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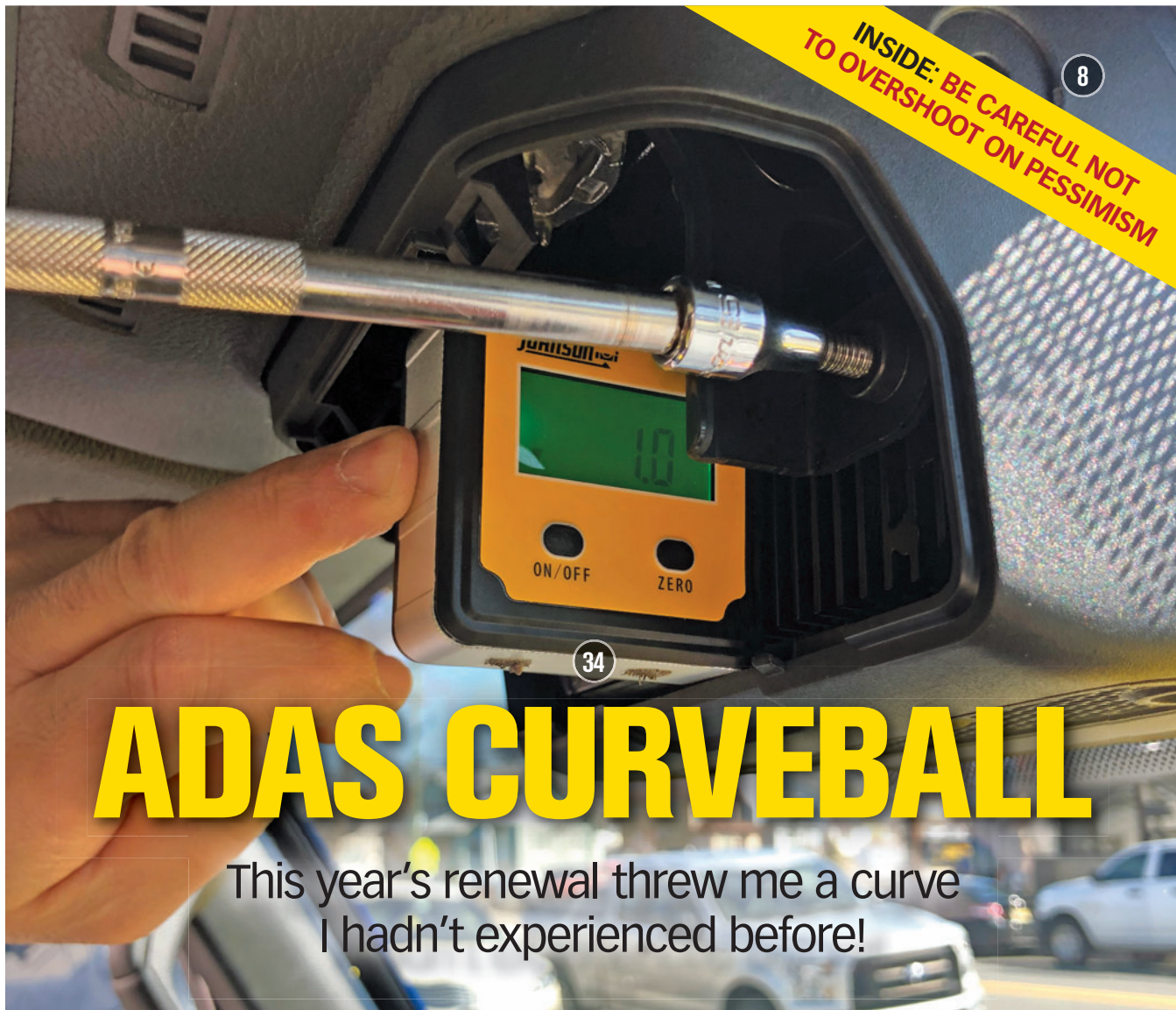
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ADAS CURVEBALL

This year's renewal threw me a curve I hadn't experienced before!

**12 PRACTICAL
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SERVICING HYBRID A/C — TIPS FOR THE NON-HYBRID TECHNICIAN

Most of the country is, or soon will be, in the middle of A/C service season. In this webinar, *Motor Age's* Pete Meier and G. Jerry Truglia will show you the fundamentals of hybrid technologies, including an overview of heat exchangers, as well as the particulars of safely and properly servicing hybrid air conditioning systems.

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WIPE AWAY ISSUES WITH WIPER SERVICE

MITCHELL 1 //

➔ It's likely that you're experiencing lower car counts like many shops around the country. But this is your chance to go above and beyond by wiping away customer complaints they literally see through their windshield.

Windshield wipers are a simple vehicle part to check and fix if necessary — even if your customers haven't cried the "Wiper Blade Blues."

Mitchell 1, known for its technical auto repair information through ProDemand[®] and SureTrack[®], has simple steps

any service advisor can suggest and any level technician can complete quickly and easily.

First, service advisors should explain a wiper's lifespan is really only one to two years on average. But if your shop is in a hotter climate or your customers regularly drive in wet, muddy or snowy conditions, that timeframe is much shorter.

For technicians, there are simple solutions they can do now. Start by cleaning the rubber blades with a glass cleaner such as Windex or isopropyl alcohol to remove any dirt, oil and road



grime. Contaminants like this are the main cause of the blades chattering, smearing and just not cleaning the windshield.

Take another step to clean the windshield with the same glass cleaner and check the washer fluid container for contaminants. That container is an often overlooked vehicle component that can cause more issues for a driver.

When the customer comes to pick up the vehicle, a service advisor can share the extra tip of how to make your own windshield washer fluid. Taking a few minutes to share the simple recipe that

can save them time if they run out is an easy way to show care and kindness toward drivers. The easy mix is about 85 percent water, 15 percent glass cleaner (e.g. Windex) and just a tablespoon of liquid dish washing soap.

If after these steps there still is chatter on a post-repair test drive or the customer still reports problems, it's time to replace the blades.

With this simple approach, everyone in the shop can help wipe away customers' complaints and boost your customer relationships as you work to regain car count. **TL**

TRENDING

LAWSON HELPING CUSTOMERS NAVIGATE CHALLENGES

President and CEO Michael DeCata speaks on the company's response to COVID-19, industry challenges and how they are helping their customers.

[MOTORAGE.COM/LAWSON](https://www.motorage.com/lawson)

ASE CANCELS CONFERENCE

The ASE Education Foundation cancelled its Instructor Training Conference, scheduled for July 14-17 in Frisco, Texas, which provided training for high school and college instructors.

[MOTORAGE.COM/FRISCO](https://www.motorage.com/frisco)

AASA: AAPEX IS A "GO"

AASA President Paul McCarthy held a media briefing last month that discussed the coronavirus pandemic and industry response, and reiterated that as of now, AAPEX 2020 in Las Vegas is a "go."

[MOTORAGE.COM/PAUL](https://www.motorage.com/paul)

AFTERMARKET OPPOSES CASH FOR CLUNKERS

Major automotive associations are united in opposing a new "Cash for Clunkers" type program from being included in the next COVID-19 stimulus legislation and sent a letter to Congressional leaders.

[MOTORAGE.COM/CLUNKER](https://www.motorage.com/clunker)

EXPERIAN DETAILS VEHICLES ON THE ROAD

To help aftermarket organizations better understand the current market, Experian took a closer look at vehicles on the road. Marty Miller shares insight on what shops can do to prepare.

[MOTORAGE.COM/MARTY](https://www.motorage.com/marty)

80% of the top-10 vehicle models sold in 2019 use R-1234yf

Getting started with R-1234yf service

What's required?

- › A new machine with R-1234yf high and low side couplers
- › A new leak detector for R-134a AND R-1234yf
- › A new oil injector with the R-1234yf coupler



AC1234-9



LD7



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Locating leaks

- › Tracer gas fills systems fast and is much cheaper than R-1234yf
- › SAE J2913 and J2791 certified leak detector
- › UV dye can be added to find long-term slow leaks



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Accessories

- › A new manifold set with R-1234yf couplers
- › A refrigerant analyzer for R-134a AND R-1234yf
- › Contaminated refrigerant recovery machine
- › Contaminated refrigerant tank
- › PAG and/or POE oil injectors



41234



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Time or money — what's more important now?

A four-day work week could benefit your shop and employees

In this article, Mike Haley will share his thoughts on how you can achieve a productive shop while offering your employees more free time. Four-day work weeks are being discussed in many companies, and the automotive repair industry is no different. Mike will share the benefits of offering a four-day work week along with the pitfalls. He will also give you his sample four-day work week schedule.

To say it is tough to attract a quality technician is an understatement to say the least. The pressure this puts on a shop is incredible. Almost everyone in the business has to change their regular job duties and take on a hybrid job. If the service manager or owner grew up a technician, they find themselves dusting off their box and turning wrenches just to keep the business going. This means other aspects of the business slip. The estimates are taking twice as long to build, and the selling effort is minimized to just sell what will fix the vehicle and get it out the door. After a few weeks or months of this, the morale and culture are at the lowest.

Because the manager and owner are pulling double duty they will say they don't have time to recruit and interview. We have written several articles prior to this one on how important it is to recruit 24/7 and that is not the point of this article. A shop needs to have an attractive package for the prospective employee. You will probably not be the shop that can pay the highest wage or offer 100 percent health care coverage. But what can you offer? I believe it comes down to two factors that attract potential candidates: It's time or money.

Time and money are what we hold in high regard. If you're under the belief your area will not tolerate a high labor rate, but can't open the payroll checkbook to pay a tech anything they are asking for, you need to offer something else that is just as important to our employees — and that is time.

At my last job as a service manager I took over a shop that was run into the ground. The best techs had already left because of their decrease in car count, and morale was at an all-time low. The shop was open five days a week, but the owner just announced to me, within two

minutes of me accepting the position, he wanted to expand to six days a week. I rubbed the skin off my temples, sat down and looked at the situation, and wondered what I could do to improve morale, get good technicians back and, more importantly, make employees happy to work Saturdays. I would say almost out of desperation I came up with the four-day work week schedule for this shop. I'm lying if I said I was 100 percent confident this was going to work and turn everything around. I actually thought this might be the shortest tenure at a shop in my career.

I broke down what a four-day a week schedule would do for the business. Remember my opportunities for improvement were:

1. Low morale
2. Best techs leaving
3. A six-day work week

I thought the four-day work week would immediately address low morale, but it didn't at first. Many of the technicians were concerned they could not turn the same amount of production in four 10-hour days compared to five 8-hour days. They grew up working five and a half or six days a week. That's the way it's always been, that's what everybody does, so that must be the only way. Since I was opening an extra day during the week the techs were concerned with how I was going to keep the bays full and who was going to get stuck with working every Saturday.

I sat down with every employee and went over my plan and how it was good for the customer, the employees and the business. I explained how the custom-



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ers are going to embrace the extended hours and the extra day giving them more options on dropping off and picking up their vehicles. It also gave them a weekend day to have work performed on their vehicle when they could most afford to allow us to work on their vehicle. With a rotating four-day work week technicians and writers are only working four days a week. With the extended hours and an extra day, the business was able to increase revenue and car count. I asked everyone to give it an honest 90 days and then let's reevaluate.

The transformation was one of the most amazing things I have experienced in my career. The customers immediately enjoyed the ability to have their vehicle serviced on Saturdays. I don't think it was the first or second week, but it did not take long for the employees to start liking the four days a week.

Something else that stopped was the request for time off for dentist appointments or follow-up doctor visits. Once the employees had their four-day schedule they were able to schedule those events on the weekdays they were scheduled off. It was a beautiful perk I didn't realize when I created the schedule. Our sales jumped immediately with the additional hours and day — we were always saying "yes" and never saying "no" or "let me check." Needless to say, after the 90 days almost unanimously everybody had bought in.

