Motor Age®

ADVANCING THE AUTOMOTIVE SERVICE PROFESSIONAL SINCE 1899

UBM

FEBRUARY 2019
VOL. 138, NO. 2 // **MOTORAGE.COM**

Motor Age®

ADVANCING THE AUTOMOTIVE SERVICE PROFESSIONAL SINCE 1899

COMMITMENT TO TRAINING
PREPARING YOUR TEAM FOR THE TECHNOLOGY TIDAL WAVE 22

UBM

FEBRUARY 2019
VOL. 138, NO. 2 // MOTORAGE.COM

ELECTRICAL: DIAGNOSING CAN SYSTEMS

40

BATTERY DOS & DON'TS

Batteries have an increasingly tough job to perform. Proper service and inspection is key to making them last!

Motor Age®

ADVANCING THE AUTOMOTIVE SERVICE PROFESSIONAL SINCE 1899

Talk Shop Anytime

FEBRUARY 2019

VOL. 138, NO. 2 // MOTORAGE.COM

OPERATIONS

automechanika
Commitment to TRAINING

TECHNICAL

IN EVERY ISSUE

SPECIAL SUPPLEMENT

KIA QUALITY CONNECTION

View the Fall 2018 edition of the Kia Quality Connection now!

MotorAge.com/KQCFall18

WEB EXCLUSIVES // MOTORAGE.COM

PRESSURE ACQUISITION ANALYSIS FROM THE INSIDE OUT

Motor Age is proud to partner with TST to bring you presentations featuring the best trainers in the industry. Brandon Steckler will teach technicians labscope/engine mechanical operations to help them capture pressure waveforms. At the end of the webinar simulcast, technicians will be able to use information from the pressure waveforms to make diagnostic decisions.

Additionally, Brandon will cover transducer functionality with both absolute transducers and delta transducers; benefits and characteristics of both types of transducers; how the two types of transducers can be used to gain an edge; and real-world examples and case studies.

MOTORAGE.COM/PRESSUREANALYSIS

Motor Age

MOTORAGE.COM

Millennium Place East // 25115 Country Club Blvd. // North Olmsted, OH 44070
Phone: (440) 243-8100 // Fax: (440) 891-2675

EDITORIAL STAFF

MICHAEL WILLINS
GROUP CONTENT DIRECTOR
michael.willins@ubm.com
(440) 891-2604

KRISTA MCNAMARA
CONTENT CHANNEL DIRECTOR
krista.mcnamara@ubm.com
(440) 891-2646

CHELSEA FREY
SENIOR ASSOCIATE EDITOR
chelsea.frey@ubm.com
(440) 891-2645

PETE MEIER ASE
TECHNICAL EDITOR
pete.meier@ubm.com

STEPH BENTZ
ART DIRECTOR

STALIN ANNADURAI
SENIOR DESIGNER

JAMES HWANG
EDITORIAL DIRECTOR, ASE STUDY GUIDES
james.hwang@ubm.com
(714) 513-8473

CONTRIBUTORS

ROBERT BRAVENDER
CHRIS CHESNEY
CHRIS FREDERICK
DAVE HOBBS
JOHN D. KELLY
TONY MARTIN
DAVE MACHOLZ
SCOT MANNA
RICHARD MCCUISTIAN
MIKE MILLER
ALBIN MOORE
ERIC OBROCHTA
SCOTT SHOTTON
BERNIE THOMPSON
G. JERRY TRUGLIA
SCOTT "GONZO" WEAVER

PRINTED IN U.S.A.

Connectiv
The Business Information Association, a division of SIIA

SUBMISSIONS:
Motor Age welcomes unsolicited articles manuscripts, photographs, illustrations and other materials but cannot be held responsible for their safekeeping or return.

MEMBER OF:

BUSINESS STAFF

JIM SAVAS
VICE PRESIDENT/GENERAL MANAGER

TERRI MCMENAMIN
GROUP PUBLISHER
terri.mcmenamin@ubm.com
(610) 397-1667

DAVID PASQUILL
COMMERCIAL FINANCE PARTNER

SOFIA RENTERIA
BUSINESS ANALYST

JILLENE WILLIAMS
SALES COORDINATOR

KAREN LENZEN
SR. PRODUCTION MANAGER
(218) 740-6371

KRISTINA BILDEAUX
CIRCULATION DIRECTOR

TRACY WHITE
CIRCULATION MANAGER
(218) 740-6540

BALA VISHAL
DIRECTOR OF DIGITAL MARKETING

TSCHANEN BRANDYBERRY
SPECIAL PROJECTS EDITOR

DOMESTIC SALES

MIDWEST & WESTERN STATES, CLASSIFIED SALES
MICHAEL PARRA
michael.parra@ubm.com
(704) 919-1931

ILLINOIS, EASTERN & SOUTHERN STATES
PAUL ROPSKI
paul.ropski@ubm.com
(312) 566-9885
Fax: (312) 566-9884

OHIO, MICHIGAN & CALIFORNIA
LISA MEND
lisa.mend@ubm.com
(773) 866-1514

CUSTOMER SERVICE

SUBSCRIPTION CHANGES
(888) 527-7008
(218) 740-6395

PERMISSIONS/INTERNATIONAL LICENSING
JILLYN FROMMER
Jillyn.Frommer@ubm.com
(732) 346-3007

REPRINT SERVICES
Licensing and Reuse of Content: Contact our official partner, Wright's Media, about available usages, license fees, and award seal artwork at Advanstar@wrightsmedia.com for more information. Please note that Wright's Media is the only authorized company that we've partnered with for Advanstar UBM materials.

Motor Age (Print ISSN: 1520-9385, Digital ISSN: 1558-2892) is published monthly, by UBM LLC, 325 W. 1st Street, STE 300 Duluth, MN 55802. Periodicals postage paid at Duluth, MN 55806 and additional mailing offices. POSTMASTER: Send address changes to Motor Age, P.O. Box 6019, Duluth, MN 55806-6019. Please address subscription mail to Motor Age, P.O. Box 6019, Duluth, MN 55806-6019. Canadian G.T.S. number: R-124213133RT001. Publications Mail Agreement Number 40612608. Return Undeliverable Canadian Addresses to: IMEX Global Solutions PO Box 25542 London, ON N6C 6B2 CANADA One-year rates for non-qualified subscriptions: U.S. $70.00; Canada/Mexico $106.00; International surface $106.00. For information please call (866) 529-2922 (Domestic inquiries); (218) 740-6395 (Canadian/Foreign). Printed in the U.S.A.

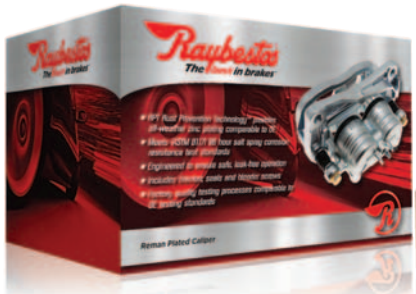
AD DEADLINES: Insertion orders–1st of month preceding issue date. Ad materials–5th of month preceding issue date.

To subscribe, call toll-free 888-527-7008. Outside the U.S. call 218-740-6477.

BIG BRAKE-THRU

You Asked. We Simplified.

Each Raybestos® line is packaged in distinctly identified boxes for straight-forward inventory and to help your customers quickly select the right brake parts for each job.



The Best in Brakes Made Easy.

www.raybestos.com

NEW LEADERSHIP

ASA'S FISHER SPEAKS OUT ON WHAT'S TO COME IN 2019

KRISTA MCNAMARA //
Content Channel Director

Improved communication, member representation and engagement and enhanced industry professionalism top the list of priorities for Ray Fisher — the newly appointed executive director of the Automotive Service Association.

Less than two weeks after officially beginning his duties, Fisher sat down with members of the industry press to discuss what we can expect to see from ASA in 2019 and beyond.

Fisher, AMAM, replaced Dan Risley, who left to pursue an opportunity in his home state of Illinois in July. Executive director of ASA's Michigan affiliate, Fisher will wear both hats until a replacement can be found at the state level.

What are your goals for 2019?

FISHER: Not just for 2019, but for the road ahead, we want to engage membership more and listen to our membership. One of the biggest things that you will see in 2019 and beyond is the different mediums that we are going to use to reach out to our membership. The bottom line is we are really focused on our mission statement and what we can do for

the industry and that is to enhance the professionalism of the repair industry. We represent that professional group and are ecstatic to have that opportunity going forward.

What have you learned through your prior experience that will best benefit you in this new role?

FISHER: After the dealership environment and management that I was in for over 20 years, I had the opportunity to go to go to ASA Michigan and represent the collision side. I became executive director of ASA Michigan in 2010. I did some legislative work very suc-

>> CONTINUES ON PAGE 5

BREAKING NEWS

SHOP SAVINGS

SAVE MONEY IN YOUR SHOP WITH THESE TIPS

If you resolved to save money in 2019, watch "Three Steps to Save: What You Should Be Ordering," a short video from eBay Motors.

The company shares simple yet systematic ways shop managers can improve spending in 2019. The video outlines three steps to boost the budget with commodities and consumables for the shop.

For example, do you put into your daily, weekly or monthly schedule time to look at commodities around the shop and take note of what you see? Even more, do you schedule time to order product?

If not, you could be losing money by not buying in bulk, paying too much on shipping or losing on something just as valuable – time.

Watch the video at **MotorAge.com/2019save.**

TRENDING

GARAGE GURUS ANNOUNCE 2019 TECH SCHOLARSHIPS

Garage Gurus will award up to $30,000 in scholarships to future techs, part of a "Tech First" initiative. Students can apply online and winners will be announced in May.

