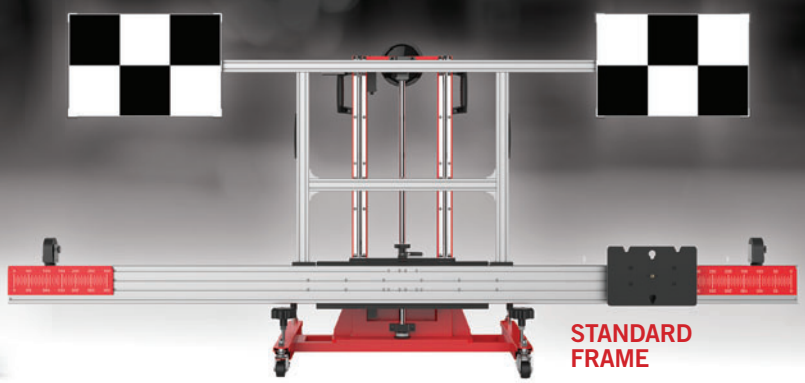

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MOUNTING PLATE
MA600RAP
Expands coverage of MA600 to match standard frame calibration capabilities

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Allows MA600 to perform front radar calibration on Nissan/Infiniti, VW/Audi, Porsche, Hyundai/Kia vehicles

RADAR CALIBRATION BOX
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RADAR CALIBRATION PLATE
CSC0602/02
Allows MA600 to perform front radar calibrations for Nissan/ Infiniti and Hyundai Kia models

NIGHT VISION CALIBRATOR BOX
CSC0603/01
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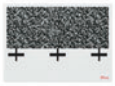
MA600LDW3 COMPATIBLE WITH THE AUTEL MA600 FRAME

EXPAND COVERAGE FOR LDW CALIBRATIONS



SUBARU LDW 2
CSC0601_17
Adds coverage for 2013-2016 Subaru Eyesight

ALFA ROMEO LDW
CSC0601/10
Adds coverage for 2018+ Alfa models with LDW

TOYOTA ONE TIME RECOGNITION LDW
CSC0601_25
Adds coverage for new Toyota vehicles, improves setup time

HONDA LDW 3
CSC0601_24-01
OE sized target, reduces dynamic calibration time for Honda vehicles

LDWTARGET3 COMPATIBLE WITH THE AUTEL STANDARD FRAME

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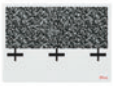

SUBARU LDW 2
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ALFA ROMEO LDW
CSC0601/10
Adds coverage for 2018+ Alfa models with LDW