Now, it was not all sunshine and rainbows. We had growing pains with vehicles not being completed and a technician starting his three days off. With some careful planning and good communication, it typically was not any worse than a Friday job not being completed. I hope my experience has at least got you to think about changing the way you currently run your

business and there are win/win ways to help the customer, employee and the bottom line. To get help with implementing a four-day work schedule at your shop, get ATI's Four-Day Work Week Schedule. Simply go to www.ationlinetraining.com/2020-06 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 Team Leader Mike Haley. chubby@autotraining.net

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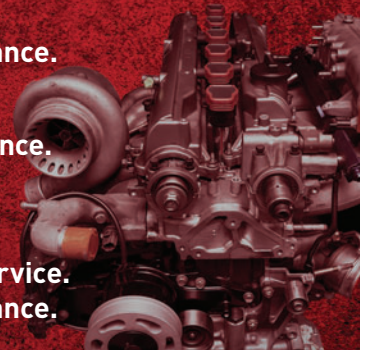


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Be careful not to overshoot on pessimism

There are opportunities in a declining economy if you look for them

There is no doubt that the COVID-19 virus is putting a huge toll on the economy AND with people's attitudes and their mindset.

It is time to slow down and understand that the opportunities that come in a declining economy can be just as exciting as opportunities that show up in a growing economy. It depends, though, on your management approach to new realities.

The average consumer is experiencing things they have never have in their life up to this point. This situation is stressful for them and you; however, the governments in North America have stepped in and made various guarantees to ensure businesses and the consumer can get through these unusual times. This keeps credit flowing within the overall economy; however, the aftermarket does have a problem with the credit issue.

The people with the greatest worries from a general consumer perspective are ones who are looking for financial retirement stability from their investments within the next 3 to 5 years. They usually have safe interest-bearing investments, and as interest rates decline so does their potential income. If they have stock market investments that they must rely on, then their income is going to be dramatically affected and the declining dollar will affect their "ability to travel" status as well after the main virus issue has been dealt with and allowed the economy to return to some level of normalcy.

These situations do create opportunities for the aftermarket, especially in relationship development with the consumer and commercial accounts. Review how you develop relationships

within your business. Do you take the time to listen to their complete story and then educate the client as to how you can adapt your business to ensure they are looked after? Are you educating the client on safety and reliability of their vehicle based on how they use the vehicle and their expectations with it? How are you showing the client that you care about their concerns? You are in the relationship business, and today that is the most important point about growing your business because as relationships get strong, trust is built.

YOU ARE IN THE RELATIONSHIP BUSINESS AND TODAY THAT IS IMPORTANT BECAUSE AS RELATIONSHIPS GET STRONG, TRUST IS BUILT.

The credit issue will affect the independent shop of the aftermarket. Banks have a lot of concern with the automotive industry in general. This can be a very real concern for a shop owner who is not managing their business properly. Balance sheet management must become the highest priority. The question every shop owner must ask themselves is "What steps must I immediately take to strengthen my balance sheet to meet or exceed key banking ratios and guidelines?" When was the last time you took each account that is on your receivables and did a true net profit analysis in terms of what that account is contributing to the businesses bottom line? Just measuring the average sale per RO and gross profit contribution of the account is not good enough anymore. If the

account does not create net profit, why are you dealing with them? This is a huge move in the "new norm" because the business can only survive when consistent net profit is being created. Do the math and calculate your true cost per billed hour so you can calculate the accounts contribution. Do you need to fire this account in order not to jeopardize the business?

Management must control the strengthening of the business to ensure its stability and security. Credit arrangements with the bank must be secure as well in order to run the business. However, it is good advice to not rely on increased credit from any institution over and above what the business currently has. The key over the next 12 months should be to reduce debt loads to the lowest achievable amount possible. Low debt or, better yet, no debt goes a long way in creating business and employee security in tough economic times.

These steps will allow the business to get through any turmoil, but the weight is on management's shoulders. Pay attention to the opportunities in front of you one day at a time and one week at a time and then your business will move forward very nicely with the current turmoil in the economy. *ZZ*



BOB GREENWOOD, AMAM, is president and CEO of Automotive Aftermarket E-Learning Centre Ltd. (AAEC), which provides business

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Cash for Clunkers is still a bad idea for the industry

The aftermarket must engage early to stop it

The automotive aftermarket has struggled for a number of years with government-sponsored vehicle retirement programs commonly known as Cash for Clunkers. These programs offer cash to consumers to trade in old vehicles for more fuel-efficient ones. A few states have long-established programs including California, Colorado, Delaware, Illinois, Texas and Virginia. Countries such as Canada and Germany have also had programs. The aftermarket has opposed these state programs with limited success. The state programs pale in comparison to what was established by the federal government during the 2008 recession: a program that provided up to \$4,500 per vehicle destroyed. In President Obama's words in July 2009, "the CARS (Consumer Assistance to Recycle and Save) program was an effort to boost the economy and sell more fuel-efficient vehicles." U.S. Secretary of Transportation Ray LaHood stated in the summer of 2009 that the CARS program was a "win-win for our economy and our environment."

The CARS program was signed into law on June 24, 2009, and the National Highway Traffic Safety Administration (NHTSA) established an eligibility period of July 1, 2009 through Nov. 1, 2009. The program proved popular enough that Congress appropriated an additional \$2 billion for it in August 2009. This program took approximately 700,000 post-warranty vehicles out of independent repair shop bays and destroyed them, which harmed not only independent repair shops, but also distributors and aftermarket manufacturers. In many cases, the program harmed some consumers who took the money but were pressed to be able to purchase a new, expensive, environmentally friendly vehicle.

Who were the winners? New car dealers and vehicle manufacturers. According to the Brookings Institution research study, "Cash for Clunkers: An Evaluation of the Car Allowance Rebate System," some OEMs saw large stock spikes during the Clunker program with significant decreases once the program ended.



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The Automotive Service Association heard from independent repairers across the U.S. that they were seeing losses in their customer base during the program.

To date, at least two OEMs have called for Congress to bring back Cash for Clunkers as a response to lagging vehicle sales due to the COVID-19 pandemic. Although this would clearly benefit OEMs and new car dealers, what about aftermarket stakeholders? The U.S. Government Accountability Office (GAO) noted the importance of including other stakeholders prior to any re-establishment of a Clunker program: "Given the number of stakeholders that are financially affected by the auto industry, it would be important to collect and consider information on how a future program would affect these stakeholders and take mitigating actions."

Unfortunately, even in its own review of the 2009 Clunker program, GAO did not include the aftermarket as part of its analysis.

Recently the automotive aftermarket, Auto Care Association, Automotive Oil Change Association, ASA, Service Station Dealers of America and Allied Trades, and the Tire Industry

Association joined in a letter to Capitol Hill opposing Cash for Clunkers as part of the COVID-19 stimulus response. "We urge you to OPPOSE any new Cash for Clunkers vehicle retirement program in the next COVID-19 stimulus package. COVID-19 has had a devastating effect on small businesses. As an important sector of the U.S. economy, we cannot survive any further negative effects."

Both the U.S. House of Representatives and Senate are now considering a fourth COVID-19 stimulus package. It is critical that Congress consider the impact of a Cash for Clunkers-type program on all automotive industry stakeholders and not just one segment of the industry. **ZZ**

ROBERT REDDING is the Automotive Service Association's Washington, D.C. representative. He has served as a member of several federal and state advisory committees involved in the automotive industry. rredding@reddingfirm.com

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- Auto Detect VIN
- ADAS Calibration
- WiFi Software Update
- Multi Special Functions
- VW & AUDI Guided Functions
- ECU Coding & Reprogramming

- Full Function
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- WiFi Software Update
- Multi Special Functions
- VW & AUDI Guided Functions
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PRACTICAL PRESSURE TRANSDUCER DIAGNOSTICS

IF YOU WANT TO IMPROVE YOUR DIAGNOSTIC ABILITY, TAKE A LESSON FROM SHERLOCK HOLMES!

BERNIE THOMPSON // Contributing Editor

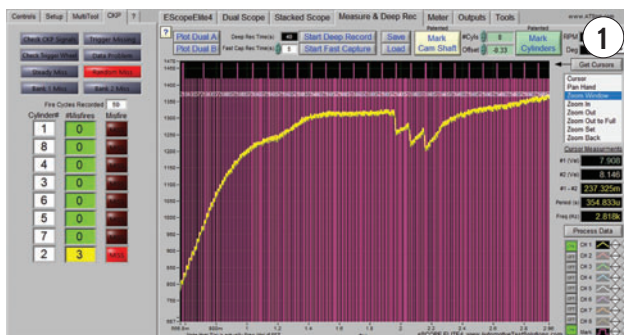
Perhaps one of the world's greatest known detectives is Sherlock Holmes. Sherlock is known for his proficiency with observation, deduction, cutting-edge equipment and logical reasoning that borders on the fantastic. These are all attributes that one needs on a daily basis when diagnosing the modern vehicle. When Sherlock takes on an investigation, he immerses himself in the available data that is present. This is what you must do when looking into your new investigation, for each and every vehicle diagnosis you take on is an investigation that will require your proficiency with observation, deduction, cutting-edge equipment and logical reasoning.

The game is afoot!

Our first investigation is a 2011 Jeep Cherokee Overland with a 5.7 Liter V8 engine that has a misfire. This misfire is elusive and only presents itself once the vehicle has reached operating temperature. Additionally, the misfire is intermittent and will only occur on heavy acceleration, such as that from a stop. The first observation is the vehicle is in good condition and has been maintained. The engine components are all intact and appear to be in good condition. The engine sounds normal without any unusual noise. Our first clue is provided from scan data. The data from the onboard engine control module has DTCs set for misfire; P0300 random misfire, P0302 misfire on cylinder 2, P0305 misfire on cylinder 5. There is no direct connection between cylinders 2 and 5, firing order 1-8-4-3-6-5-7-2. The cylinder arrangement is Bank (1) 1-3-5-7 – Bank (2) 2-4-6-8. These cylinders are not next to one another, nor do they proceed one another in the firing sequence, nor are they on the same crank plane.

The scan data also provides additional data on the fuel control for the engine. Upon monitoring the oxygen sensors for bank 1 and bank 2, they indicate that the fuel control is working correctly. The total fuel trims for both banks are less than +/- 10 across all load ranges. This indicates that the fuel control system is working within a control window that should not be contributing to that of an engine misfire.

Now we need a better understanding of which cylinder



or cylinders are actually misfiring. A wiring diagram for the vehicle is analyzed. An oscilloscope is then connected to the crankshaft position sensor signal and the #1 ignition coil control wire. The vehicle is then driven until the misfire is present. The data is then processed with an advanced frequency plot so the crankshaft velocity changes can be analyzed. The only cylinder presently misfiring is that of cylinder number 2, as can be seen in **Figure 1**.

Figure 1 indicates the crankshaft speed changes. If the fuel stock is combusted, the thermal energy expands, accelerating the crankshaft. If the fuel stock does not combust, then this thermal expansion does not occur, so the crankshaft speed slows down. These crankshaft slowdowns can be seen as the three drops at the top middle of the screen. Since the control for the #1 ignition coil is also monitored, a firing sequence can be established. Thus cylinder 2 can be identified for the misfire.

Cylinder identified — on to the culprit

Now that the misfiring cylinder is known, the oscilloscope is moved to the #2 ignition coil control. The vehicle is then driven until the misfire occurs. The ignition waveform is then analyzed. The waveform does not show that an ignition spark event was responsible for the misfire. The spark plug is then removed and a 300 PSI pressure transducer is installed in its place. Without a spark event present within the cylinder the cylinder will misfire. This is acceptable because the pressure changes within the cylinder can help identify the cause of the misfire. Additionally, a -30 Hg transducer is installed in the induction system behind the throttle plate. This allows the intake pressure pulls

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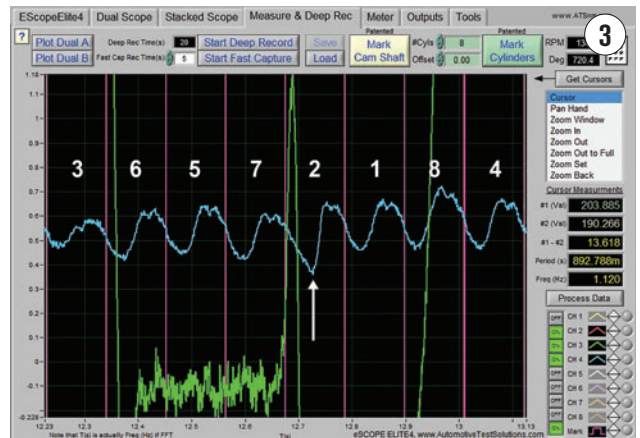
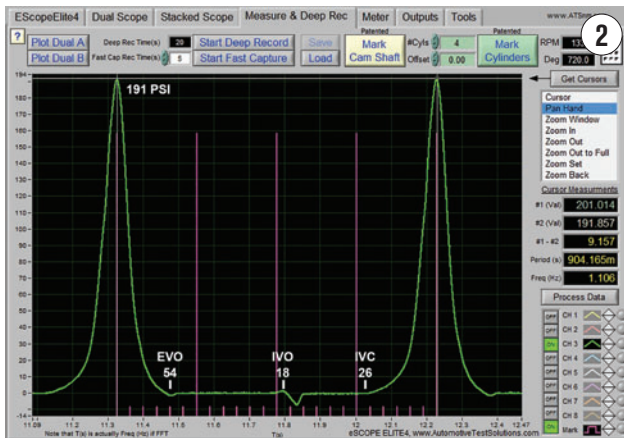
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for each cylinder to be monitored. A +/- 25" H₂O transducer is also placed in the exhaust system at the tailpipe outlet. This will allow each cylinder's exhaust pushes to be monitored.