MOTORAGE.COM/TECHFIRST

MACS 2019 TRAINING EVENT, TRADE SHOW SPACE SOLD OUT

Exhibit space for the MACS 2019 Training Event and Trade Show, A/Ccess, taking place Feb. 21-23 at the Anaheim Marriot in Anaheim, Calif., is sold out.

MOTORAGE.COM/SOLDOUT

ASA, CHEVRON PARTNER FOR SAVINGS

The Automotive Service Association has partnered with Chevron to provide special member services, including savings up to 35 percent on Havoline Motor Oil and lubricants for their shops.

MOTORAGE.COM/CHEVRON

CALIFORNIA EXHAUST NOISE BILL PASSED

California Assembly Bill 1824 is now in effect. Despite some confusion, the bill does not change existing laws, but rather how excess exhaust noise is handled by law enforcement.

MOTORAGE.COM/1824

16TH ANNUAL TST EVENT ANNOUNCES LINEUP

Set for May 30 in Tarrytown, NY, the 2019 TST Big Event features more than 30 vendors, chances to win amazing tools and training seminars taught by industry experts.

MOTORAGE.COM/TST19

cessfully over a six-year period where we updated the Motor Vehicle Service Repair Act, which is all about our licensing. We also got rid of sales tax on court charges, which had been going back to 1932. We also did a layer of protection for repair facilities who follow OEM procedures on autonomous vehicles. I plan to carry that passion forward.

What is your main message for the association?

FISHER: My main message is we are only going to be as successful as the engagement of our membership. That is my focus. Everything will be based on our membership and their needs. I am a very proactive person. I use the windshield, not the rearview mirror. I like to be on the forefront of things.

What are ASA's current legislative focuses?

FISHER: That is where Bob Redding comes in. It is not just about creating legislation but monitoring it to make sure it is in the best interest of industry. It is important that we have that representation looking out for the industry because sometimes you don't have that voice at the table. Currently Bob is working on telematics and who owns the information, which is a very large concern for everyone right now.

What are the plans for ASA Michigan's leadership?

FISHER: Right now we are in a transitional period. We want to make sure continuity is there going forward. For next 90 days, I may be back and forth between Texas and Michigan. But I will ultimately be in Texas working on strategic planning.

How will your leadership be different from those in the past?

FISHER: I have one goal and that is to represent my customer. We are going to have times where we will agree to disagree, but the board of directors really feels our membership is important and we want to represent them well, and in the selection process they looked at that. I want to represent our membership. It's not to say the others didn't, but perhaps their focuses were on other things. When we went through the most severe recession we ever had in the United States, there were a lot of things that hit everybody. Sometimes you get in that mode where you are just trying to maintain, and those were some of the aftershocks we had going on after the recession. But again, I like to look out the windshield, not the rearview mirror.

What other issues should be top of mind for members?

FISHER: Change is the biggest thing. The biggest challenge as an industry is making sure we don't bury our heads in the sand and instead that we look for that opportunity of what is next. And that is where we are going to be coming into play, and we are there already. The biggest thing right now is preparing the industry for the changes coming at it. I am all about goals and making sure our priorities are the right thing for the industry. For specifics, stay tuned. I don't mean to be vague, but we are dialing in. We are here for our industry.

IMPROVING THE CUSTOMER SERVICE EXPERIENCE

Find ways to make the process as efficient, quick and easy as possible

JOHN BURKHAUSER //
Contributing Editor

Customers are our business, so keeping them is a priority. We not only have to provide excellent repairs and maintenance, but make the service experience as convenient and smooth as possible. This means that from the appointment scheduling to the drop-off to the customer picking up their completed vehicle, we must be sure that the service process flows smoothly.

Working for BOLT ON TECHNOLOGY, I no longer have the luxury of getting my vehicle serviced at my own shop. I have become a customer. Recently, I needed to get my state inspection and oil change done and thought this was the best chance I have to experience what a customer goes through to get service.

The call

I called to make my appointment and was immediately put on hold. When the gentlemen picked up my call, I told him what I needed, and figuring I should give him the vehicle type and year, he cuts me off asking for my phone number and when I can bring it in. I give him my number. He says, "We will see you then," and hangs up. It wasn't a negative experience, but it wasn't a positive one either. That's not the best way to start the whole service process.

How well does your shop handle customer appointment calls? This step can set the tone of the entire service visit, so it is extremely important to have a system in place that anyone who answers the phone follows. Additionally, the person answering the phone can prepare the customer for the visit by getting the information the shop needs and going over any recommendations generated by previous visits. By discussing recommendations during the call, you can set the caller up for the costs related to this work so that they can be better prepared.

Setting an appointment during the call can make the visit much better. Staggering customers' appointment times not only reduces the time customers wait to be written up, but it will also give you more time to work with each customer, resulting in getting all the correct information and upselling recommended services.

Calendar

I arrive for my appointment and find that several other customers are there

PHOTO: GETTYIMAGES.COM / XIXINXING

PARTSOLOGY.com

FREE NEXT DAY DELIVERY

TIMING CHAIN KIT

~~$356.98~~

$176.79

FITMENT: 2011-2015 Subaru / Impreza, BRZ, Forester, WRX, XV Crosstrek , FR-S
2.0L, 2.5L / H4 / DOHC 16v 122cid / **FA20D, FA20F, FB20**

ORDER ONLINE!
ENGINE PARTS

www.partsology.com

BBB ACCREDITED BUSINESS
BBB Rating: A

ORDER BY 4PM
GET YOUR PARTS TOMORROW!

QUESTIONS?
TOLL FREE 1-844-800-6866
HABLAMOS ESPAÑOL

already waiting. My turn to speak with the advisor comes, and I walk up to the counter. On the counter, I see a paper calendar and my appointment listed as my name and phone number, nothing else. Thus, I need to repeat everything to him that needs to be done to my vehicle today as he writes the estimate.

Paper appointment schedules are more of a roadblock than a help. Management systems all have a calendar function that, in its most basic form, is much better than any paper calendar. If you gather information from the customer during the making of the appointment and put it into your management system, you can use it to start an estimate, ultimately saving time for both the customer and yourself. This is especially appreciated during the morning rush. Getting customers in and out of the shop quickly and efficiently will improve the entire service experience.

Texting

Clear and quick communication makes the customer's experience quicker and cleaner. The phone is now more of an asset than ever. Texting is the newest and most efficient way to get in touch with customers. Text messages are viewed in under two minutes since they can be read anywhere and at any time. Better yet, customers will generally respond within minutes, helping your shop get the authorizations needed to get the vehicle service completed.

The shop I dropped my vehicle off at has the capability to text, so I made sure that they knew it was my preferred method of contact since I'd be in meetings all day. As the day passed, lunchtime had come and gone, and I was getting nervous about not hearing any word on the status of my vehicle. I was feeling just like a customer, because I was. During a meeting, my phone rings, and I see it is the shop calling. All I could do was silence the phone and wait for the meeting to end. Worse yet, I was distracted the whole time wondering what the shop may have found.

The meeting ended, and I quickly listened to the message the shop left to find out that nothing was wrong with my car and it was ready for pickup. Though I was relieved the car was done, I found myself frustrated by all the worrying I did for nothing. If the shop had texted me instead of calling, I would have been able to focus on my meeting instead of worrying.

Digital inspections

Performing digital vehicle inspection with pictures and video sent right to a customer's phone not only improves the service experience but builds a new level of trust between your customers and shop. Seeing is believing. With properly taken pictures, customers can see the "what and why" of your shop's recommended repairs or service. Unlike paper inspections in which the service advisor needs to explain each item, customers can look at the inspection as they speak with the advisor.

Digital inspections can also provide the customer with a history of the wear and tear on their vehicle. They can watch as the brakes wear down over time and are prepared to replace them when needed. The shop my car was at has these inspections, but for some reason, chose not to send me a copy until I asked for it.

You should also take the time to go over recommendations and future required services with customers. Once again, doing this prepares them for future work and costs while planting in their mind that they will need the money to pay for these items on the next visit.

Appointments

Why not set the customer's next appointment at this time, too? With all the recommendations that you just discussed still fresh in their mind, set the next appointment based on their driving habits. Calculate how many miles they drive a day, and set that appointment based on the type of oil used in the vehicle. Put the appointment in your management system calendar and discuss what recommendations should be done at that time. Even provide the customer with a cost estimate so that they can be prepared for the work due at that time. Don't stop at just setting that appointment; have a system in place that will remind the customer when it gets near.

Conclusion

When I arrived to pick up my car, even after being told it was completed, the service advisor still had to close out my paperwork. The advisor made it nearly impossible to have a discussion with me as I noted above. He needed to fly through the paperwork to close it, so he could print it. Worse yet, he was holding me up. I had just expected to pay and go. How could this have been a better experience? Don't call the customer until everything is completed, including paperwork!

These are just a few things that your shop can do to make each service experience a good one for your customers. Many of them are easy to do. You will find that there are multiple software solutions out there that can automate these simple tasks for you. You just need to find and use them consistently to keep your customers happy and coming back again and again.