TOYOTA ONE TIME RECOGNITION LDW
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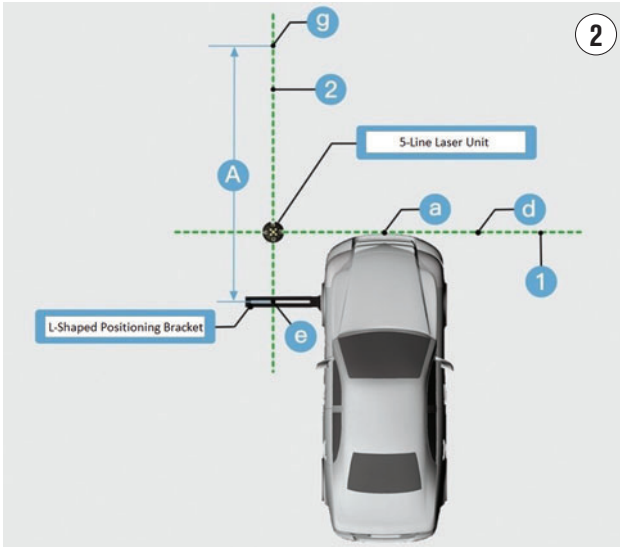
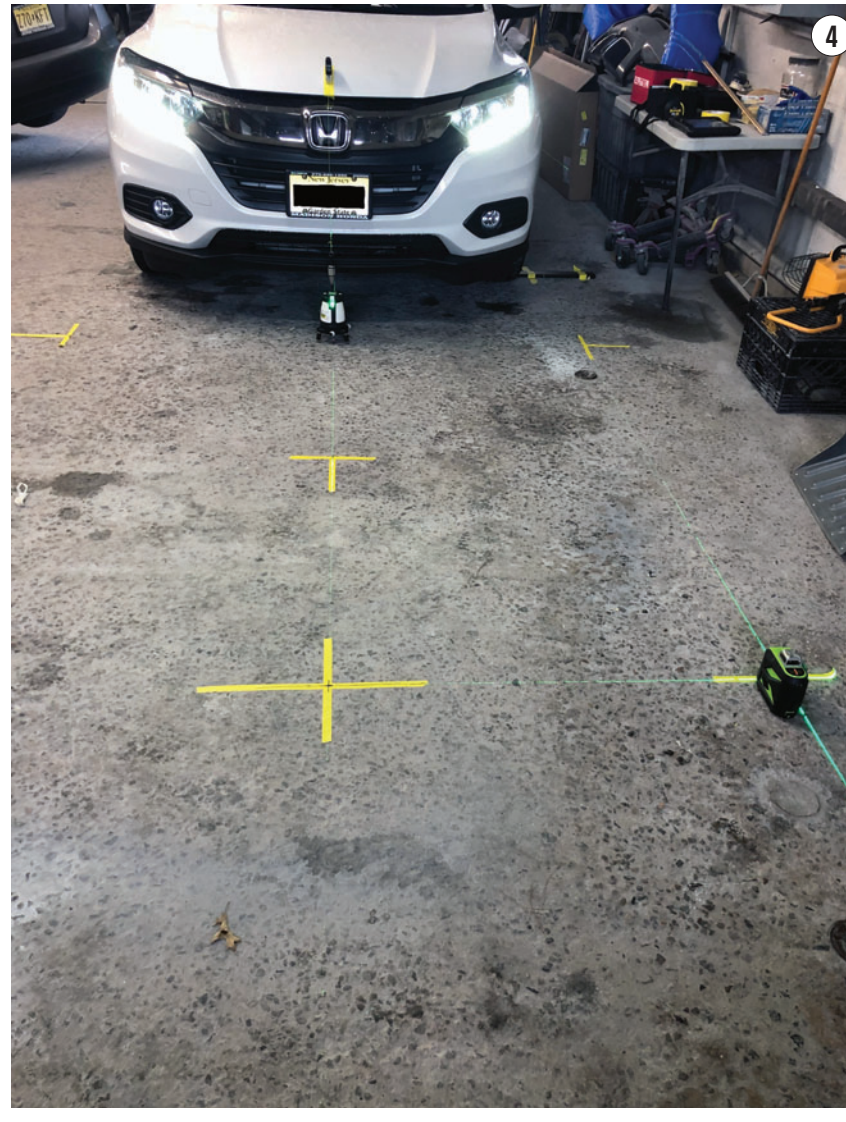


bration (using a frame machine with a target) and then followed by a dynamic calibration (drive on a three-lane highway). Most manufacturers will opt to do either calibration, but not both at the same time. Some manufacturers will require you to properly set up a camera statically (using a target) then allow the camera to fine-tune its calibration over the accumulative highway driving by the owner of the vehicle. Then other manufacturers do not require any targets, but need the vehicle to be driven on a three-lane highway, keeping in the center lane, while it reads the lane marking to self-calibrate using a scan tool.



Climbing out of the deep hole that was dug

The first step in the static procedure is to make sure you have a level floor and about 4 meters of open area ahead of the vehicle to place the frame. This vehicle will require you to measure out 3 meters (9 feet 10 inches) from the center of the left front wheel extended out to the front of the car (**Line "A" in Figure 2**). A centerline will need to be established, under the vehicle from the rear of the car extending out past the front of the vehicle. This can be done using a plumb

bob hanging from the trunk and one from the hood, aligned with the car emblem that is usually centered on the vehicle. You will have to mark the floor in the rear and place a laser target on its mark, then place a five-line laser under the front plumb bob centering it over the laser assembly, and line the laser housing to strike the rear laser target (**Figure 3**).