It is important to run the in-cylinder testing during crank, idle and snap/decel, with all three transducers on the engine. The following data does not show each test, but each test was completed on each investigation. The results are shown based on which test was used to identify the problem.

The engine was disabled so it would not start, then the engine was cranked for a long period — about 8 seconds. Make sure to not open the throttle plate during this crank period. If the throttle plate is opened there will be less vacuum produced from each cylinder pull in the induction system, thus making the diagnoses harder. This in-cylinder cranking pressure waveform (green trace) was then taken and is shown in **Figure 2**. The peak pressure is 191 PSI at TDC. The compression towers are not leaning but are even. The exhaust valve opening occurred at 54° BBDC. The intake valve opening occurred at 18° ATDC. The intake valve closing occurred at 26° ABDC. Additionally, there is an induction pressure drop present at 45° ATDC.

The first indication that a problem exists is with the valve opening and closing. The exhaust valve opening is normal; rule of thumb is the exhaust valve

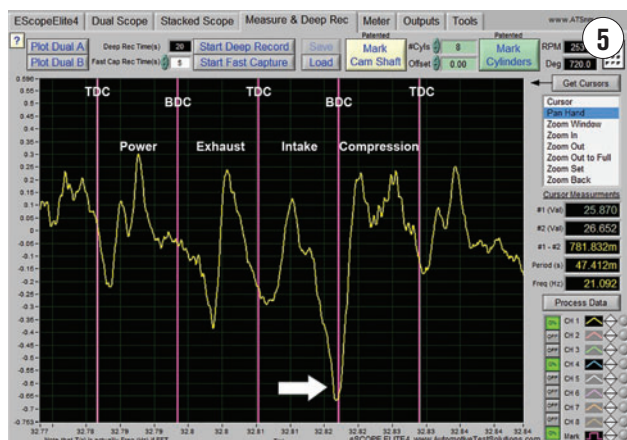
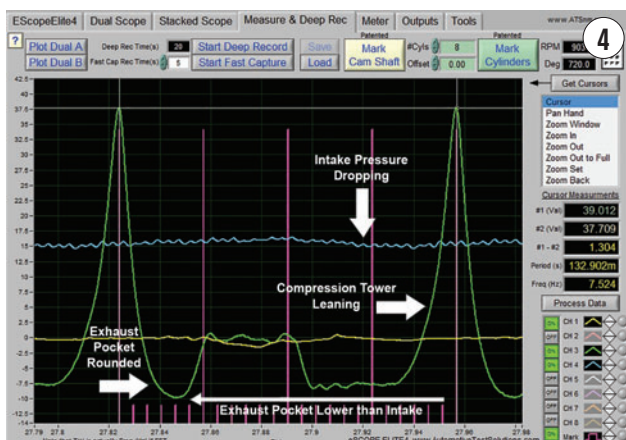
should open from 30° to 60° BBDC. However, the intake valve should open as a rule of thumb at about TDC, and rule of thumb is the intake valve should close 30° to 60° ABDC. The late intake valve opening at 18° ATDC, and the early intake valve closing at 26° ABDC indicates a problem. The pressure drop occurring at 45° ATDC is due to the piston moving down, creating a negative pressure within the cylinder. This negative pressure is established due to the cylinder still being sealed. Once the intake valve opens the pressure within the cylinder quickly rises as volume is moved from the induction system into the cylinder.

This can be seen in **Figure 3** within the intake pulls (blue trace). This is the same data as is **Figure 2** but the intake pulls are now turned on, and the data has been zoomed. Note the pull for cylinder 2 is different from the other intake pulls. When you inspect these pulls across the center (up to down) the pulls should be even across the middle of each pull. Additionally, each intake pull should be formed like the other pulls. It can clearly be seen this is not the case with the cylinder 2 pull. First the transition point (marked with an arrow) from where cylinder 7 is ending its pull and cylinder 2 is starting its pull, falls to a point of less negative pressure (vacuum) than the other transition points. Since cylinder 2 intake valve is not open, the intake pressure

drops. Note that the transition point is very sharp. This occurs from the valve not opening slowly as it is designed to do but opening rapidly. The quick rise in negative pressure is due to the high vacuum that was contained within the cylinder from the late intake valve opening. With high negative pressure within the cylinder when the valve does finally open, there is a greater force between the intake pressure and that of the cylinder pressure. Therefore, a fast rise in negative pressure occurs within the intake pressure. This indicates that the intake valve opening mechanism is loose or worn. In this case the intake camshaft lobe and lifter roller are worn.

Next case!

Our next investigation is a 2001 Ford Ranger with a 3.0 Liter V6 engine; this vehicle has a misfire. This misfire is elusive and is only present after running the engine hard with the engine at operating temperature. The first observation is that the vehicle is in fair condition and is in need of maintenance. The engine components are all intact and appear to be in fair condition. The engine sounds normal without any unusual noise. Our first clue is provided from scan data. The data from the on-board engine control module has DTCs set for misfire; P0302 misfire on cylinder 2. This 3.0 Liters firing order is 1-4-2-5-3-6. The cylinder arrangement is Bank (1) 1-2-3 Bank (2) 4-5-6. Mode 6 also has data indicating



that cylinder 2 is the misfire.

The scan data also provides additional data on the fuel control for the engine. Upon monitoring the oxygen sensors for bank 1 and bank 2, they indicate that the fuel control is working correctly. The total fuel trims for both banks are less than +/- 10 across all load ranges. This indicates that the fuel control system is working within a control window that should not be contributing to that of an engine misfire.

An oscilloscope is then connected to all of the ignition coil control wires and the engine is run hard on the test drive until the misfire occurs. The ignition data shows turbulence on cylinder #2. The #2 cylinder's sparkplug is then quickly removed and replaced with a 300 PSI pressure transducer. Additionally, a -30 Hg transducer is installed in the induction system behind the throttle plate. This will allow the intake pressure pulls for each cylinder to be monitored. A +/-25" H2O transducer is also placed in the exhaust system at the tailpipe outlet. This will allow each cylinder's exhaust pushes to be monitored.

The engine is started and allowed to idle. The pressure waveform is shown in green, **Figure 4**. The peak pressure is 38 PSI and the compression towers are leaning, which indicates the problem is mechanical. The exhaust valve opens at 52° BBDC, the intake valve opens at 6° BTDC, and closes at 52° ABDC. Note that

the exhaust pocket is lacking definition and it appears very rounded. This indicates that the exhaust valve is not seating properly. Furthermore, the exhaust pocket is lower than the intake pocket. This indicates that the cylinder lost volume during the compression stroke.

Elementary, my dear Watson

When the intake valve is open and the piston is moving downward increasing the volume within the cylinder, a negative pressure is produced. When the intake valve seats, this negative pressure is sealed within the cylinder. Under the compression stroke, if anything is leaking, the volume contained within the cylinder will be reduced thus lowering the exhaust pressure. When the piston returns to the same position it was in when the intake valve closed, if there is no leak, the volume will return to the same volume contained within the cylinder when the intake valve closed so the same pressure will be present. In some cases, it may be slightly higher (within 2 PSI). This difference is due to the intake valve closing and the exhaust valve opening occurring at different crankshaft degrees. If there is a leak, the volume will be less, thus the pressure in the exhaust pocket will be less — lower than the intake pressure. This always indicates a volume loss within the cylinder.

The intake pressure (blue trace) can

be observed to be dropping pressure during the intake valve opening. So, this clue is that the intake valve is not the leak. This is due to the intake valve being off of its seat during this pressure drop. This would indicate that the leak is the exhaust valve or the piston rings.

The throttle is then snapped open and closed. This will allow the engine to go into decel. During the snap throttle event the RPM increases so that when the throttle is closed the engine RPM is about 3000. This increases the negative pressure (vacuum) within the intake system and the cylinder. With this greater pressure differential leakage can be located. For example, in **Figure 5** the exhaust waveform has been zoomed in on, the exhaust indicates a high negative pressure during the intake stroke on cylinder 2. This indicates that the exhaust valve is not seating. With this high negative pressure within the cylinder there is a greater pressure differential between the cylinder and exhaust system. When the exhaust valve is not seating, the negative pressure being lower than that of the exhaust pressure pulls the exhaust into a lower pressure state. This indicates that the exhaust valve is leaking. This vehicle had the exhaust seat beat into the head. When the valve seat moves into the head the valve moves as well. Eventually the hydraulic lifter runs out of adjustment. When the valve



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gets hot it expands, which, in turn, causes the valve stem to increase in length. The lifter can no longer properly adjust the valve lash so the valve does not seat properly.

When you have eliminated the impossible...

Our next investigation is a 2015 Mercedes Benz C300 with a 2.0 Liter inline 4-cylinder engine; this vehicle has a misfire. This misfire is elusive and is only present upon first start with the engine temperature cold. The first observation is the vehicle is in good condition and has been maintained. The engine components are all intact and appear to be in good condition. The engine sounds normal without any unusual noise. Our first clue is provided from scan data. The data from the on-board engine control module has DTCs set for misfire; P0300 random misfire. This 2.0 Liter firing order is 1-3-4-2. The cylinder arrangement is Bank (1) 1-3-4-2.

The scan data also provides additional data on the fuel control for the engine. Upon monitoring the Wide Range Air Fuel (WRAF) sensor for bank 1, it indicates that the fuel control is working correctly. The total fuel trim for bank 1 is less than +/- 10 across all load ranges. This indicates that the fuel control system is working within a control window that should not be contributing to that of an engine misfire.

Now we need a better understanding of which cylinder or cylinders are actually misfiring. A wiring diagram for the vehicle is analyzed. An oscilloscope is then connected to the crankshaft position sensor signal and the #1 ignition coil control wire. The vehicle is then started cold. The data is then processed with an advanced frequency plot so the crankshaft velocity changes can be analyzed. The only cylinder presently misfiring is that of cylinder number 1.

Now that the misfiring cylinder is known, the oscilloscope is moved to

the #1 ignition coil. The vehicle is started cold and while misfiring the ignition is monitored. The ignition waveform is then analyzed. The waveform shows turbulent air but the ignition spark event is not responsible for the misfire. The spark plug is then removed and a 300 PSI pressure transducer is installed in its place. Additionally, a -30 Hg transducer is installed in the induction system behind the throttle plate. This will allow the intake pressure pulls for each cylinder to be monitored. A +/-25" H₂O transducer is also placed in the exhaust system at the tailpipe outlet. This will allow each cylinder's exhaust pushes to be monitored.

Whatever remains, however improbable...

The engine is then started cold and the pressure data from the engine is analyzed. The first indication that a leak is present is the exhaust pocket is lower than the intake pocket. This is always a loss of volume during the compression stroke. The exhaust valve is opening at 36° BBDC, the intake valve is opening at 5° ATDC, and closing at 40° ABDC. Thus, the valve timing is good. The next clue is that the exhaust pockets are all clean and all look like clones of each other. When a valve leak occurs the exhaust pockets usually have cyclic changes. These will be warping on the falling and rising edges and flat bottoms on the exhaust pocket itself.