JOHN BURKHAUSER is an auto repair specialist with more than 30 years of experience. As the Director of Education at BOLT ON TECHNOLOGY, John coaches independent and franchise repair facilities on how to grow their business using simple best practices and everyday technology, resulting in increased car count, repair order revenue and customer trust.
jburkhauser@boltontechnology.com

eSCOPE ELITE4™

Electronic Lab Scope 4 Channel

eSCOPE ELITE4
with Surface Pro 4 Tablet
(ESL3000)

eSCOPE ELITE4 (ESL3100)

eSCOPE ELITE4
Handle Articulation

Crystal Clear Diagnostics in the Palm of Your Hand

eSCOPE ELITE4 - 4 Channel scope

- **Capture All Data:** ATS' unique circular buffer system does not drop data.
- **Ultra Sharp Waveforms:** No need for filters that can mask data. ATS designs our scopes so the signal is accurate and clean.
- **Dual Time Base:** This allows two different frequencies to be displayed on one screen with two different scope displays, simultaneously.
- **Pull Down Circuit:** A Controlled pulse that sinks power from vehicle circuit to ground. Control circuits like ignition coils, fuel injectors and solenoids.
- **TTL Output:** Sends a 0-5v square wave signal out of scope. Turn on devices such as ignition coil drivers, test vehicle's circuits, and test vehicle's circuits for loading.
- **Automatic Test Lead Connection Detection:** This unique feature allows you to know the scope lead has a good connection. "Red"= Bad connection. "Green"= Good connection. It's that easy!
- **Patented Overlay Technology:** ATS' unique programming overlays an engine cycle grid over your waveforms.
- **Automatic Voltage Attenuator:** Just change the voltage setting and the scope does the rest.
- **Deep Record Function:** No time, voltage, or trigger setup needed.
- **Pressure Transducers:** Drives four pressure transducers at once.

ATS AUTOMOTIVE Test Solutions

automotivetestsolutions.com

800.572.6112

Available at NAPA AUTO PARTS · WORLDPAC Wholesale Distributor of Original Equipment Automotive Parts · CARQUEST · AE TOOLS & COMPUTERS

60 percent gross profit — fact or fiction?

It is a needed, strategic and intentional business approach. Are you ready?

I often hear: "Dollars pay the bills, not profit margins!" I agree, but you can't effectively manage your shop by dollars alone. Percentages, or Key Performance Indicators (KPIs), give you the ability to measure and manage your business, assess the integrity of pricing strategies and manage by each profit center. For example, using profit margin percentages, not dollars, to measure parts, labor and sublet profits allows you to compare results to your expected profit margin. If you're not meeting the expectation, you can dig into each profit center and diagnose where and how you lost gross profit dollars. Skilled service advisors, when building estimates, track profit on parts and labor per job by profit margin percentages. If you're just tracking dollars to manage your shop, how do you determine where and how you can improve? Let's listen to ATI's VP of Client Fulfillment, Bryan Stasch, share what he has learned from decades of experience with this question.

Using profit margin percentages to build your WIN # (Gross Profit Dollar need for your shop), then setting the daily production expectations in dollars for total sales, ARO and GPD for service advisors has proven to be a great recipe for successful shops. It's the combination of profit margin to create the plan and setting expectations in dollars that makes the magic happen.

WHAT HAS CHANGED FROM THE '80S? THE AUTO REPAIR LANDSCAPE HAS CHANGED, CREATING THE NEED FOR SKILLED SERVICE ADVISORS.

Choose a profit model

Profit models have been around as long as I can remember, but they weren't really explained to me as a profit model — more like parts pricing and technician pay. You know, your cost times two on parts and the technician gets 50 percent of the labor. That model would be 50 percent gross profit (GP) on parts, and an expected 50 percent GP on labor. Leaving 50 percent GPM for the shop to pay expenses and themselves. That was in 1984, and automotive repair shops were chasing 50 percent profit margin.

Here we are today looking for the supposed myth of 60 percent. Why? The auto repair landscape has changed, creating the need for skilled service advisors, who weren't needed back in the day because cars broke often, and plenty were to be found to create the sales shops needed. That's what has changed. Thus, ATI is creating a new profit model. Those additional 10 gross profit points are to cover the cost of the service counter and your advisors. You can do that or just accept the old school model and expect to make less money for a whole lot more work.

The topic of service advisors is now in question. "How many do you need in relation to the car count your shop needs in order to be profitable?" And that will vary from shop to shop and advisor to advisor; however, that money still needs to come from somewhere. You either build it into your profit model, like ATI's, or just eat the cost. Which makes the most sense?

60 percent gross profit on parts?

You better be very heavy on maintenance sales. The recommended matrix ATI uses is designed to hold a 53 percent GP by pricing strategy. That's only three percentage points over 1984. Three! Creating a pricing strategy for shop or job supplies, versus the shop eating those costs, adds roughly three to four points to the GP line. That would be 56 percent

to 57 percent GP. And those final few gross profit points are found in your service/repair ratio. What percentage of your sales are maintenance sales versus repair sales? Repairs are expensive, and we would encourage a lower markup on these parts. However, maintenance sales are a much lesser cost with a larger markup. So, achieving the 60 percent gross profit on parts is a combination of managing three key components of your parts sales: pricing, waste and service/repair ratio.

60 percent gross profit on labor?

Tech wages. The market sets the demand. And if so, and if we recommend building your labor rate based on the cost of generating labor, won't the market also dictate what the market will bear on labor pricing? You can't have both arguments. High tech pay because of the market should allow the market to support the rate. Economics alone tell us this.

But you definitely need to focus on your customers' value proposition. Do you know what makes you different? You can't just start throwing numbers around and expect not to get challenged. You need to focus on how you justify it. What do you offer your customers that they can't get down the street? You can't use the fact that you fix cars better than anyone in your market. I get it, most reading this will get it, but to the consumer, that is a low-level expectation. So, try going big or go home on warranties — like five years or so. How many of your competitors are willing to try that?

Another perspective on this: Let's say you are $5 more on the labor rate than a competitor. And let's say you are hitting the benchmark for Average Repair Order of 2.5 hours of labor; that is only $12.50 more ($5 x 2.5) for the job. If you can't justify the $12.50, I am afraid there is something else fundamentally broken at your counter, not your labor rate.

So, for the informed shop owner, 60 percent profit is not a myth. It's a much-needed, strategic and intentional approach to managing your business. We have tons of shops over the years that decided that this approach sure beats walking in every day hoping for the best and trying to push more cars through. And, in my honest opinion, isn't the strategy of just pushing cars through the shop and a swinging pricing strategy based on how loud a customer complains about pricing the level of thinking that put most shop owners in the position they are in, working way too hard for such a small return on their investment? History has taught us that many automotive franchises and multi-store operations used to operate with the "just give me cars to make GP dollars" mentality — but many went bankrupt when car count slowed down. The economy might be humming along right now; however, you can't stop the business cycle of recession, slow growth and what that does to car count five years later in independent shops.

Try the ATI WIN number drill

"Dollars pay the bills, not profit margins!" Yes, but you must know your margins. If you would like an easy-to-use tool that will allow you to determine the dollars and the margins to get there, click on the link below. This tool will let you determine what changes you will need to make to get where you want to go. If you need help filling out the boxes, listen to our Teleseminar on Creating a Win Number. For both the Teleseminar and the Win Number Drill, you can, for a very limited time, simply go to *www.ationlinetraining.com/2019-02* and learn what tons of successful shop owners have used to keep their businesses safe for decades.

CHRIS "CHUBBY" FREDERICK is the CEO and founder of the Automotive Training Institute. ATI's 130 full-time associates train and coach more than 1,500 shop owners every week across North America to drive profits and dreams home to their families. Our full-time coaches have helped our members earn over 1 BILLION DOLLARS in a return on their coaching investment since ATI was founded. This month's article was written with the help of ATI VP of Client Fulfillment Bryan Stasch.
chubby@autotraining.net

DO MORE WITH LESS

Get your staff to follow the three Es to ensure your shop productivity remains

DAVID ROGERS // Contributing Editor

The old saying "many hands make for light work" can sometimes go both ways.

Being shorthanded in any situation, especially in terms of staffing at a small business, can make it seem like you're swimming against the current, and every day is a struggle just to make a dent in your to-do list.

In the auto repair industry, making do with a smaller staff is fast becoming a reality. As we've all noticed, the quantity of quality techs entering our field in recent years has dwindled significantly, and the average age of an ASE-certified tech is getting higher and higher, currently sitting right around 45.

There are several reasons for this trend, all of which seem to stem from societal factors and none of which can be remedied easily. While we can't control how many techs are entering the industry or how many "hirable" techs are available in our given market, the one thing we can control is being proactive and putting ourselves in a position to do more with less by having good systems and policies in place. In my experience, the best way to accomplish this is to make sure your shop's culture is the very best it can be and that your staff members are 1) educated, 2) energized and 3) efficient!

Knowledge is power

Training is an element of this industry that a lot of shop owners are guilty of ignoring or taking for granted. Your employees need to constantly be on top of emerging trends, new technologies and modern equipment if you want to have a competitive advantage in your market, and they need to understand precisely how things work in your shop and what is expected of them for things to run smoothly.

There is no substitute for giving clear expectations. Proper training provides

PHOTO : GETTYIMAGES.COM / WAVEBREAKMEDIA LTD

an opportunity to get everyone on the same page and working together, towards the same goal.

Training removes any confusion or blurry lines from your process. It gives your culture a chance to grow in a direction that ownership can define and maintain influence on.

By choosing to constantly train, you quickly notice the chaos dissipating and the team engaging with customers and one another in a positive, confident manner. Training allows people to really shine as they begin to understand the parameters within which you wish them to operate. If knowledge equals power, then training is precisely what you need to fire up the engine of your shop and improve productivity no matter what your tech count might be!

Incentivize to energize

In order to properly motivate your staff and get the most out of your employees, having a good incentivized payment plan in place is an absolute must. Properly and positively rewarding good work and good workers who go the extra mile will ensure your staff is operating at an optimal level regardless of its size.

Many shops struggle with this concept. They fear that if they don't give the employees a salary or hourly pay, they will leave for a more stable situation. The truth is, only the lowest performing would prefer that over a great opportunity that is based upon their own production and effort.

There are many types of incentive pay plans in the industry. We have found that the vast majority of them have hidden disincentive traps built into them. You must test your incentives to make sure they do not become disincentives!