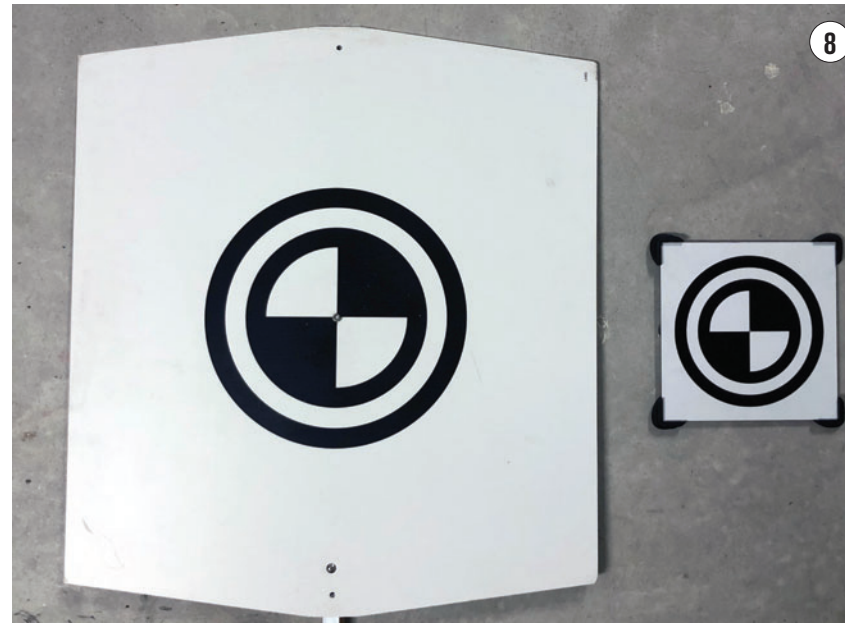
Once this is done, you can place a four-line laser down the left side of the vehicle, placing it 3 meters forward from the center of the left wheel and intersecting with the 5-line laser at the front of the vehicle (**Figure 4**). This would be the spot that the frame machine will be centered on. The frame machine has its onboard four-line laser to properly square it up with the laser grids that are already on the floor. Once the frame machine is in place, it is equally important to use the base knobs to lock it in place and make sure it is perfectly level (**Figure 5**). Once the frame and target are in place, you need to set the proper height of the target, center from the floor. On this vehicle, the spec is 1100 millimeters (43.4 inches) and this is achieved with a crank handle on the frame assembly and the use of a laser measure attached to the frame. The last step before aiming the camera would be to input the measurements of the front wheel housing arcs distances to the floor. Suspension height is critical to achieving the proper aim of the camera, so it must be within an allowable spec and on this

car, the measurements were about 722 millimeters (**Figure 6**).

Everything was now all set to go so I next commanded the system to learn the target and it proceeded without any issues. This particular vehicle needs to see the same target in three positions, so I then moved the target to the adjustable target mount on the left side frame arm and slid the target mount out to 700 millimeters from the center of the frame (**Figure 7**). After learning position #2, I repeated this procedure for the right side, and everything went smoothly without any problems of any kind. The final step was not to cycle the key but rather to proceed with a Dynamic Calibration on a nearby highway. I dismantled my frame set up and put all my equipment safely locked into my vehicle and secured my truck inside the shop's building, where someone could keep a close eye on it while I was away for the calibration drive.

A swing and a miss

Luckily for me, this shop was not too far from a three-lane highway, because if it was, it would be hard for me to spend a lot of time to get to a highway of choice within the time frame I allow for each shop visit. The time of day is crucial, and you can't have a lot of traffic on the roadway. You need to maintain at least a four-car distance (with a speed about 40-70 MPH) on a straight and flat road. This has to be carried out without stopping, while the camera is using the highway lane markings to perform the calibration. You also need to make sure the weather conditions are correct and not have rain, snow or darkness on the roadway or the calibration process will not succeed. I drove this vehicle for almost a half hour in one direction, turned around and drove another half hour and the camera system would not learn the roadway. I returned to the shop to tell the shop owner that there was something wrong with the vehicle or the process, and I had no answers for him. The windshield and camera were never touched, but I was unable to finish the job. The shop owner was under pressure with the owner of the car and the insurance company, so I lost the job to the dealer who tried calibrating the camera. In the meantime, I was only paid for the Blind Spot camera system I calibrated.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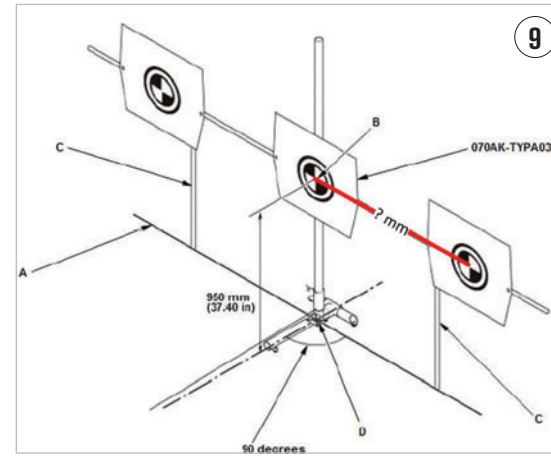