Since these exhaust pockets have no changes within them, it is likely that the piston and or piston rings are where the leakage is occurring. The tailpipe sensor that reads +/- 25" H₂O is put on the dipstick of the engine using a spark-plug boot. Note before this dipstick can be used you must lightly blow into it to make sure that the tube is not under the oil level. If the tube is under the oil level, you must use another location. The engine is disabled so it cannot start

and then the engine is cranked for an extended period.

The green trace is that from the in-cylinder pressure. The peak pressure is low at 66 PSI and the compression towers are leaning, indicating a mechanical problem. When measuring the difference between the intake pull and the exhaust pocket bottom, the exhaust pocket is large at 8 PSI. If the exhaust pocket is greater than 3 PSI during crank a leak is most likely present. The yellow trace is the crankcase pressure; note that the crankcase pressure increased after the compression of cylinder #1. Since the crankcase has a large volume contained within it, it will take the volume moving past the rings a period of time to actually change the crankcase pressure. Also, the crankcase pressure hump for #1 cylinder is much wider as well. This indicates that the piston and or rings are leaking. A borescope was used to inspect the #1 cylinder. It was observed that there was scarring on the cylinder wall caused from overheating of the engine.

Must be the truth!

It will be important to always test the engine under the conditions that the problem is occurring under. For instance, if the cylinder on this MB would have been tested on a warm or hot engine the problem would not be present. It will be important during your investigation to keep proficient with observation, deduction, cutting edge equipment, and logical reasoning. By using this format you can become the sleuth of your shop. **TT**



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MY TEACHING AND LEARNING ADVENTURES OVER THE PAST 40 YEARS

RICHARD MCCUISTIAN //
Contributing Editor

I guess one of the more difficult things about teaching a variety of incoming students is the challenge of adjusting lessons and tasks so that they fill in the gaps for inexperienced incoming trainees, but also ensuring the more experienced ones don't get bored with the basic tasks. A hands-on pretest can help with this, if done right.

Tool recognition and proper use is a great beginning exercise, along with teaching the newbies how to recognize bolt head and shank sizes head markings and thread pitch. I don't know how many times I've seen a gray-haired mechanic take a bolt to the parts counter and say "give me one like this" because he couldn't recognize bolt sizes and thread pitch by just looking at them. Metric sizes are a bit easier to learn than the Imperial graduations; it's downright embarrassing to ask somebody to hand you a 7/16 wrench and see them pick up a 3/4 to check the size stamp. In the offshore services industry, I have known of engineers doing that. And using a 12-point socket on just about any really tight fastener is a recipe for disaster.

Then there's the useful knowledge of making inertia work in our favor. I've seen muscled-up teenage football players bow up on a wrench with the veins bulging in their neck and then showed them how an old man with less muscle but more smarts can get more done by just whacking the opposite end of the wrench with the heel of your hand or holding the head of the ratchet with one hand and jerking on the handle to break the same bolt loose. Sometimes



THIS EXERCISE WAS ONE OF MY EARLIER ONES, structured to strengthen a trainee's ability to recognize wrench and bolt sizes – we all need to cultivate that skill!

(as with brake caliper bolts), the lefty loosy, righty tighty rule can be confusing to a newbie — I always told my people to think of the way you want the bolt to go and then screw it in that direction. If it's right hand thread, away from you is clockwise, etc. Some will try to turn the bolt the wrong way until they break it off, even if they're looking right at the bolt head.

Just knowing which tools to use is important, but so is gumption and staying power. In my Fundamentals class, I tested trainees' grit by having them cut a 1-3/8-inch-thick piece of mild steel stock with a hacksaw starting with a new blade on the saw and not stopping until they were done. This was an optional task, but in some of my groups, the girls would be the ones most likely to complete it, just to prove they could. For the boys it always helped to use a stopwatch and make it a competition. Some of the lazy ones would shy away from it entirely.

It also takes grit and what I like to call MacGyverism to deal with some of the stuff we run into on older vehicles. The most common situation is when a

Fundamentals Bolt Sizing Worksheet

Name: _____

Bolt Number	Guess the Wrench Size	Measure the Thread Pitch & Bolt Size	ACTUAL Wrench Size
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Standard Metric

Score: _____



THIS IS AN OLD SUSPENSION PART I saved for the hacksaw exercise – when the student was done sawing off a thin wafer of this I'd polish it and give it to them for a souvenir, sometimes with their initials stamped on it.

fastener is so tight or rusty that it wants to round off or break off. Valve grinding compound on the wrench or socket usually helps with the rounding off if you catch it early, but I have had students keep on rounding the head with a power tool until driving a smaller socket onto the bolt head or using an

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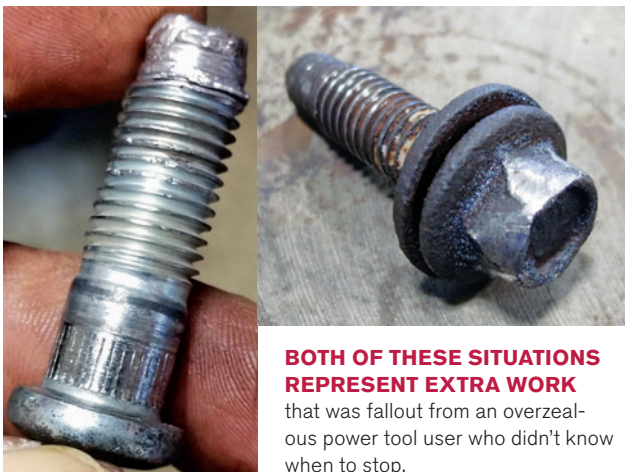
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BOTH OF THESE SITUATIONS REPRESENT EXTRA WORK

that was fallout from an overzealous power tool user who didn't know when to stop.



THE JOY OF TEACHING IS IN WATCHING young people grow not only in their technical skills but their "adulting" skills as well.

acetylene torch (if space permits) is the only solution that might work. There are also those times when a very important bolt in a difficult place will twist off, and then the best solution for that problem must be determined and applied. Crafting fixes for these potential disasters sharpens our skills, and trainees learn from watching us.

Routine operations

Even after a trainee develops tool skills and becomes proficient in mike, caliper and DVOM reading, and when they've honed their problem-solving skills and developed an understanding of basic physics and natural law, they must be encouraged to maintain top quality work on routine operations — any competent technician should be able to do regular maintenance tasks without making a mess of things. Three or four times in my teaching career I have shouted "STOP!" to students who were about to start vehicles after forgetting to add oil to the crankcase. And it goes without saying that newbies need to be warned repeatedly about oil filter gaskets that stick.

Further, every technician needs to be able to properly change a set of rear brake shoes without making a mess of it. Radiator hose clamps need to be tight enough not to leak. They need to know that you don't torque six millimeter bolts

with a half-inch drive ratchet. Connectors need to be handled carefully so as not to damage the pins and sockets (four simple disconnect/reconnects can compromise some of the newer connectors). Hose quick-connects need to be seated properly. All the hoses and wires need to be disconnected before you drop the fuel tank. Harnesses need to be secured where they won't contact sharp edges, belts and pulleys, or hot exhaust parts. Bulkhead grommets must be perfectly in place or there will be a floorboard full of water after the next rain. These cautions are learned from comebacks that will blind-side a new guy who hasn't learned to pay attention to detail.

I've seen people do every job right for weeks, months or years, and then make some of the most boneheaded mistakes imaginable, like putting brake pads in backwards after having done lots of good brake jobs or forgetting to look at the old oil filter they screwed off to make sure the gasket came off with it. One guy in co-op training did dozens of oil changes flawlessly at the dealership and then double-gasketed an oil filter during an oil change right there in one of my department service bays.

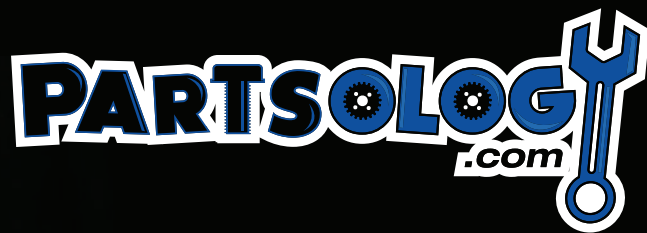
Old school troubleshooting

Certainly, one of the more obviously important skills is the ability to deter-

mine what's wrong before repairs are attempted. Working at a VW/Mazda dealer in 1983, I test drove a GLC while the customer (a military flight student from Saudi Arabia) rode with me, and the first time I accelerated during the test drive, I felt the car lose power during its upcurve and without thinking I verbally condemned the fuel filter as soon as I felt it. That was one of the first things I had learned working with Dad at his shop. The customer was impressed and said so.

When I was at the Ford dealer, I had a teenage helper who was carefully watching while I troubleshot about 10 or 12 vehicles a day with drivability concerns, and he was totally mystified by the whole process. One day we drew a work order on an 80s Tempo, and I knew there was a recall on the Tempo Engine Controller that year. To determine if the processor needed replacing, you'd simply reach under the dash and feel to see if the Controller had cooling fins. If it did, the controller would need replacing. When my helper saw me reach under the dash, feel the brain box, and pronounce that the vehicle needed an engine controller, he threw up his hands in exasperation.

"Oh, now he FEELS the processor and says it needs replacing? How can I EVER learn to do this?" After a hearty laugh, I explained my reasoning.



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At that dealer, the service manager and shop foreman tended to send me trainees and helpers who knew absolutely nothing about any part of a vehicle beyond driving one. Their idea was that these inexperienced guys would learn everything they needed to know by watching and helping me, which was kind of dumb, since I was the shop's primary drivability and electronics guy at that point in my career. This error in judgment by the management happened repeatedly, and while I taught these guys what I could, most of them washed out because they had no foundational knowledge to build on. Some of them couldn't even replace a serpentine belt, and with all the real work I had to do, I didn't have time to provide the basic training they should have had before they came.

Among all these, there were two trainees who survived that upside-down training process. Guy Number One never learned to troubleshoot anything no matter how hard us older guys tried to teach him, and he didn't have the foundational knowledge to even replace a set of brake shoes on his own vehicle, but he was good at selling injector flushes and intake cleaning jobs and turned a lot of labor hours that way. If somebody told him what part to change, he could usually do that quickly, but he couldn't fix a ham sandwich when it came to troubleshooting even the simplest concerns. He was always in a big hurry, shortcutting everything across the board to try and turn lots of hours. One day he checked all the boxes on the 29-point inspection sheet, and when somebody opened the hood for a jump start before the car left the service lot, there was a big squirrel nest on the battery. Can anybody say "Busted?"

Guy Number Two who survived the training was Memory-Dependent Mark, because he brought foundational knowledge with him when he came to

me; he had done a lot of tinkering on his own hot rods and whatnot at home and was pretty sharp. But Mark's Achilles heel turned out to be that he relied too much on his memory rather than developing his troubleshooting skills. He could recall every symptom-related repair he had ever done and why, but if he was presented with a problem he hadn't seen before, he struggled dreadfully, and tended to use the parts shotgun rather than surgically troubleshooting vehicles that had unfamiliar concerns. That being said, a guy who can remember most all his previous troubleshooting experiences AND troubleshoot on the fly is gold if he can get enough work done to make his service bay profitable.

Honing the understanding

One day, memory-dependent Mark got smacked around by an issue on a Bronco II that had previously befuddled me on an old distributor ignition Mercury Tracer. On that one, you could snap accelerate the engine and it would always fall on its face, even in the service bay. If, however, you blocked some of the air supply into the inlet hose with your hand, the engine would accelerate normally. Logic seemed to dictate that this was a fuel problem, but once I eliminated a fuel concern, I discovered by using a timing light on a plug wire that the spark was going dark at the plugs when I snapped the throttle, and that's when I did exploratory surgery and found that somebody had replaced the original ignition rotor with an oddly cheap two-piece phenolic aftermarket unit that had burned through. Unlike the old Chevy HEI system, this one would start and run but when the engine was loaded suddenly, the spike in cylinder pressure caused by the incoming air would shift the path of least spark resistance so that it punched through the burned-out rotor instead of making its way to the plugs. That one was tricky, and I hadn't seen it before, but I remember it to this day.