In my experience, improperly paying your employees can cause more problems for you than just about anything. Expecting a poorly incentivized team member to reach the goals of management is quite simply impossible.

When you let the team win when your shop wins, it stands to reason the team will work harder and there will be more winning all around. If they get paid the same whether you are slow or whether your shop is slammed, what is their incentive to get the work out more quickly? Why would they make the extra effort to make the shop busy every day? People need a reason to put in the extra effort day in and day out. Whether ownership realizes it or not, the type of people and the level of effort they will achieve is all a matter of how well we incentivize those people and whether we provide them with enough of the right training (and accountability) on a consistent basis!

Adapt or fade away

When it comes to efficiency, I can't stress modernization enough. The first thing that comes to mind when I think of modernizing is the customer waiting area and conveniences. Whether it be a loaner car program or an espresso machine and snacks with free WiFi and charging stations for personal devices, these are things that can set us apart from the competition and provide a quantifiable difference that customers will use and appreciate.

The concept of "modernizing" in our industry also gives me visions of how Artificial Intelligence (AI) can be utilized to improve shop efficiency. So many shops today are using five to 10 different computer programs to address each vehicle. They will sign the customer in on a POS program, look up diagnostic info on another, use yet another to order parts, and then possibly use another one or two programs to look up and compare labor times. Add to those another couple of CRM programs, plus another one for marketing, and you have a tangle of expensive and outdated processes.

All these programs have different passwords and hoops to jump through in order to get the job accomplished. Plus, none of these ancillary programs seem to talk to one another, or work in an integrated manner, no matter what claims are made to the contrary. This completely hamstrings the processes and efficiencies and is the major obstacle to making progress and improving productivity via modernization.

The future is much more streamlined and doesn't include all that hopping around. AI will allow us to achieve much more work with less employees, even techs. We are experiencing that in our own shop (Keller Bros. in Littleton, Colo.) right now where we're producing well over $3 million in annual revenue with only four techs in a smooth, stress-free manner thanks to the integrated management platform we use. We encourage our peers to jump on board with this idea and drop all the "standard" programs and processes that eat up so much time and profit and require multiple staff members to operate.

Staff shortages have certainly been known to cause headaches and heartburn. But if you have the right systems and the right personnel in place, being shorthanded won't be as big of a liability as you'd think. It may even teach you how to be more productive when fully staffed thanks to the lessons learned while doing more with less. An auto repair shop is like an engine, and having a well-oiled machine complete with staff that's educated, energized and efficient is essential to keep your motor running no matter what!

DAVID ROGERS is chief operating officer of Keller Bros. Inc., president of Auto Profit Masters and president of Shop 4D, the industry's first Artificial Intelligence (AI)-enabled, self-learning system for proactively managing repairs, customers, marketing, profits and employees.
contact@shop4d.com

Work better "on" your business with this checklist

Learn what you should be doing during your "office time"

Many shop owners have an issue with spending time daily in their office to work on their business. They are consumed with working in their business. One reason for that is they truly don't know what to do with their time in the office.

Consider that "office time" should be all about "How do I make our business better and more productive than what it is today?"To answer that question, one must have another series of questions that help guide them to the ultimate answer(s).

Think about these questions to get you started. These are not questions that can be knocked off in one office session, but may take a couple of months to think about and determine an answer that will truly move your business forward. Determine which questions could become a great staff meeting with the team so that there are encompassing solutions that everyone believes in and wants to be part of.

1. We face increased competition and/or shrinking margins. What should we do and what will be the effect on the business?

2. We need to better understand our target clients — who are they, why do they buy and what do they really want? What is our internal game plan to build a long-lasting, trustworthy relationship?

3. We need to do a better job of creating client value and experiences that will clearly differentiate us and grow our bottom line. What do we need to fortify and how will we do it?

4. We need to do more business with existing clients and attract new and profitable clients. Are we only measuring sales and car count or are we measuring billed hours per client?

5. We don't charge as much as we should. Define what is our specific problem — how are we going to fix that?

6. We need to find ways to promote our business in a market where traditional advertising is too expensive. What is the right plan for our business?

CONSIDER THAT OFFICE TIME SHOULD BE ABOUT "HOW DO I MAKE OUR BUSINESS BETTER AND MORE PRODUCTIVE THAN WHAT IT IS TODAY?"

7. We need to increase bottom-line profitability. What must become our key focus to achieve the result we desire?

8. Our industry faces trust and image issues that we must overcome to create client confidence. What is our internal game plan?

9. We serve a shrinking or declining market and need to reinvent or relocate ourselves. What plan must we build?

10. We need to find, motivate and retain top performers at every level of our shop. How are we going to do that and what are the results we expect?

11. There's a need to improve our focus and productivity. Do we believe in accountability as an important part of our business culture?

12. We need to train and develop our staff more effectively. What courses are required and where/when are they held?

13. We need more clarity and consistency from the top. Is management fully accountable to the business?

14. What is wrong with our current communication and what must we do to correct it?

15. We need a clearer vision for the future of our business and a plan to get us there. Will the plan have proper and accountable timelines?

16. We do not have the working capital we need to operate or grow the business effectively. What must we do to achieve that and what is the timeline?

17. Our industry is changing quickly. Are there specific courses we must take to clarify our industry and business knowledge?

18. There's a lack of clarity about who will lead our business in the future. Do we have a proper succession plan in place?

After dealing with the above questions thoroughly, you will be in a position to address the next level of thinking.

I hope you now can see how valuable your time in your office can and will be. You are the owner and or manager of the business. Please make yourself accountable and earn your paycheck just like the rest of your team earns theirs. MA

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

O'Reilly FIRST CALL
DEDICATED TO THE PROFESSIONAL

INDUSTRY-LEADING

ALTERNATORS & STARTERS

FROM ULTIMA SELECT

Let us be your Parts & Equipment Supplier

www.oreillyauto.com/professional-catalogs

100% NEW
NOT REMANUFACTURED

ULTIMA SELECT

STARTERS

- High-strength armature connections guarantee consistent and reliable starting
- The highest power and cranking torque to handle the toughest starting conditions

ALTERNATORS

- Industry-leading electronics eliminate common failures caused by voltage spikes
- High performance copper windings generate optimal electrical output

AVAILABLE EXCLUSIVELY AT

O'Reilly FIRST CALL
DEDICATED TO THE PROFESSIONAL

O'Reilly PARTS PAYOFF

REWARDS FOR PURCHASING & INSTALLING THE BRANDS YOU KNOW & TRUST
FOR DETAILS VISIT FIRSTCALLONLINE.COM

FIRSTCALLONLINE.COM
Visit our website for a complete, internet-based catalog designed exclusively for the Professional.

ADV 1369


it's a partnership.
PartsPro

Government shutdown causing unfinished business

Lack of legislative and regulatory progress impact automotive industry

Embarking on the longest federal government shutdown to date, funding for Fiscal Year 2019 Transportation is just a small piece of the unfinished business that threatens all segments of the automotive and transportation industries. The standoff is between the Administration and Congressional Democratic leaders over funding for the wall versus FY 2019 funding for the seven remaining appropriations bills, including Transportation. This funding package is impacting states with highway and other projects until there is an agreement reached.

The federal government shutdown is just part of the dilemma faced by the automotive industry. Prior to the end of the 115th Congress, the Senate failed to consider the U.S. Senate Commerce Committee's AV START Act, autonomous vehicle legislation. In addition to Congress not providing states a set of rules for research and implementation of vehicle technologies, more importantly for automotive repairers, the Senate bill addressed vehicle data access and cybersecurity. Without direction from Congress or the National Highway Traffic Safety Administration (NHTSA), states are left to address these issues on their own.

Although NHTSA — during both the Obama and Trump Administrations — issued guidelines for new vehicle technologies (i.e. the roles for states and the federal government), they are only guidelines. Numerous states have moved on research and deployment rules for new vehicle technologies, but the data access issue, critical to independent repairers, has been left in limbo. This will likely lead states to attempt to address data access and related cybersecurity issues on their own, as in Massachusetts, where legislation has been introduced expanding the scope of the 2013 state Motor Vehicle Right to Repair Law proposing several key changes:

- "Mechanical Vehicle Data," any data in a vehicle related to the diagnosis, repair or maintenance of that vehicle
- Access to vehicle onboard diagnostic systems shall be standardized and not require the use of any authorization, directly or indirectly, by the manufacturer. Manufacturers may utilize an authorization system for access to vehicle networks and their onboard diagnostic systems that is standardized and is administered by an entity unaffiliated with a manufacturer.

Without specific guidance or an industry agreement, repairers could face a 50-state footprint of varying regulations. This will work against independent repairers and OEMs. Collision repairers face this regulatory model today with every state insurance commissioner and legislature having a shot at regulating how consumers, repairers and insurance companies interact.

The Automotive Service Association (ASA) inquired of NHTSA as to the possibility of addressing data access in the foreseeable future, and NHTSA was very clear that this would not occur without Congressional action.

Looking ahead at the federal level, Congress must first address U.S. Department of Transportation funding for FY 2019. The new Chairman of the House Transportation Committee, Peter DeFazio (D-OR), has made transportation infrastructure the Committee's most immediate priority. Some related new vehicle technology issues could arise in this debate. The House Energy and Commerce Committee has jurisdiction over the data access and cybersecurity issues related to new vehicle technologies, and Chairman Frank Pallone (D-NJ) has not indicated a committee agenda as of this writing, but there is increasing party pressure for climate change to be a priority. If a federal data access and cybersecurity policy is not implemented soon, states will move forward. Independent repairers can look for additional state and federal activity with Congress' inaction offering no clear data access policy path.