I walked away puzzled because I have been successful in calibrating windshield cameras for other manufacturers. This one beat me for now, but I was ready for the next one and hopefully the next shop would be patient and willing to work with me. That day came soon enough, and I was served another Honda SUV with the same target and equipment set up. The static calibration went very well, but the dynamic calibration would be the challenge. I was ready for anything this car would serve me. Well, after another hour of wasted time, another failure hit me that sent me into a denial mode. I had to reach out to a friend of mine who was an "A" tech at a local Honda dealership to see if he could unravel my problem. He invited me over to the dealership to show me their setup.

When I arrived at the shop and showed him the target I was using, he chuckled and said, "You're using that?" I compared the target he was using with my target, side by side and discovered that his target was about 42 percent larger than my target! The diameter of his target was 12 inches compared to the one I was using, which was 7 inches (**Figure 8**). If you look at the Honda set

up, you can see that they use three identical targets at the same time, and they are all preset on the frame, equidistant about 1200 millimeters from the center to center of each target (**Figure 9**). My frame was set up to place the targets 700 millimeters apart at a 42 percent reduction of spacing. My frame machine could only measure out to 800 millimeters max. I was very confused when he even told me that the distance from the target to the center of the left wheel was 6 meters (19 feet 8 inches) and not 3 meters (9 feet 10 inches). At this point, I was suddenly having a "Honey, I shrunk the frame" moment.

The frame I was using was reduced to accommodate mobile service, but I am guessing the company had to accommodate a fix to do this procedure on certain Hondas. When I started to reach out to the company, they were aware of the problem, but did not have a newer/larger target available yet. So, I needed to spring into action. I reached out to a Honda tool supplier and they had the target kit for a price of $350, but it would take a week to get. Well, guess what? I lost this job also because the wait time was too long for this shop, and they had to get the job out sooner. A lot of these shops are on cycle time and are pressed by the insurance companies to get the cars out ASAP, and I fully understand their position.

A shot at redemption

So, my part finally arrived, and I removed the mounting plate from the back of my original target. I glued it to the rear of the Honda target so that my frame could accommodate the mounting of this target and be ready for my third attempt (**Figure 10**). I was anxious for my next chance and sure enough, it came within a week. I followed all the Honda specs on this third vehicle, but wasn't able to lower my frame to 950 millimeters (because the frame was only able to reach a low point of 1007 millimeters), but I was hoping all my other measurements would meet the criteria to teach the camera statically. This would allow it to be trained properly and look down the road with no issues. The only drawback with my altered set up was having to set the frame up in three equidistant positions of 1200 millimeters (the frame arms were too short), but it was all I had to work with. I finally finished my static calibration, packed all my stuff away and went for a dynamic calibration down the highway. Then the most incredible thing happened!! The dynamic calibration was done in 10 minutes. I could not believe how fast the procedure went, once I did the correct factory static procedure.


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I can tell you that I lost many hours on these three Hondas (and lost my credibility with the first two shops), but in the end, I won the war. You fight these issues in small battles, keep moving forward and do not give up. You need to suffer losses in your business on that never-ending learning curve to be successful. You can also provide valuable input to companies that build factory (or aftermarket equipment) to let them be aware of glitches in their systems. It is up to us, as a working force, to help these companies by testing their products in the field. As I am writing this article the company whose frame I am using has already addressed the problem with a new target and new updated procedures. Many companies will go as far as to Beta test their equipment and software daily. That also becomes a valuable asset to our industry so we as technicians are not plagued by issues that make us scratch our heads and put us into denial mode. My only hope is that this article has enhanced what you know or did not know.