I HAVE WATCHED MORE THAN A FEW NEW TRAINEES take lug nuts off and then screw them back on there like this, and I absolutely do not understand why they didn't notice how the nuts were installed while removing them.



THERE ARE SIMPLE THINGS WE ALL NEED TO NOTICE when we're doing routine maintenance, but sometimes these service-necessary things and others can be missed even when trainees are taught to catch them.

When Mark encountered the same concern on an 88 Bronco II, he cleaned the injectors and did various other fuel system repairs, all the while repeatedly ignoring my advice that he check the rotor. When he finally did check the rotor, he found it burned through. I'm sure he never forgot that. But in a word, when it comes to troubleshooting, there's no teacher like experience,

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and applying experience requires good memory skills.

Two good fights in 1989

In 1989, after we had bought the Renault/Jeep/Eagle franchise, the Eagle Summit was a brand-new platform (still OBD1), and I drew a work order on a low-mileage unit that was exhibiting strange tachometer fluctuations at highway cruise but had no other symptoms. Not sure what else to do, I cleaned the injectors and the problem went away, only the problem had returned within a week, and this time it had a mild surge I could feel. Coming out of a decade that had been rife with EGR surges, I found this one to be very interesting.

Since cleaning the original nozzles had helped, I replaced the injectors on that Summit with a new set from a new vehicle on our lot and the problem went away again, only to return a week later. What the..? I finally noticed that the Summit was only surging when the torque converter lockup was engaged, and I found out (using a dwell meter of all things) that the torque converter on this car was being modulated, not locked at road speed. I had not seen this before, and as I watched the dwell meter needle, this surge was happening when the converter was at about 50 percent engaged. I called New Orleans to talk to a Chrysler guy about it and after a couple of days of ruminating on it with his engineers, he told me to change the transmission fluid and put Mopar ATF+4 fluid back in there. At first I laughed at that, but I did it, and that problem was fixed, and I learned volumes from that experience.

Sometime later I was handed a work order on an Eagle Talon that was exhibiting exactly the same concern, and I pulled the vehicle's file history to find that our own transmission mechanic had serviced it and had used the wrong fluid. Later, I caught some Taurus surging for the same reason by watch-



I TEACH THAT JUMPING A VEHICLE OFF RIGHT

requires the ground connection to be made at the engine block after everything else is connected to prevent sparks at the battery (and safety glasses are a must). But regardless of how the cables are connected, a good solid pair of cables are needed, especially if the vehicle being started is a diesel. One thing my trainees would end up being very good at was jumping vehicles off, because most of the trainer units had dead batteries whenever they went to bring one in.



WHEN IT COMES TO IGNITION SYSTEMS


and spark plug wires on DIS systems particularly, trainees need to be taught that a carbon track on a spark plug always has its counterpart in the boot – and if the wires aren't replaced in a situation like this, that carbon track will re-track the new plug for a comeback.

ing the torque converter PID on NGS while feeling the surge. I added a bit of that smelly Motorcraft friction modifier to the transmission and took care of that on those. Nowadays most transmission fluid smells like that stinking friction modifier.

Around that same time, there was a 1989 Taurus rental unit that showed up in my bay before we even had any '89 models on our lot. This one was very hard to start cold, and if you could feather the throttle and keep it going until it warmed up, it would stay alive, albeit with just a bit of blue exhaust smoke. And when you test drove it, that car had LOTS of muscle

— it was extremely powerful for a plain old 3.0L but would ping just a bit on hard acceleration. Checking the compression (3.0L OHV engine) I was accustomed to about 160 psi across the board, but this one had 210 on every cylinder, which explained the extra muscle that one had over a normal Taurus. But why was the compression high? The end of that story is that somebody who had returned the vehicle at the end of a rental had pumped some diesel fuel into the fuel tank — this would seem difficult, considering the nozzle size difference, but it explained the blue smoke and the higher compression. Replacing the fuel was all that Taurus needed. After that, also I found vehicles with cold start stumbles due to 93 Octane fuel, which burns slower and doesn't work well if the vehicle is set up to run 87 octane. There are TSBs from Ford and Chrysler about that issue.

Conclusion

Every technician's learning curve is different, and some technicians may be satisfied doing simple fast service work, but there are some elements of our profession that every service technician needs to embrace. Those of us who love troubleshooting benefit from the tough ones. Performance, Integrity, Attitude, and Dependability (P.A.I.D.) are the four things most employers and customers have a right to expect from those of us who pull steel to eat. Integrity, attitude and dependability are important, but performance grows from the foundation of those other three, coupled with basic understanding and self-reliant learning, to build good, solid troubleshooting skills. 



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BRANDON STECKLER //

Technical Editor

Covid-19, “coronavirus,” “pandemic,” “social-distancing,” “essential-worker”... These are all words the world has recently become intimately familiar with. I have to be honest — I never thought I’d see the day the world would shut down for weeks or even months for a microscopic virus. Not in this day and age! But I was wrong. And the entire world is indeed feeling the tightly drawn noose of quarantine. And for me, it brings to light memories of the 1993 movie “Groundhog Day,” with Bill Murray and Andie MacDowell — each day is virtually the same.

From a full day to nothing

I’d like to speak a bit from my own experiences as a traveling instructor, encountering roughly 100 different techs every week. I’m in and out of different hotels all over the country, Canada, and at times, even Europe. Needless to say, I’m a bit of a social butterfly. So, when news of the potential danger spread and my classes for CarQuest Technical Institute, World-PAC Training Institute, as well as my private training events all began to cancel, I was bummed. Financial hardship is something many of us are feeling, and it certainly is stressful.

Others have been feeling the anxiety of wanting to work but simply can’t



GROWING MY OWN SKILLS and helping others grow theirs is both my passion and my vocation.

(I can attest to that!). Then comes the emotional toll many of us are feeling. The deepening depression and per-

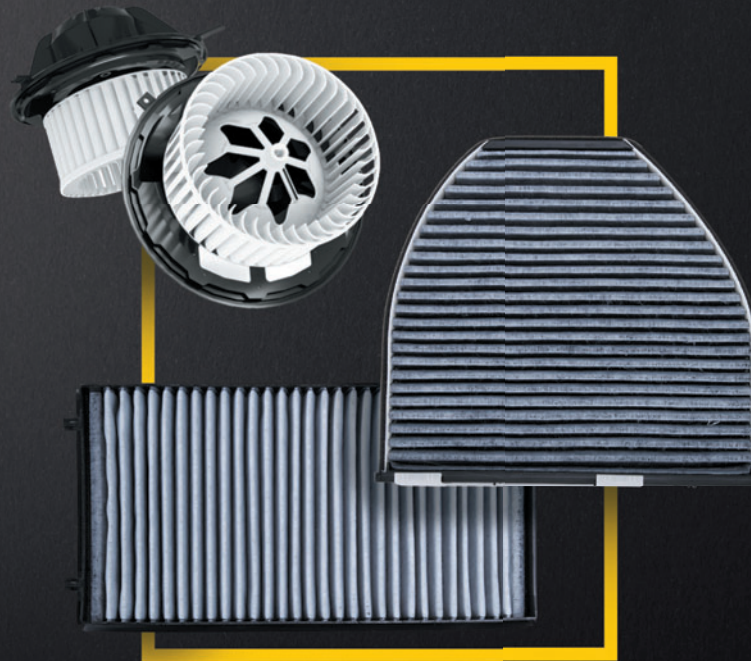
haps the feeling of loneliness that accompanies it. In fear of endangering my family, I’ve isolated myself. I have

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not pet my dog nor held my daughter in my arms nor seen the whites of her eyes in almost five weeks. I consider myself a strong person but I'm nearing my limit, from that angle. This virus has turned the world I know upside down and inside out.

So, to keep my sanity, I begin each day with a shower, to renew my sense of normalcy. Like an incarcerated prisoner, it's the little things in which I've become very appreciative of. I have available to me thousands of hours of classroom development work and other responsibilities I can invest my new "free time" in. At first, I was feeling a bit of excitement, a sense of relief. I viewed this time as a chance to stay focused and develop some very practical content for the future, once these classes resumed.

Those who know me from class know how much I love to be in class with all of you. It is one of the most rewarding feelings I've ever experienced, and I wouldn't exchange it for ANYTHING. I'm very passionate about it and feel ever so fortunate for the opportunities I've been afforded. I've been so blessed to have so many people in my corner, growing up in the industry. So many have helped me, and being an instructor allows me the opportunity to give back and help others to be successful as well.

Very shortly thereafter, though, I began to bury myself in my work and became overwhelmed. By not allowing myself some time away from the class-development work, it became a chore, instead of a task I was passionate about. It not only became depressing and redundant in and of itself, it wasn't something I was proud to teach. I realized at that time that I was going to have to manage my time rather than allow the hours to just roll by each day. If I hadn't, I'm scared to think what my state of mind would be at this moment.

Handling the emotional challenge

Although we are all in this together, I've never felt more alone. So, I find things to do, outside of my responsibilities. Most of us have been on a flight, I'm assuming. In every flight, they remind us as passengers that in the case of an emergency, to secure our oxygen masks

before helping others. Think about that statement for a moment. If you don't secure your mask and ensure your safety and well-being, you can't be of any assistance to someone else. I've grown to realize over these few seemingly-endless weeks, that I will be no good to my students or my readers if I try to create when I'm not feeling passionate. I real-

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ized that I had to take care of myself first. I needed to be in the correct frame of mind. I had to want to create a curriculum. So, what do I do to engross myself in a bit of healthy distraction? I cook; I LOVE to cook! I now take advantage of the free time and make something delicious for my loved ones to enjoy.

I also love nature! Nothing clears my head better than a hike in the hills of Antietam Trail Head, just a few miles from my home. With the sun on my face and listening to nothing but the breeze blowing through the 100-foot pines, I spend hours there and hike for miles. It does wonders for my well-being. It's like pressing the "reset button" each day. These are things I do to help me keep my head on straight. This allows me the mental relief I need to pursue my goals and tasks with more efficiency and passion.

But, I'm not you, and we are all in different situations. I'm no longer what we now consider an "essential worker." You ladies and gentlemen still have to be at work. Some of you may have been afforded a salary, others not so lucky. Many of you are told you must be at work, only to stand around as flat-rate technicians, with productivity ratios in the single digits. That certainly takes a toll on the mind as well as the wallet.

Many shops have taken advantage of these slow times and devoted the majority of the day to cleaning and shop maintenance. Acid-stripping floors and repainting. Perhaps getting rid of old clutter and revitalizing the work areas or organizing a tool room. Good for you! But how much cleaning can we do? How long will this keep our minds busy? I'd like you to take a moment and ask yourself honestly. Do you feel as though you invest enough time in yourself, in your pursuit to be the best technician you can be? I don't think there is a single one of us that can honestly say "yes."

Invest in yourself

By now, many of you are aware that there has been somewhat of a paradigm shift regarding how we train, in the wake of the COVID-19 virus and the practice of social-distancing. Many, if not all, of the automotive training institutions offer online webinars and other interactive training at either low cost or even NO COST to you. We can take advantage of these tough times. We can capitalize on the fact we have no physical labor to conduct and utilize time to exercise our minds. We can grow our knowledge and depth of understanding so that we can reach new heights and potentially exit this crisis as better, more well-rounded technicians than we were about five weeks ago.


So, I invite you to join me and my fellow instructors. Reach out on Facebook. Join us in some discussion, and converse with your peers. I've found that there is always someone who understands at a different level than I, and I learn from all of you every day — much more than you learn from me. Keep your eyes open for posts advertising upcoming online events and GET YOURSELF REGISTERED! Events like *Motor Age*/TST webcasts. Or, get caught up on over 100 episodes of "The Trainer," featuring *Motor Age*'s own Director Of Training Pete Meier. WorldPAC and CTI are both offering free training under the World Professional Automotive Community and Virtual Classroom banners, respectively. These course feature classes led by instructors like myself and others



IN THIS TIME OF ISOLATION, I've spent part of mine working on another passion I have — cooking!

from WTI/CTI, guest industry-leaders, and automotive system experts (both from OE and premium aftermarket suppliers/manufacturers). You can see a full list of complimentary training available from Advance by CTI/WTI. Just visit www.worldpac.com/training/classes/online or at www.ctionline.com for details.