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. *rlredding@reddingfirm.com*

FVP®

VERIFIED. PROVEN.™

REACH FOR WHAT WORKS.™

PLATINUM AUTOMOTIVE BATTERIES

The FVP Platinum Battery lineup:

- Engineered to meet exact OE fitment specs
- Backed by nationwide free replacement warranty
- Distributed by Factory Motor Parts

Visit FVPparts.com for more!

FMP

FACTORYMOTORPARTS™

WE SUPPLY YOUR SUCCESS.

Diagnosis: Less dollars

Shop owner knows that time counts when uncovering vehicle issues

ROBERT BRAVENDER // Contributing Editor

There aren't too many shops that tender a question in their title, but Why Pay More Auto Service makes perfect sense when you think about it. Founded in 2012 on the principal of sound diagnostics, owner Russell Bates felt that customers were paying an excessive amount of money just to learn what was wrong with their car.

"I've always thought if I can't get a good grasp of what's wrong within a solid hour, then something's wrong with me because that's a long time to be looking at a car," Bates explains.

"If you spend $800 and we don't fix your problem, that's back on me because I didn't do my job correctly. I feel we have enough equipment, enough tools, enough knowledge, enough databases that we can get 90 percent of the stuff diagnosed and repaired right the first time.

"Is it an easy thing to do? Absolutely not," Bates continues. "We make mistakes, but it's my job to stand at that counter and tell the customer that we screwed up, we missed it, and we're going to take care of it. You'd be surprised how many people appreciate that."

A lifelong resident of the Baltimore, Md. area, Bates explains that while his shop is only seven years old, he's been in the industry as a technician for over three decades. His reputation is such that a former instructor recommended him for an Automotive Service Excellence (ASE) panel to help refine their certification test.

"I think there were 11 invites from across the country," recalls Bates. "But with hundreds of thousands of qualified technicians available nationwide, I wondered 'why me?'" This question led him to ignore ASE's calls at first. "I hung up on the guy; I thought it was someone in the shop screwing around," he laughs.

But once he learned it was legit, Bates headed to ASE's headquarters in Leesburg, Va. "They basically wanted us to look over (their questionnaire) to decide if there was a right answer, a wrong answer or a 'maybe' answer," he explains. "We got rid of the 'maybes' to help guys understand the test better. I did three categories: electrical, brakes and engine performance.

"I was known for electrical work when I was a technician," he notes. "I brought it with me when I opened this shop up, and I always try to hire somebody who at least understands how a power circuit works and how a ground circuit works, because I can teach them the rest."

WHY PAY MORE AUTO
Essex, Maryland // www.whypaymoreauto.com

Russell Bates
Owner

5
No. of employees

1
No. of shops

3
No. of bays

6
Years in business

Bates has incredible acumen for electrical systems. "For some reason I can look at wiring diagrams and understand where everything's going, what it's doing," he observes. Plus his insights help teach others. "I told [a technician] 'don't ohm anything out anymore; do voltage drops — it's more accurate. It's a better picture of the circuit' and [the technician] said 'I've never had someone explain it to me that way before.'"

Bates' need to go independent is even easier to explain. With his regular job 25 miles from his house, Bates got the okay from his employers to do some side work from home. "But it got out of hand one week," he notes. "There was so much to do I took a vacation from work to just get caught up. Then my wife asked if I could make this work all the time."

She offered him a bet: if he got through the week and still had work scheduled for the following week, Bates would put in his notice and give independence a shot. It did, he did, and the Bates family was going into business for themselves. With a financial partner, Bates set up shop with just his toolbox, six jack stands

PHOTO: WHY PAY MORE AUTO

and two floor jacks. "I didn't get my first lift until about seven months into it. Since then I've kept adding."

To that end they recently moved to a new location within the town of Essex, part of the metropolitan Baltimore area. A repurposed gas station, Bates' crew overhauled the building and are entertaining plans on enclosing the old gas pump canopy and adding two lifts for work trucks.

"If you're capable and you have the facility, do the heavy duty, too," says Bates, "because that's going to combat your slow times. If you get that mix of everything, as an owner you're going to be busy throughout the year.

"We have been extremely busy for the past 8-10 months," notes Bates, "and I make a point with every new customer who walks in here to ask how they heard about us. That's very important to me, because one, if somebody is recommending us, I want to tell them thank you. Secondly, I need to know if my advertising is working or is this word-of-mouth.

"We've gotten probably a 60 percent increase in new customers," he remarks. "Looking at the notes being put on the work orders, probably 80 percent of it is word-of-mouth. The other 15 percent would be internet reviews. I do very little paper advertising; I pretty much keep all my advertising dollars to the internet because that's what driving them in here."

What Bates emphasizes on the internet is also what he teaches his technicians. "We're not like everybody else," he maintains. "There are other shops, so the difference has got to be the service. That's what we can control the most — the service the customer gets as they walk through the door.

"I've always wanted to make the customer feel comfortable, to relax, to watch some TV," he continues. "I keep very little auto advertising up front; I want people to come in, sit down, read a book, use the WiFi, be comfortable. Everything that we do that is the service end of things; I try to do top notch. That's what sets us apart."

With the auto market shifting drivetrain technology to electrics and hybrids, and self-driving cars becoming a very real possibility in the near future, isn't that reason enough to ask Why Pay More?

ROBERT BRAVENDER graduated from the University of Memphis with a bachelor's degree in film and video production. He has edited magazines and produced shows for numerous channels, including "Motorhead Garage" with longtime how-to guys Sam Memmolo and Dave Bowman.
rbravender@comcast.net

Preparing your team for the technology tidal wave

GETTING READY FOR THE FUTURE WILL NOT BE EASY — BUT IT IS NECESSARY

CHRIS CHESNEY // Contributing Editor

With the tidal wave of technology on new vehicles, you need to prepare your team to service and repair highly complex vehicles. What I'm going to suggest will require significant change in the way you do business. It is going to mean you need to pay for the talent required to solve problems with complex machines and systems. It also means you're going to have to invest in the right equipment and information. You're going to need to raise your labor rate and modify how you price and communicate value to your customers.

We as an industry are woefully unprepared to be working on the vehicles in our bays today. I fear we don't have enough skilled people who truly understand the foundations of electricity and physics of the technology in a way needed to provide confidence in the owner of the vehicle. This takes time to acquire and deploy. So, let's look at three groups who we need to support in this effort: your technicians, your sales team and your business model.

Most of the vehicles in your bays today are equipped with a data network that requires a technician with a solid electronics foundation to understand and repair. So, the first step in becoming prepared for future technologies is to ensure anyone working on these technologies has a deep understanding of foundation electrical/electronics and is fluent in data network analysis and diagnosis. These skills include the ability to effectively use a factory wiring diagram and a digital storage oscilloscope; it means being able to read with full comprehension the service information provided for the system being serviced. It also means that not only can the technician understand and apply what they read, but that they have the ability to teach these skills to others.

How do you put this process in place to create competent electronics experts? First, you need to identify those who have some or most of these attributes. Work with your training provider to schedule foundation electrical classes with hands-on sessions in your market so that you can enroll your entire team. Inexperienced techs need to be exposed to the foundation skills, and your experienced techs need to refresh their foundation skills. Your advanced techs will mentor your less experienced techs during class and especially during hands-on exercises. Keep in mind that it is not easy to ask a journeyman technician to attend a foundation electronics class; ask them to attend to assist in mentoring your younger techs, and the context in their mind changes. But don't stop there; find advanced courses for the mentor where they can grow their skills in the discipline where they can become the mentee.

For your service sales team, the challenge is massive because we have such a gap in understanding of technology that allows easy explanation of the service or analysis process to the customer. To close this gap, require your sales team to attend technical classes. The goal is to immerse them in the terminology, diagnostic process, tests required and complexity involved so they can begin to create the word tracks they will use to help motorists understand not only how the technology works, but how it must be serviced, why it takes time to do so, the significant skill needed to service it correctly, and most importantly, the risk involved in cutting corners, skipping steps or not doing the service at all.

Finally, your business model must be updated to provide for the margins needed to pay for talent in a way that attracts young people to our industry, retains existing talent and provides a great return on investment. This means you need to charge enough and pay enough. The owners of these technology-laden vehicles don't communicate like our older customers. They expect you to provide exceptional service that makes them go "Wow!" It means you need to be different, but most importantly, it means you have to be perfect in your ability to service their technologies right the first time. Because you are only going to get one chance before they decide you aren't the right choice.

CHRIS CHESNEY is the Senior Director of Customer Training for Carquest Technical Institute (CTI) and Advance Professional.
chris.chesney@carquest.com

BUY THE SBA & ATTEND THE EXPO FOR FREE!

SBA

SHOP BUSINESS ANALYSIS

AMI AUTOMOTIVE MANAGEMENT INSTITUTE
Course Approved for Elective Credits

GET A DIAGNOSTIC CHECK OF YOUR SHOP

The Shop Business Analysis (SBA) will evaluate the key points in your business:

- Website
- Sales
- Marketing
- Finances
- Social Media
- Production

For a limited time, you can purchase the Shop Business Analysis for $395 and receive 2 tickets (with some meals included) to DRIVE's premier networking and training event. The SBA will evaluate all areas of your shop and provide you with a detailed score card, as well as suggested improvements. This amazing package will give you everything you need to take your shop to the next level!