JOHN ANELLO owns Auto Tech on Wheels in northern New Jersey, which is a mobile diagnostic service for 1,700 shops, providing technical assistance and remote programming. He is also a nationally known trainer. *atowscopeit@aol.com*

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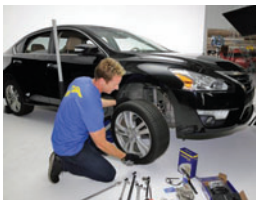

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AD INDEX

AD INDEX

TRAINING

OVERLOOKED CAUSES OF POOR A/C PERFORMANCE

WHAT DO YOU LOOK AT WHEN THE A/C SYSTEM YOU JUST REPAIRED IS COOLING — BUT JUST NOT COOLING AS WELL AS YOU KNOW IT SHOULD?

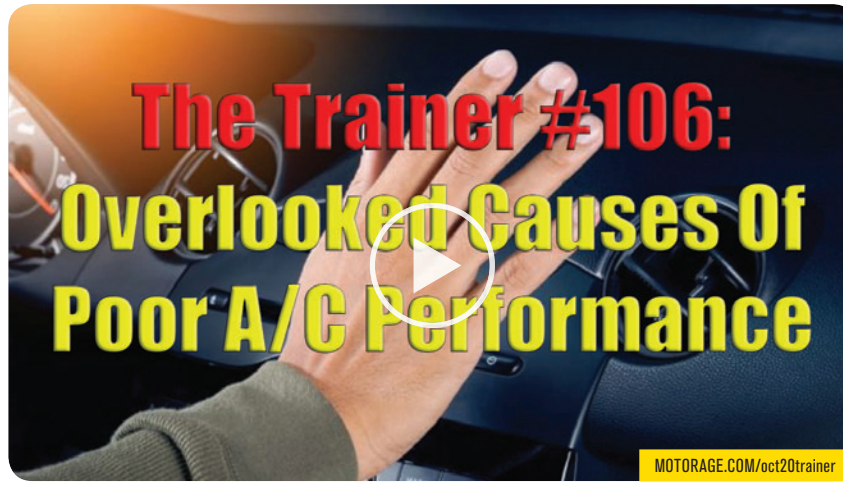
PETE MEIER // Director of Training

You found the leak; you made the repair and you recharged the system with the correct amount of refrigerant. You start the engine and turn the A/C on and while it is blowing cold, it just isn't as cold as you know it should be. What did you miss, if anything?

It's no secret that modern automotive air conditioning systems are more efficient than ever before. They are tasked with cooling cabin volumes that have changed very little, with only half of the refrigerant used in the past. With increased efficiency, comes less tolerance for errors. For example, a charge amount 10 percent lower than specified will impact cooling ability and may be the cause you're looking for. A charge amount in excess of 10 percent of specification can result in higher compressor head pressures and temperatures, shortening the life of the compressor.

And what about airflow through the system? With so many flow paths controlled by the HVAC or body control module, it's always possible that one door isn't in the position it should be. Or it may be something even more simple, like a heat exchanger that is clogged or, more likely, a cabin air filter that is clogged and restricting air to the entire system.

In this edition of the Trainer, we'll focus on the latter — flow through the A/C system — and how to test for restrictions using an inexpensive anemometer (a tool used to measure wind speed). We'll also talk a bit about the role the cabin air filter plays in the HVAC system and in your customer's overall comfort. Be sure to check it out and let us know what you think!



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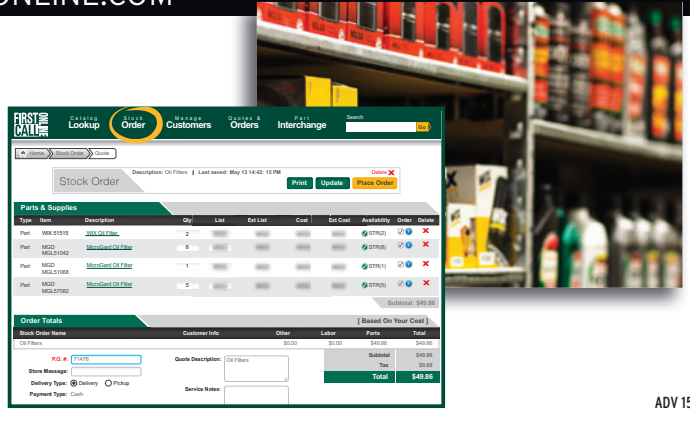

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