Another company that had made free training opportunities available is Dorman, in partnership with TST and features Jerry "G" Truglia. For additional information on these offerings, visit the TST website at www.tstseminars.org.

These times are tough but I'm confident that we will soon be seeing the light at the end of the tunnel. Hang tough, stay safe, be healthy, and I will be seeing you on the other side, my friends! 



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JOHN ANELLO // Contributing Editor

There comes a point in a business where you need to decide to renew your operations to keep up with the times rather than go stale. I have always kept a strategy of renewing my business about every five years to make sure I have that updated look and the latest and greatest equipment. I have a lot of equipment in my attic that is antiquated within five years because the technology just keeps accelerating at a pace that sometimes becomes hard to keep up with. The introduction of Advanced Driver-Assistance Systems (ADAS) has had a major push for me to retool my entire business, so I needed more room to accommodate the amount of equipment involved in working on ADAS systems. My 2014 Jeep Wrangler on steroids was just not cutting it anymore, so I needed something different to take me into my next business phase.

Shadow boxing?

The 2020 Jeep Gladiator looked very promising — a 4-door SUV and a 5-foot truck bed (**Figure 1**). I decided to modify the interior by taking out the back seats and use the truck bed to carry all the equipment necessary to perform ADAS calibrations on the road. A custom stainless-steel bed top is still in the works to store 3.5 x 4.5-foot target boards in the roofline. When I ordered the truck, I made sure it was a Rubicon with every option this vehicle could have, including the ADAS system. I was



very intrigued by the way the vehicle was able to maintain advanced cruise control and vehicle braking on its own while driving on the highway, but I was not aware of its added feature of Automatic Emergency Braking. This I found out when my Gladiator abruptly issued a warning tone and stopped while I was moving slowly in traffic on a highway without any logical reasoning. I was served an ADAS “curveball” that I was not prepared for, and I needed to do some serious research to figure out what this AEB stuff was all about.

AEB systems are now in at least 50 percent of all vehicles produced in 2020 and by September 2022 it will be mandated that ALL vehicles produced will be required to have AEB equipped onboard. These systems will use both

radar and camera systems on a network or integrated into one unit to interact with engine and ABS control systems to control deceleration and braking. The ABS will be the main “arbitrator” of the system and will have a final say in what actions to take. The radar and camera systems will calculate a “time-to-crash” scenario and warn the ABS of a possible crash. The ABS will first pre-fill the brake hydraulics to bring the brake pads closer to the brake rotors, issue a warning to be displayed to the instrument cluster, instruct the Body Control Module to prepare for a brake light activation and even possibly create a brake jerk to get the driver’s attention. Then when a final decision is made to put the driver out of harm’s way, a full brake apply will run

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its course. This all happens in milliseconds of time through bus networks that allow fast interaction between onboard control modules.

The Jeep Gladiator was different than most systems I have worked on in that most vehicles use separate radar units behind the front grille and a camera up in the windshield. This vehicle had a Driver Assist System Module that incorporated both radar and front camera at the top of the windshield for a sensor

fusion operation. It was also equipped with AEB that was controlled by a Soft Switch in the dash menu (Figure 2) that you could use to set the sensitivity or turn on/off operation. This system usually works at low speeds (under 15-20MPH) depending on the manufacturer. What I experienced in traffic happened twice on sunny days heading the same direction going under an overpass about 10 miles per hour. While heading North with the sun in the East

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a perfect shadow was cast on the highway from the overpass, and the DASM thought the shadow was a vehicle in front of me, so my Gladiator came to a quick halt. I was unable to move forward to prevent the vehicle behind from hitting me because the brakes were still being held. Luckily for me, the driver behind me stopped in time. What I experienced was “phantom braking” because cameras, in general, can’t comprehend shadows but rather see them as 3-dimensional objects. I have since turned the AEB off and placed it in warning mode only so I could learn more about its system strategies.

Be careful what you wish for

I was hoping that soon I would be able to work on one of these systems to learn more about it because it threw me such a curveball. This ADAS vehicle was so new with many other features such as Blind Spot Detection, Cross-Traffic Alert, and even Automatic Braking when the driver door is opened while backing up. There is a saying of “be careful what you wish for,” and I think I wished a little too hard. It was about one month and 3,500 miles later that I noticed a crack in my windshield that started at the base of the glass perimeter from a stone that kicked up on the highway. I had to put an insurance claim for almost \$1,400 for the windshield to be replaced that included a radar/camera alignment procedure. The windshield was on back-order, so I had to wait about four weeks because the truck parts were still in production mode.

I chose to purchase a factory windshield because I did not want any post issues with my DASM System operation. Windshield glass has always been mandated to have specs of clarity and structural safety. There is a membrane between two pieces of glass to keep the glass from shattering into many tiny pieces if the vehicle is involved in an



accident of any kind that could compromise the windshield and cause injury to a driver and passengers in a vehicle. With the introduction of ADAS into our automotive industry, there have been many changes to windshield specifications. They must have the proper pitch for camera mounting, because 1 degree could make a difference and create a problem for the system to properly finish its calibration process after windshield replacement. There is also a need to make sure the camera view area has specified inclusions or a heated grid that does not restrict the view. A camera looking through a piece of glass that is not to specification could distort the images it was designed to see putting it into a “Kaleidoscope World.”

When the windshield finally ar-

rived, I met the glass guy at a local body shop to remove the old glass on my Gladiator (**Figure 3**). It was interesting to see that the DASM Unit was not mounted to the windshield but rather on a bracket mounted to the vehicle. There was a grommet surrounding the DASM and secured tightly against the windshield. This is critical because you don’t want pirate light to sneak past the grommet and cause issues with the camera’s view. There were also two wires to the left of the DASM unit that feed power and ground to a heater grid built into the windshield that covers the camera view area to prevent fogging near the camera lens. The manufacturer states that a radar and camera alignment must be done if the DASM or windshield is replaced,



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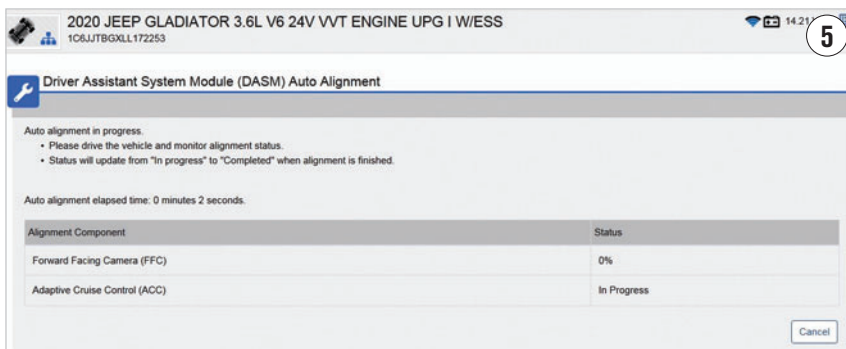
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and this even includes if the vehicle is modified with a lift kit or bigger tires. This system does not use targets of any kind for a “static” alignment and is all done “dynamically” on the roadway. Before doing the roadway alignment a vertical alignment of the DASM housing is needed by checking the assembly with a Digital Inclinometer (Figure 4). Before measuring negative 1.0 degrees +/- 0.2 degrees, the vehicle must be on level ground and the suspension and tires can't be comprised.

Dynamic calibration in Jersey?

Once the DASM housing is vertically adjusted then you can proceed to the Road Test calibration. If the vehicle has been modified, then you will have to measure the height of the vehicle from the center of the lower control arm bolt to the ground (Figure 5). The vehicle must be unloaded with nothing in the truck bed and the tires at the proper air pressures. You will need to add a value of 300-600 mm for left and right sides of the vehicle into two different windows on the dis-



played screens. If a value above 600 mm is entered, you will be warned that the system may NOT function properly at all as a liability awareness from the manufacturer. Once this is completed, you will see the next screen (Figure 6) that will show you progress bars for both the camera and radar systems that will count from 0-100 percent as you drive. This is not a time-based drive, but rather a condition-based drive. You must find a straight roadway with visible lines and many roadside objects such as guardrails, telephone poles, trees, signs, etc. (Figure 7). You must also keep a speed above 42 MPH with a 3-4 car length in front of you so the systems can properly learn the roadway.

I was surprised that the camera system finished quickly after just one minute and 11 seconds. Then after about another two minutes and 14 seconds, the radar system was completed. The total drive with the proper conditions was

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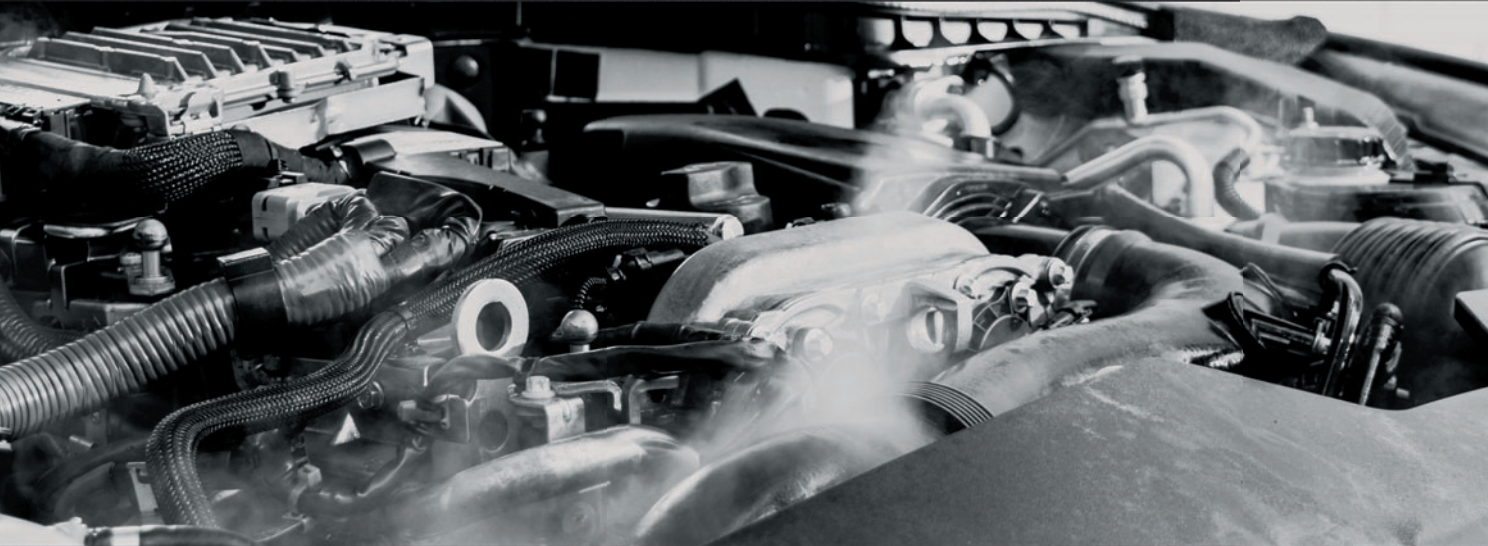
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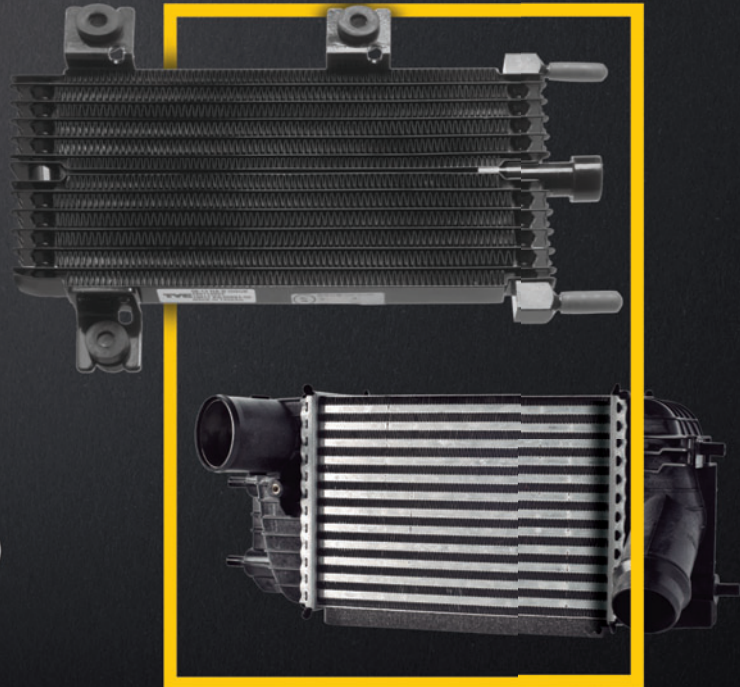