For more information, visit:

www.DriveShops.com/sba

D

Your Shop • Your Success • Supercharged

For more information on how DRIVE can help your shop call 818.863.8898 or visit www.DriveShops.com

Savannah, GA | March 22ND-24TH, 2019

DRIVE EXPO 2019

Collision, General Repair & Heavy Duty Truck

Amazing guest speakers and sponsors:

I-CAR • SCRS REPAIRER DRIVEN • asTech • REPAIR PAL • NAPA • MERITOR

Networking • Interactive Workshops • New Technology

SAVANNAH MARRIOTT RIVERFRONT

100 General McIntosh Blvd, Savannah, GA 31401

SAVE YOUR SPOT TODAY

Visit www.Drive-Expo.com
or call 818.546.5866 for more information

WHEN VOLTAGE DROP STRIKES

UNWANTED CIRCUIT RESISTANCE CAN "STEAL" FROM THE PRIMARY LOAD AND IMPACT ITS FUNCTION. LEARN HOW TO CATCH A THIEF!

G. JERRY TRUGLIA // Contributing Editor

In this article on voltage drop (VD), we will explore what it is, how to check for it and share some vehicles that I have come across with VD issues. Let's start with an explanation of VD so you can better understand what we are dealing with. Remember that there are many vehicle problems with a component or system not working right that can be traced back to a voltage drop. Have you ever noticed a vehicle driving down the road with one headlight that is not as bright as the other? How about a vehicle that has high LTFT numbers? A blower motor not turning fast enough or a rear window defroster that partially clears the window? Well, if you answered yes to any of them, you have experienced VD.

A dynamic problem found with a dynamic test

You should know that voltage drop = electrical resistance that we measure in Ohms and check dynamically by performing a voltage drop test with our volt meter. There are many connections on a vehicle that may contribute to a VD issue, such as loose, stripped or crushed connections and broken wire strands. We cannot expect damaged wires or loose and dirty connections to provide the proper current flow or voltage. If all connections are not intact and well connected, the result will be unwanted resistance, and that equals a voltage drop. A VD problem will prevent the proper flow of current causing a starter motor, bulb, blower motor, solenoid or any other electrical device from performing as designed. In other words, VD results in the poor performance of a load.

Let's consider a vehicle's headlight that is dim even after it has been replaced. What is the next step in getting that headlight to operate correctly? We know that many techs have a Power Probe or if not, they at least have jumper wires that they can use to test the circuit quickly. This quick test is just that, a quick test that can be utilized at the load to see if the headlight will illuminate correctly. Take the Power Probe/fused jumper

1

wires and apply power to the B+ side of the circuit and see if there is any noticeable change to the brightness of the headlight. If it helped or not, never think you're finished until you apply ground to the negative side of the headlight. If the headlight now illuminates to the level of the other headlight, you now know that there was a bad ground, but what you don't know is how much of a voltage drop there was.

Now let's try using a VD check the correct way so we can measure the exact amount of VD. First, we will start with the DVOM. The DVOM, when it is set to read voltage, measures the voltage potential between the two leads. Keep this in mind as you take your measurements so you can learn how to speak the language of the meter. Connect the leads to the battery positive and negative post. You should read the battery's voltage potential on your meter. On a healthy, fully charged battery, that potential will be 12.6 volts.

Next, leave the positive lead at the battery post and take the

PHOTOS: G. JERRY TRUGLIA

negative lead of the meter and go to the positive side of the headlight. With the headlight "on," the meter will measure the voltage potential (difference, or drop) in the circuit. In other words, all of the available voltage (that is, all of the 12.6 volts you measured at the battery) should be going to the headlight that is being checked to make sure that it did indeed make it to the battery, give or take a couple hundred millivolts. This is followed by taking the negative test lead and placing it back on the battery negative post followed by taking the positive meter lead and going to the negative side of the headlight. The meter is still on the DC voltage scale and will provide the exact reading of the drop.

In this example, let's say your meter reads 00.90 on the meter's 40/60-volt scale. How much of a voltage drop is the meter measuring? That's right — 900mV. Let's take a look of a voltage drop test on a vehicle, since a picture is worth 1,000 words. In **Figure 1**, we have our Power Probe connected to the vehicle's battery and then connected our meter's positive lead to the Power Probe positive tip (note the rocker switch is depressed to the positive position as indicated by the red light) while the meter negative lead is connected to the starter positive post.

An important thing to remember when performing a voltage drop is to always make sure that the load is "on." There will be no voltage drop if no current is flowing. In this case, I have my tech up in the vehicle so he can crank the starter over while the meter captures the voltage drop. The complaint on this vehicle was that the engine cranks over slowly intermittently. Can you see why? Yes, that 00.96 equals 960 mV, almost 1 volt on the feed/B+ side. Now how about the ground side?

Well as you can see in **Figure 2**, the reading there was 320 mV for a total voltage drop of 1280 mV or 1.28 volts. As we know, the battery has 12.60 volts before we crank the engine over. The voltage usually drops about a volt or so, making the available voltage level about 11.60 minus our 1.28 voltage drop, only leaving 9.8 volts available. Now add in mechanical resistance from a cold motor or thick oil and "Bingo!" — we have a starting problem. Does that make sense? If not, as we continue on, we will have more real-world examples to help you grasp the concept.

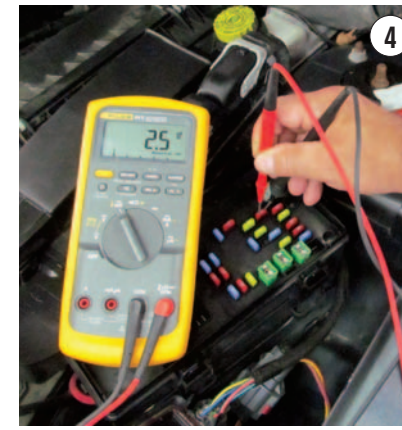
Essentially, a voltage drop test measures the reduction in voltage due to resistance (more than normal/excessive) in the circuit. It is impossible to get a 0v voltage drop on a working/complete circuit. A reading of up to 200 mV is permissible on a non-computer circuit, while when dealing with a computer component, 100 mV or less is permissible. To measure the small amount more accurately, scale your meter down to the mV scale. Another thing to also remember is that there are 1,000 mV in 1 V. For example, 1.11V = 1,110 mV. When performing a voltage drop test on mV DC scale and the meter displays "OL," you definitely have VD, and you need to take care of it!

Real-world examples of a thief at work

Our next example is checking a voltage drop on an engine with an open ground circuit (**Figure 3**) at the intake manifold. The volt meter leads are connected a little differently than what I described earlier when doing the starter circuit ground check. Here, the negative (black) meter lead is attached to the battery negative post and the positive (red) meter lead is connected to the engine's intake manifold.

If you look at the battery negative post, you will notice that the cable is disconnected from the battery on purpose. The volt meter is reading 11.87 volts — equal to the battery's voltage level.

If the two measurements are equal, there is 0v voltage drop. If our meter



leads were placed in the same manner as our starter circuit test, the meter would read exactly that — 0v. Since everything in a circuit has some resistance, we should always measure a few hundred millivolts. A perfect reading like this reveals the true reality. There is no current flow and no voltage drop, likely due to an open (or infinite resistance) between our two test leads.

A great use for voltage drop testing is testing for Parasitic Draw. Again, every component in an electrical circuit has some resistance, and voltage will "drop" across that resistance, even if it's a small amount. But only if current is flowing, remember? And isn't that what we're

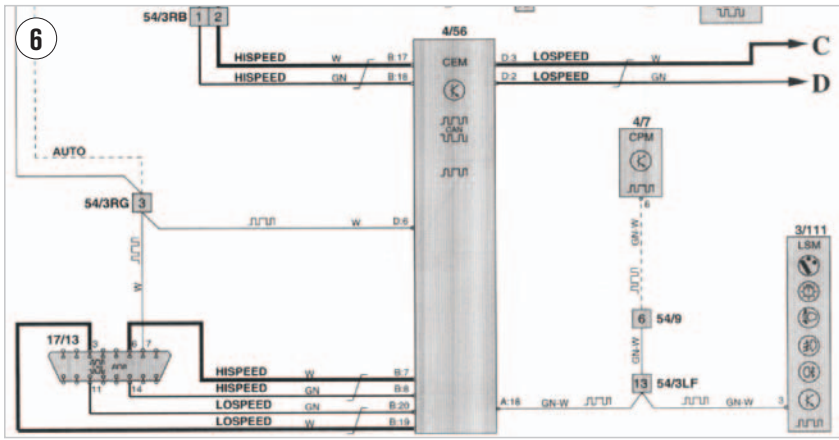
looking for when chasing down a parasitic draw — something that is flowing current when it isn't supposed to? To use the voltage drop method (**Figure 4**), place the meter lead ends on the exposed metal blade tops with the meter set to mV. This method is not usable on all fuses, but for this example we have fuses where the metal is exposed on the top. If the lead ends are connected correctly, the meter will either read 0 or a mV reading as the one pictured. If the meter reading is bouncing all around (numbers not steady) you are not connected correctly to the metal of the fuse.

An important point to remember is that there is NO voltage drop if the load is NOT on. So, if the lead ends are connected properly, you will either get an mV reading that indicates a voltage drop, thus equaling a parasitic draw, or zero, which means there is no draw.

Case studies

A Ford Explorer came in with a no-start complaint that was traced down to a voltage drop. The vehicle owner had already replaced the battery and the starter motor before he had the vehicle towed in. While performing a voltage drop on the B+ side, there was nothing abnormal, but it was another story on the ground side. The meter indicated a reading of 8-plus volts that was causing the no-start condition on this Ford. We made a temporary ground cable so we could start the engine up and drive the vehicle into the bay. We attached both ends of the negative clamps from our jumper cables, placing one at the negative battery post and the other to engine block. With those connections, the engine cranked over and ran. Since the temporary cable worked, we knew that we had to check the negative cable. Take a look at this source of voltage drop! This major ground (**Figure 5**) is a common problem on many vehicles that have a battery that has an out-gassing issue leading to cable corrosion.

A 2005 VW Jetta came in with another recurring issue — the fuse box that is on top of the battery is melted. This has been a problem that goes back at least to the 2002 model year on VWs. A common mistake that is made is just replacing the fuse box and not finding the root cause of the problem. Each of the terminal wire ends needs to be checked very carefully for a VD. There has been an issue with the wire insulation not being totally stripped back from the factory that causes amperage to flow through less strands. The current flow through a small area of wire strands causes heat buildup due to voltage drop. Since the circuit is not designed to flow the high demand of current through a small connection, this causes the voltage drop. The most common terminal that causes the box to melt is the black wire that goes to the alternator, followed by the cooling fan terminal. Before you change the fuse box, it is recommended that you open up the terminal ends and make sure the connections have full contact with the wire. The fix for this vehicle was new terminal ends with full contact of the wire strands, heat shrink and a new fuse box.



Our next case study is on a 2000 Volvo S80 that came into our shop about 12 years ago with the complaint of no start, no crank and shifter locked out. Even though this is a case study from a while back, it has very important information that can help bring a voltage drop issue to life. I sometimes use this case study when I am teaching a class to show a more advanced voltage drop problem. I believe that the information will help you to understand what VD can do besides prevent a motor, bulb or load not to function as designed. The vehicle owner stated the vehicle was starting and running normal until the no-start issue appeared. We started our diagnostic procedure as we usually do, by asking the customer when it happens, if any work was recently performed, followed by a visual inspection.

Our visual inspection at first did not uncover anything unusual, so we moved on to scanning the vehicle systems by connecting our Autologic scan tool. At the time, the Autologic blue box Volvo software provided very good information, along with vehicle programming capabilities. The scan tool uncovered a problem with no communication, so we installed our BOB (DLC Breakout Box) and checked for power at Pin 16 along

with ground at Pin 4. The results of our voltage checks were normal, so before getting ourselves in too deep, we checked for TSBs and information in Identifix and iATN. Neither information sources had any published information regarding our problem. Since we came up empty handed, we looked in ALLDATA and ProDemand to check the wiring diagrams and traced them out. We found that the system we were working on was a CAN (Controller Area Network) system, which meant that there could be something on the BUS that was preventing scan data from being transferred to the scan tool.

Next, we connected labscope leads to Pins 6, CAN High and Pin 14, CAN Low (high speed CAN) looking for the normal square wave, but that's not what the scope displayed on the screen. We proceeded to check Pins 3 and 11, which are a low-speed CAN network that are the communication lines for the CEM (Central Electronic Module) — aka body module. The results that we found were the same issue — no square wave communication. When you look at the wire diagram (**Figure 6**) you will notice that the low and high-speed lines both go through the CEM, making it the best place to start.

Our next step was to locate the CEM in ALLDATA, then seek out its physical location under the left dash. Looking at **Figure 7,** you'll notice the burn at the pin connections caused by a poor connection — aka high resistance — resulting in voltage drop. Another problem that we uncovered was a water leak caused by clogged body drains. The clogged drains allowed a path for the water to drip right down onto the CEM connection — not exactly helping our poor connection or possibly causing it. Our next step was to repair this problem by cleaning the drains, making sure that no more water would be able to leak down on the CEM. We followed that up by cleaning the connections and applying Stabilant 22A to enhance them before we reinstalled the new CEM. After the physical repair was complete, we had to program the module with the Volvo software so that the engine would start. With the engine now running, the only thing left was to check the gear shifter issue. We proceeded to move the shifter in all the different gears to make sure they all worked then test drove the vehicle. After the test drive was complete, we ran another vehicle scan of all modules making sure that everything was back to normal. The Volvo was now over the VD issue and was ready to ship out.

I hope this article has shed some light on VD and has helped you better understand one of the biggest problems that we facing when diagnosing today's electronic load vehicles.

G. JERRY TRUGLIA, ASE World Class Triple Master Technician Auto, Truck & School Bus, L1, L3, F1, A9, X1 C1, is president of Technicians Service Training and a nationally recognized trainer/author. He founded TST to bring affordable training to fellow techs and owners.
gtruglia@tstseminars.org

THE ABCS OF ELECTRICAL DIAGNOSTICS

JUST LIKE WHEN YOU FIRST STARTED LEARNING, MASTERING THE FUNDAMENTALS HAS TO COME FIRST!

SCOTT "GONZO" WEAVER //
Contributing Editor

We've all learned the ABC song and how to count to 10 as one of our first "organized" instructional classes, even if we didn't know that's what we were doing. Now, as adults, we're still learning the same basic golden rules — albeit just a bit differently than our ABCs. As an adult, we follow a flow chart — the basic fundamentals of an electrical circuit — which is like following along with the traditional kindergarten ABC sing-a-long song.

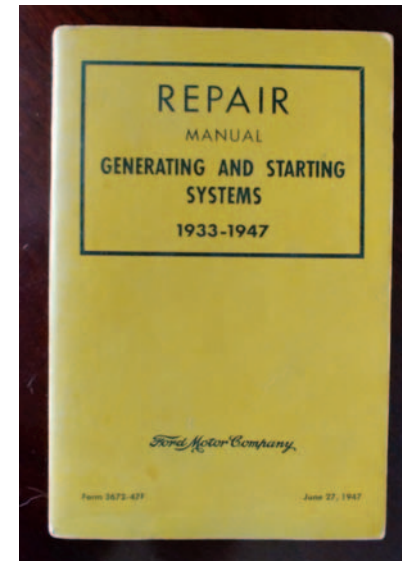
As with the ABC song, nearly every type of repair scenario starts with the right approach, and the right starting point can make all the difference. If you start on the wrong end or somewhere in the middle, it's like trying do the ABC sing-a-long song backwards. (OK, go ahead, try it.) It isn't so easy, huh? In this article we're going to go through the ABCs of basic electrical diagnostics from easy to a somewhat complex electrical circuit diagnosis.

Early systems

Throughout the history of the automobile, electricity has been a part of its makeup. For a time, 6-volt systems were the norm. Then in 1955, the 12-volt systems became the standard. Positive grounded vehicles were popular for a while due to the fact of the woven fabric-covered wire, which had the tendency to absorb moisture. The positive ground reduced the galvanic effect and corrosion that was common on the negative grounded vehicles of that era. Then during WWII, a plastic-coated wire (PVC) was developed, which greatly improved the wire quality and integrity tremendously, and the galvanic problems with the copper wires was nearly completely eliminated. This led to the standardization of the negative grounded vehicle.

Computer systems

With computer systems and high-tech components, the complexity of the electrical systems in today's cars has certainly increased. However, the basic principles of electricity haven't changed at all. Voltage, amperage and resistance are still the three main concerns. However, the critical nature of each has been greatly increased and are by far more susceptible to environmental issues and circuit condition than ever before.



A FORD REPAIR MANUAL COVERING 1933 TO 1947 for the generating and starting system consisted of only 41 pages to cover every detail of the system. Forty-on pages is just the introduction to today's complex charging and starting systems.

Simple circuit diagnosis — beginners only

Let's use a simple bulb, two wires and a voltage source as an example. Voltage runs from the battery through the bulb filament and back to the negative terminal lead, completing the electrical path, thus making an electrical circuit in its simplest form. Now let's look at what would happen if we took the negative lead off of the battery terminal. Of course, as you would expect, the bulb goes out because current flow has ceased. But what's happening to the positive voltage? Has it gone back to the battery and will decide at a later time to flow down the wire? No, not hardly.

This is a unique characteristic of electricity. Each polarity will reach out as far as it possibly can to find its opposite polarity. (Talk about opposite attraction). The disconnected lead is nothing more than an extension of the battery-positive terminal. (OK, technically there is a touch of resistance added by way of the bulb filament.) Keep in mind, the positive voltage is still at the end of that

PHOTOS: SCOTT "GONZO" WEAVER

AUTEL MAXISYS

WORK SMARTER NOT HARDER

DIAGNOSTIC INTELLIGENCE

NEW

POWERFUL HARDWARE

- 1.3GHZ + 1.7GHZ Hexacore Processor
- 64G SSD Memory/32G Micro SD Card
- 8M Camera / 2 USB Ports

NEW

4.4.2

SMARTER SOFTWARE

- Bi-Directional with Advanced Coding
- Data PIDs from Vehicle Modules
- Advanced Service/Reset Diesel Emissions
- Key Programming/ADAS Identification

MAXIFIX & MAXICLOUD

Database of Repairs, Diagnostic Tips & Procedures

DATA LOGGING

Live Troubleshooting with Autel Tech Support Team

Compatible with the MP408 Oscilloscope & MaxiVideo Digital Inspection Scopes

PRE-SCAN & POST-SCAN
COLLISION REPAIR READY SOFTWARE PACKAGE

PURCHASE INCLUDES:
- Tablet Tool
- Complete Connector Kit
- Durable Carry Case
- 1-Year Software Updates
- 1-Year Warranty

WATCH NOW
AUTEL.COM
MAXITPMS.COM
HOW-TO-USE

AUTEL TRAINING ACADEMY

YouTube TRAINING VIDEOS
@AutelTools

AUTEL TECH SUPPORT INDUSTRY LEADER

Phone: (855) 288-3587 • USSUPPORT@AUTEL.COM
AUTEL.COM • MAXITPMS.COM • MAXISYSADAS.COM

AUTEL LIVE CHAT TECH SUPPORT

Follow Us @AutelTools

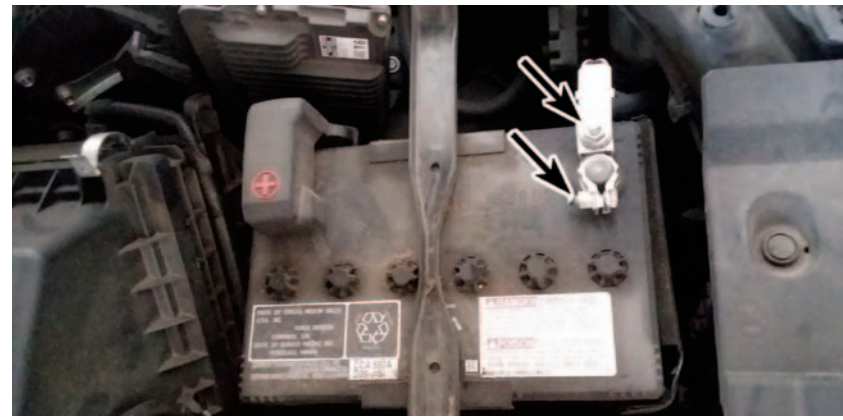
AUTEL®

wire lead, and if that wire lead happens to find another pathway to ground, it won't hesitate to take it. For the novice technician, when a scattering of electrical spark should appear it is usually followed by the complementary convulsive reaction to the sparking wire.