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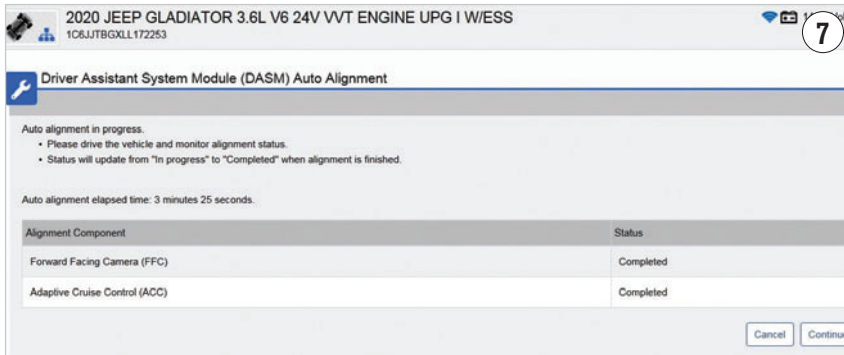
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under five minutes but this was on a clear sunny day with no rain or snow in the forecast. Camera systems will have issues calibrating if weather conditions are very poor and the radar system calibration will not complete if you are not traveling at the right speed keeping yourself properly distanced from cars in front of you. This is not a job you can do during major rush hour or on a roadway without lines on either side of the

vehicle. You also need to think about taking another person with you on the road trip to monitor the laptop while you drive, because it may be a liability issue if something should happen if you take your eyes off the roadway while giving attention to a laptop screen or keyboard function.

I hope that all you readers have enjoyed my personal experience with ADAS and the many things that af-

fect its proper operation. I am sure as time goes on there will be many changes to fine-tune operations to ensure these systems are more robust. You will see many manufacturers removing radar systems out of the front fascia of vehicles and putting them into the windshields out of harm's way to lower the cost of insurance claims. I also see a possible fusion of radar, lidar and camera systems all tucked in the upper windshield to give the ADAS system a wider spectrum of "Roadway Classification." *TM*



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.

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Autel obtains certified access to FCA vehicles with SGW module

Autel's diagnostic tablets have just been certified by Fiat Chrysler Automobiles US (FCA) to access the Secure Gateway (SGW) module on some 2017 and newer FCA vehicles.

FCA started installing the SGW on some 2017 vehicles, with each subsequent year seeing increasing adaption, so that nearly 100% of FCA's 2020 vehicles are reported to have the SGW installed.

A firewall of sorts, the SGW blocks unauthorized access and manipulation of vehicle networks and vital systems. FCA says the SGW was developed not to restrict access to diagnostic data but rather to restrict "the ability of non-registered and non-authenticated users to perform intrusive diagnostics such as bi-directional controls." Beyond the prevention of bi-directional capability, which include calibrations, relearns and actuations, even the simple act of clearing a code is denied.

AutoAuth, an authentication service, acts between the FCA server and the aftermarket diagnostic tools. As FCA describes it in their "AutoAuth High Level Overview" document discussing the process, "the SGW Authentication Bridge Server acts as a "bridge" to allow Independent Aftermarket (IAM) tools the ability to retrieve necessary information from FCA's Public Key Infrastructure (PKI) to perform the authentication process with the SGW. It provides separation between FCA US internal systems and IAM Tool Manufacturer systems for architecture and security purposes. Only those IAM Tool Manufacturers who enter into the required legal agreements with FCA US, as governed by FCA US MOPAR Techni-



cal Service Operations will be allowed to interface with the SGW Authentication."

Shops can register through AutoAuth's registration portal for \$50 a year. Up to five technicians can register under this initial fee, with additional users able to register for an additional nominal fee. The next step is for the shop to register its Autel tablets, up to 100 tools, on the site. Once registered, technicians need only to install the latest FCA software update on their tablet. A valid Autel software subscription is required. The tablet must also be connected to the Internet during any attempt at advanced diagnostics on an applicable FCA vehicle. Follow the instruction displayed on the tablet to ensure a successful connection and authentication of the SGW by the FCA server.

All of Autel's tablets can be registered to have access to the FCA SGW module, including the MX808 and TS608 service tablets, the MaxiSYS IM508 and IM608 immobilizer and key programming tablets, the MaxiSYS 905 tablet, the MaxiSYS 906 tablet series, the MaxiSYS 908 tablet series, the MaxiSYS ADAS tablet, the MaxiSYS 909 and MaxiSYS 919 and the MaxiSYS Ultra tablets.

FCA US LLC sold over 2.2 million vehicles in the United States last year. Its

best-selling line, Ram, sold over 700,000 vehicles last year, an 18 percent increase over 2018.

Though only applicable to FCA vehicles at this time, it has been reported that several manufacturers are about to announce the installation of SGW modules on their vehicles. SGW and similar server-client based authentication systems are viewed as another vital step into the security of the vehicle systems as the industry marches toward autonomous vehicles.

Autel's FCA-certification is just more proof of the company's continuing significance in the industry and its commitment to providing its users the most advanced, technology-driven solutions available.

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About AutoEnginuity

AutoEnginuity, founded in 2003 and headquartered in Mesa, Arizona, has developed into a leader in advanced aftermarket automotive diagnostics software and associated vehicle make/model coverage. On January 2, 2020, **AutoEnginuity** was acquired by **OPUS | IVS**, the **Intelligent Vehicle Support (IVS)** division of **Opus Group**.

OPUS | IVS supports automotive shops in repairing complex vehicles safely and fast. Established in 2018, the business has grown through uniting expertise and technology from **Drew Technologies, Autologic, Farsight, BlueLink** and **AutoEnginuity** to develop innovative solutions for more than 50,000 repair shops around the world. With 7 locations throughout the US, UK and Australia, **OPUS | IVS** is part of the world-leading vehicle inspection and intelligent vehicle support company, **Opus Group**.



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Keeping your shop cool is no sweat

Warm weather is great for leisure time fun, grilling out on the deck or sitting by the pool.

But there's nothing nice about fixing vehicles in a hot, stuffy shop with no air flow or air conditioning. The good news is that there are creative and cost-effective ways to keep your technicians cool and efficient on those hot, humid days.

If shutting the doors and running the A/C full blast all day isn't an option, consider these three tips on staying cool in the shop this summer:

1. Insulate and Hydrate

Although it can be costly, insulation should always be a consideration when building a shop. If the shop wasn't constructed with sufficient insulation, see if there is a way to add some now. Insulating the garage helps keep the hot air from getting in and the cool air – what little there might be – from getting out.

Hydrating is also important during hot summer days, not only for you and your workers but also for your shop. Sprinkling cool water on the roof of your building can cool the interior by as much as 10 to 15 degrees. The downside is that you may have to do this repeatedly because water evaporates quickly in the hot sun.

2. Bring in dehumidifiers

Reducing airborne moisture in the shop – getting rid of the humidity – is a good way to cool things down. A portable electric dehumidifier provides an



economical way to remove moisture from the air and can make your shop feel cooler – even if the temperature stays the same. Dehumidifiers are sized by the number of pints of water they remove from the air in a 24-hour period. Do some research on what size unit is best suited for the size of your shop.

3. Buy a Swamp Cooler

Many shops can't afford to run the A/C all day to keep things comfortable. And keeping the doors open or using fans only helps so much. If it's really nasty outside, you're just blowing around hot, humid air.

A swamp cooler is an incredibly cost-effective way to cool industrial shop environments without breaking a sweat. For just \$1 per full 8-hour

workday, a swamp cooler will chill a massive industrial space better than you thought possible.

Swamp coolers are the most cost-efficient way to keep your shop's air fresh and cool. The Cool Boss® portable swamp cooler pulls in hot air through the back and cools it instantly using an evaporative media that reduces the air temperature by as much as 26 degrees. The Cool Boss's oscillating swing-louvers push the air out in all directions, cooling down the whole shop at once. The Cool Boss also features a negative air ionizer that cleans the air as well, improving the overall air quality of your shop while it cools.

For more information about the Cool Boss® portable swamp cooler, visit www.thecoolboss.com.

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Tools to help master today's electrical diagnostics

Some technicians who have been in the industry for a while may remember when an entire vehicle's wiring diagram could fit on a printed page or two. Those days are long gone!

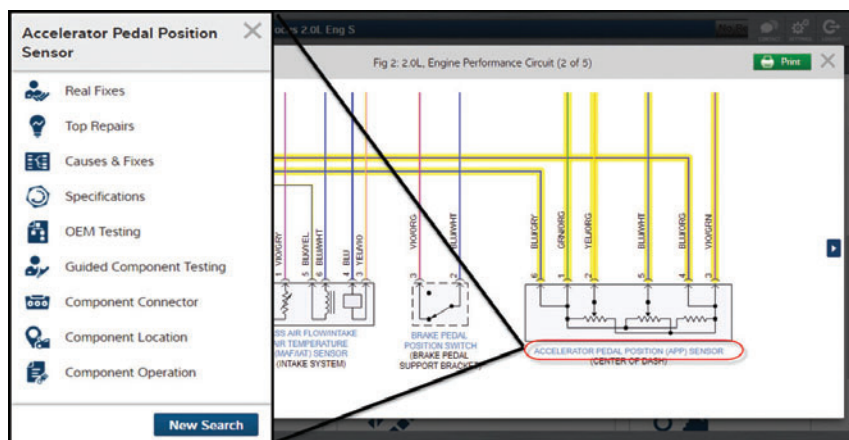
As you all know, most of the enhancements being made on vehicles today are electronic, which add circuits and networking to the vehicle to make everything work. So, wiring diagrams are becoming more and more important.

And here's the thing — with all these emerging technologies coming at us so rapidly, often a vehicle comes into the shop with a symptom that even the most experienced tech has not seen before. This is why it's critical to have access to wiring diagrams that make it quick and easy to find the related component information and arrive at an accurate diagnosis.

Let's take a step back in time and consider wiring diagrams for the 1970 Impala. The first thing you would notice is that the whole vehicle's wiring — bumper to bumper — fits on two pages. That includes body, ignition, charging and HVAC. Things were pretty simple back then.

Now let's compare the 2016 Chevy Impala. There are far too many diagrams to describe here. In fact, there are over 30 sub-systems that make up the vehicle's complete electrical system. If we look at the engine performance wiring, it now takes eight diagrams to show everything — over 60 components in all. The AC system has four diagrams. The anti-theft has four diagrams as well. The supplemental restraints system has three diagrams.

You get the picture. And without a modern repair information resource, it can be time-consuming to navigate these complex diagrams to locate the specific



PRODEMAND interactive wiring diagrams link to component information

circuit you're interested in diagnosing.

That is how the wiring diagrams in the ProDemand repair information software from Mitchell 1 can help. The collection of wiring diagrams consists of single images that are grouped together by systems. The software provides continuity across the full set of OEM diagrams by highlighting traces within a system on the vehicle.

Interactivity & Component-level Navigation

Interactive wiring diagrams allow users to navigate via the diagram directly to component information without a secondary lookup. Component names shown in the wiring diagrams are active links that take the user straight to information like component location, connector views and replacement procedures.

In ProDemand, you can find the wiring diagram you need by simply searching for the component. Just enter a component, click search, and instantly arrive at the diagram for the specific component entered as a search term. When you open that diagram the component will be in focus

with all the traces already highlighted. If your diagram has multiple pages, you can easily follow the trace as the highlighting extends across all the pages until the circuit reaches its termination.

Think how different this is from how you may have done electrical diagnostics "in the old days" with paper charts. You would have your wiring chart open and trace it to whatever component or circuit you were interested in. Then you would save that page with a bookmark and search the manual for information about the component you were diagnosing.

Now this process is completely automated and your software does all the work for you, bringing together the diagram and related components and procedures. Never before have diagrams been so complex — yet so easy to navigate when using the right tools.

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DAA also offers significant savings on installation, maintenance and operating costs when compared to traditional pipe. The quick connections eliminate the need to thread, solder or glue pipe. DanAmAir's aluminum pipe system also significantly reduces plant energy costs by increasing efficiency, reducing pressure drops and eliminating leaks.



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Labor Cost at \$65/man hour	1,459.90	5,343.65	3,927.30
Total Cost	\$ 4,740.80	\$ 7,392.63	\$ 7,057.60
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Bring flexibility to your shop with the right lift

When it comes to finding the right lift for the job, greater flexibility, as well as the ability to accommodate the widest range of vehicles, enhance technician productivity and help boost profitability are just a few “small” requirements a shop should look for.

It’s important for shops to have the flexibility they need to tackle anything from alignments and tire repairs to brake and suspension work. That’s why Rotary Lift recently unveiled the newest lift to its line of products, the ARO22 Alignment Lift. The ARO22 is the highest capacity open-front alignment lift on the market and can handle everything from passenger vehicles to larger work trucks, making it easier for shops and dealers to service a wider range of vehicles.

Of all the shop tools available, a vehicle lift can offer the greatest opportunity for increasing service speed to improve service bay productivity and profitability.

Flexibility

Rotary’s ARO22’s open-front design is engineered for both cars and commercial vehicles and can service everything from low-profile Class 1 passenger vehicles to Class 5 vehicles weighing up to 22,000 pounds.

The ARO22 alignment-ready lift has a 26-inch-wide platform runway with 40-inch spacing in between and is equipped with air-operated rolling jacks, including a 9,000-pound-capacity front jack and a low-profile, 15,000-pound-capacity rear jack.

Ease of use

The lift’s air-locking rear steer plates are



operated from a power column that eliminates the manual process of setting pins, allowing for a quality alignment, and LEDs integrated into the runway platforms illuminate the undercar to improve the work environment. The optional SmartFILL™ integrated air inflation system lets technicians set the tires to the desired PSI while performing other work and has an optional dual-tire filling capability that enables separate pressure settings for front- and rear-axle tires.

Safety

Keeping technicians safe is critical in any shop. The system’s patented articulating roller system and oversized front columns are designed to help evenly distribute the load balance, while the Sentinel Lock™ system features oversized slack cables and guide arm to ensure the lock latch stays in place. This helps extend the life of the lift and allows technicians to easily set up a vehicle and safely and quickly make repairs.

The ARO22 lift is also compatible with Rotary’s technician-friendly tower-

less alignment systems and other alignment systems on the market.

5 Lift-Buying Tips

Keeping a shop efficient and productive is a top priority, but to achieve that, you need to have the right equipment in place. The right lift can help speed up repairs, boost accuracy and give technicians what they need to safely and reliably do a job. Rotary offers five tips to consider before buying your next lift:

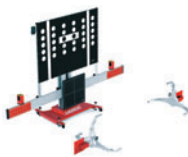
1. Understand the types of vehicles you want to lift.
2. Assess the services your business performs.
3. Consider your shop’s available space.
4. Evaluate the reputation and customer service of the company you’re purchasing from.
5. Consider your technicians’ needs and safety.

To learn more about Rotary’s ARO22 Alignment Lift or other Rotary Lift products or if you need help finding the right lift, visit www.rotarylif.com.

X-431 ADAS PRO

The LAUNCH X-431 ADAS Pro calibration tool is designed to ensure driving safety and comfort by handling the calibration of ADAS camera and radar systems. The automatic calibration frame and the multiple target boards are provided for servicing comprehensive car lines with rapid and accurate calibration. The ADAS Software's easy-to-follow process guides the technician step by step throughout the procedures. The bi-directional X-431 Throttle scanner with OE-level coverage and full diagnostic function ensure a satisfying experience for both diagnostics and calibrations.

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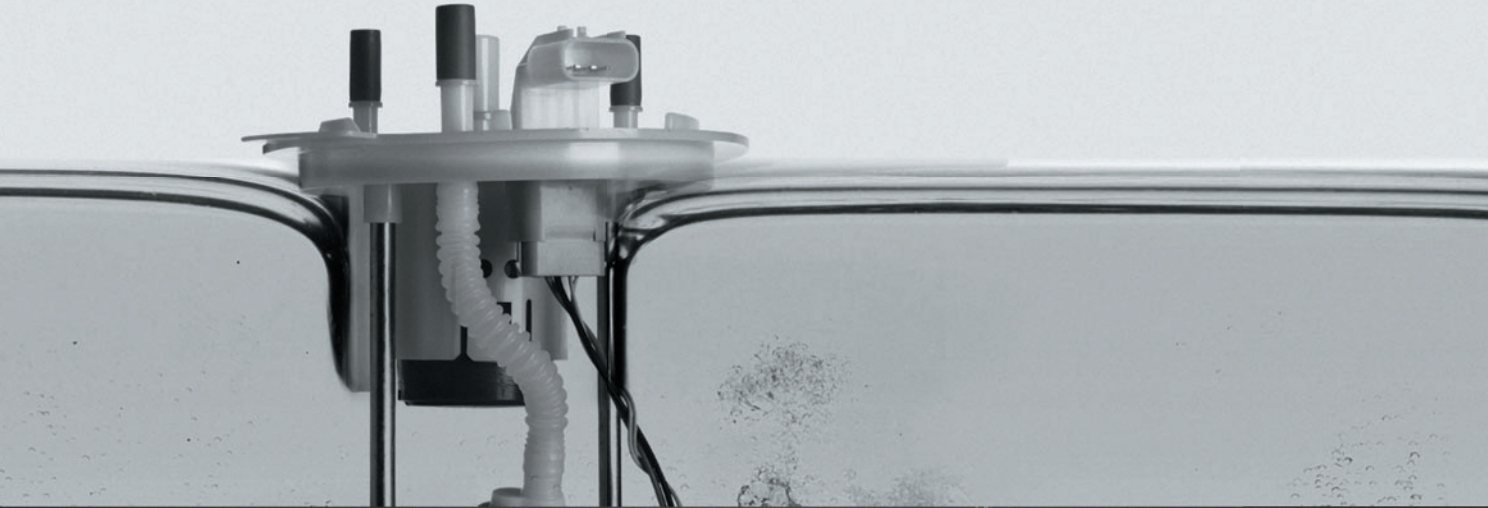
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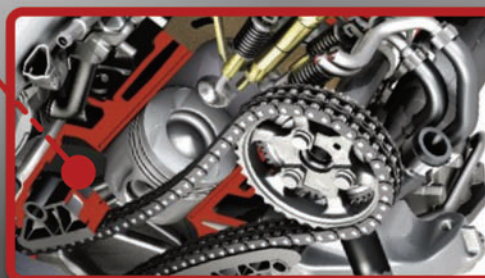
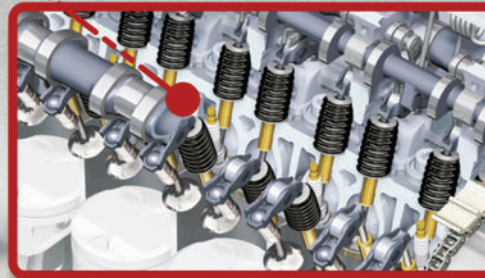
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COMPRESSION TESTING OPTIONS

FINDING THE LEAKING CYLINDER(S) CAN BE TRICKY, BUT THERE IS MORE THAN ONE WAY TO ISOLATE THE OFFENDER!

PETE MEIER // Director of Training

When a customer brings in a misfire caused by a “dead” hole, the reason for that misfire is usually pretty easy to isolate. Simply pull all the plugs and use a mechanical gauge to measure each one, looking for the odd man out. If you have a scope, a simple relative compression test would find the culprit even faster.

But what if you’re dealing with an

intermittent sealing issue — an issue increasingly common in today’s GDI powerplants? Carbon deposits on the valve are just heavy enough to prevent the valve from sealing and may even leak only under very specific conditions. Remember, too, that the valve rotates as it opens and closes, so the contact face may be located in one position relative to the cylinder head one moment (and misfire like a son-of-a-gun) and in another the

next (and run smooth as glass).

No worries. There are a number of ways to test the engine’s ability to seal. Some require nothing more than a good ear while others require a digital storage oscilloscope and specialized accessories. In this edition of The Trainer, we’ll review a few of the more common options so you have an arsenal of choices to choose from next time you’re faced with a low compression issue. **TL**



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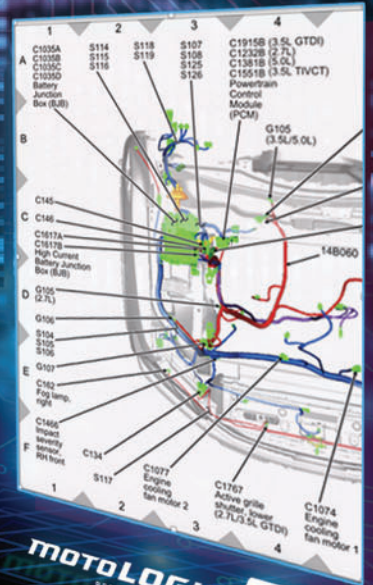


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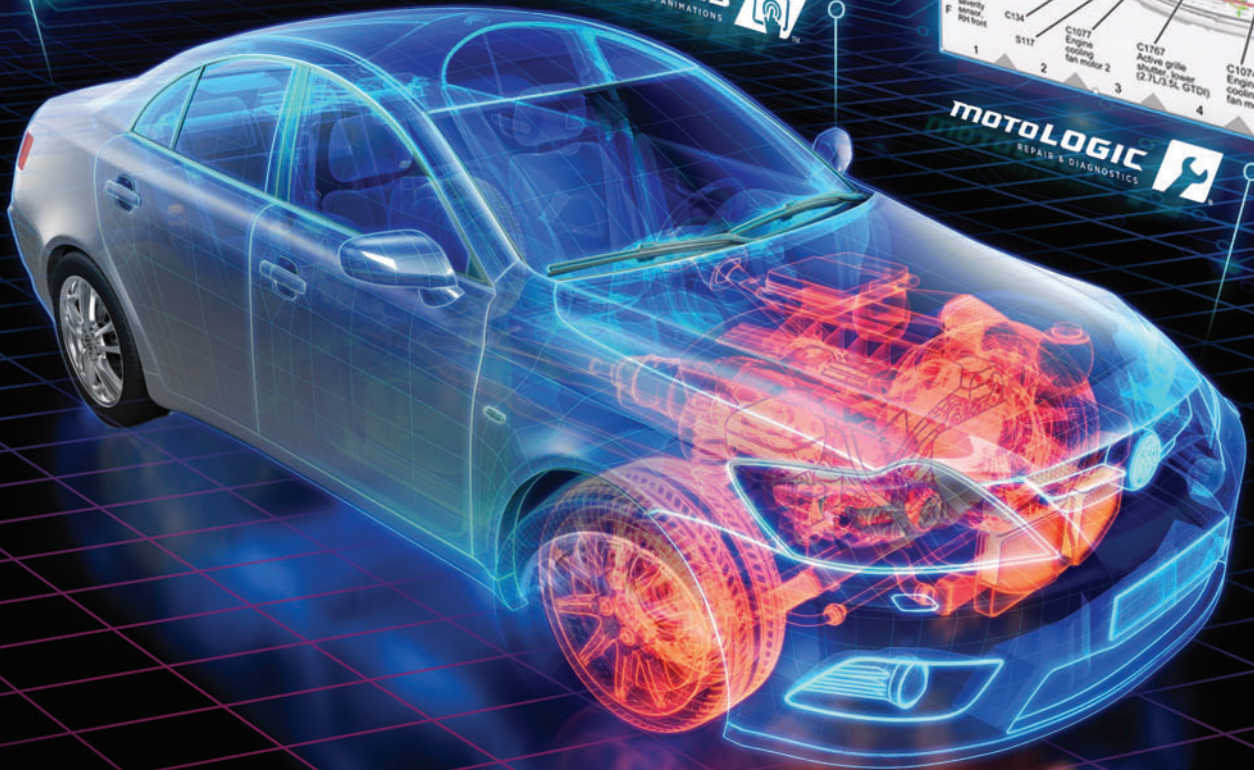
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