Open (incomplete) circuit issues

One common occurrence is the open circuit problem. An open is exactly what was used in the previous example. In other words, an incomplete path of electrical flow. In most circuits, a loss on the positive side (such as a blown fuse) basically brings the entire circuit to a complete halt. (We'll cover a blown fuse a bit later.) But, on a few occasions, you'll run across the dreaded "feedback" effect after the original positive signal has been compromised and another leg of the same circuit becomes the voltage source for the remainder of the circuit.

A typical issue would be a digital display picking up a stray or weak voltage from another component, or as in the case of some mid-'80s Chevy Blazers, which had two sources for constant voltage for the dome light and cigarette lighter positive signal, if one leg of the positive circuit would blow the other would bleed current over to its companion fuse — but only when the doors were all closed. If you'd open the door, the dome light would go off, but if you closed all the doors not only would the light stay on, but you couldn't shut it off. The only way I found the open fuse was to test the fuses with all the doors closed. (Thankfully, that was back in the day when I was quite a bit more flexible.) With the driver's door open, and using a test light across the access points of the ATC fuse, all the fuses would check good. (The contact points had voltage on both sides because of the feedback. One side would be the source voltage while the other was the feedback.)

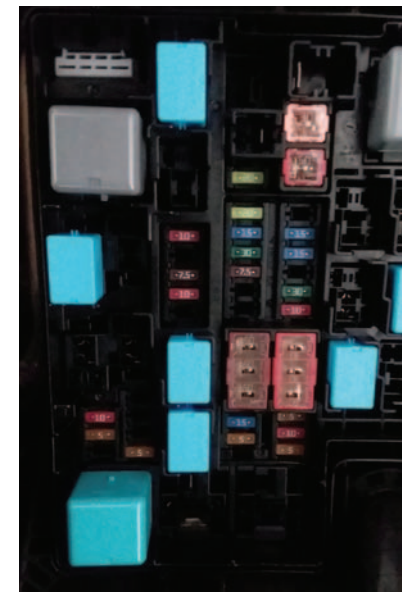


A VOLTAGE DROP can be as little as a loose connection at the battery. Examine the battery clamp connections carefully. Just because the post is secure doesn't mean the post terminal to negative wire connection is good. Check both.

However, if the connection point of failure (the open) is on the ground side, it can be an entirely different story. Since the negative is generally a common attachment point for more than one system, it's likely that you'll have some other circuit or some unlucky negative signal source becoming the surrogate ground even if it doesn't want to be. This is commonly referred to as a voltage drop (another later discussion).

When checking these circuits, keep in mind, if your measuring tool, i.e. multimeter, test light etc. is connected to a known good ground and you touch the unconnected ground lead, you will see current flow. OK, maybe a bit lower voltage (or a dim test light bulb) but you will see something. Because you're "after" the load has been applied to the circuit. (A probe that will show continuity at the same time as the current/voltage is a better choice for this test. But practice using one of these tools before attempting it on an unknown circuit. Accidentally inducing a voltage or even a ground signal in the wrong part of a circuit such as a computer lead can be hazardous to your pocket book.)

Keeping in mind that no matter if it's a 5-volt circuit or a 12-volt battery supply lead, a loose or disconnected ground lead has the same potential to cause chaos in the systems. For example, if you're working on an instrument cluster problem in which all the gauges are all reading off (or not at all), the most common issues would likely be the instrument cluster main ground. Chevy S10 pickups throughout the '90s had the main instrument cluster ground attached with the same bolt that held the parking brake release lever in place. So, after a few years of releasing the parking brake the bolt would work loose.



THE FUSE BOX is a good source of information, because we already know that a blown fuse has to be caused by a short to ground before the load.

The stories a customer would tell you about how they were driving at

night and when they'd hit a bump there was this horrific electrical zap by their left knee was more than a little entertaining to say the least. Of course, as an afterthought, they would mention: "And then all the gauges starting working again, even my dash lights!" (Not knowing the zap and the gauge problem were one in the same.)

Now, let's take that same scenario but incorporate a computer or module with various points for the electrical signals to follow. Then create an incomplete path for all of these polarity-conscious energy sources and what do you think will happen? Comparing this to our simple bulb circuit or the electric light show from one of those old S10s and the results are quite different. Now there's a better chance of having a service code lead you in the direction of the repair rather than a zap from a loose connection.

Electrical diagnostics sure has changed from when I first started in this business. Back then, a simple test light and a DVOM was about all a guy needed to perform nearly every functional test that was out there. That's not the case anymore. In fact, a test light can be as misleading as some of your customers' explanations of their vehicle's problems. Today, it's a much more detail-oriented endeavor.

However, the basic electrical formulas and fundamental principles remain the same (you know, those ABCs). Not that good connections and a constant supply voltage wasn't a concern back on those early '50s 6-volt systems, it's just a whole lot more critical in today's micro circuit-computer controlled contraptions.

Loose connections a few decades ago might bring a customer in with a blinking headlight or the ever popular "it only works when it wants to" syndrome. Oh, how times have changed.

Short (grounded) circuit issues

Here we are at a blown fuse. Yep, back at the fuse box — the common check points for any electrical circuit, and for good reasons, too. Grounded — or as they are sometimes called, short circuits — are just as the name implies. The voltage supply has found a shorter path to follow than what it was designed for. Generally, in today's electrical systems, the positive side of the circuit is fused. In our example circuit, the fuse would be placed between the positive battery source and the bulb (which can be stated as the work that the circuit is performing). But, the big factor is where in the circuit has it been shorted to affect the fuse? The easiest way to remember this is to ask yourself, "Where is the work at?" The work, in this case, is our bulb itself. So, in order to be a shorted circuit (a positive signal going to ground) we have to introduce a negative potential somewhere between the fuse and the work (the bulb) — not between our voltage source and the fuse or on the opposite side of the work, either. The short has to be between the fuse and the load for any chance of the fuse to disrupt the flow. In other words, every fuse in a car can only blow because something prior to the work has caused the fuse to reach its maximum amperage load.

Just to be clear, there are reasons for a fuse to blow other than a grounded positive signal. I've seen voltage differences cause an issue, such as 15 amps getting sent back down a 10-amp power lead. It's not as common, but it does occasionally happen, or as in the next section, it's a loose connection. Or it could be that the work is internally shorted.

NOT IN EVERY CASE — and not that every manufacturer labels the fuse box the same way — but, it's still a good idea to check the fuse box lid against the wiring diagram and make sure you're on the right fuse.

CONNECTIONS LIKE THESE are not designed to be taken off over and over again. Each time they are disturbed, some degradation to the quality of the connection may occur. Use the PIDs and scanner information first to verify a problem before probing leads or removing connections.

Loose connections and heat issues

Loose connections are a form of voltage drop, voltage loss and voltage spikes. Something else to keep in mind when it

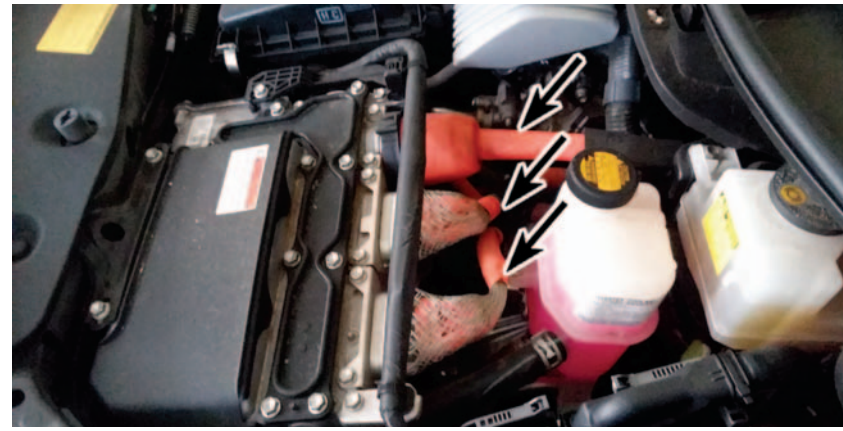
comes to loose connections is that as the connection starts to loosen, the current draw can increase as the temperature starts to increase. This heat can lead to the eventual failure of the connection. If you ever looked at a blower motor on a scope and recorded what the current does when it is first turned on, you would see a huge current spike or ramp-up at the initial startup. This is quite normal for any electrical motor (not as prevalent with brushless motors these days). This current ramp only lasts for a quick burst of energy, but if it remained high longer than designed it could certainly be another reason for a fuse to blow.

Too many times in the past I've had to go back into a fuel pump replacement job performed by another shop that failed to take a closer look at the melted connectors. Note to self: Check both ends of the connector, not just the end that's easy to see. Chances are the other end is the culprit; you know — the one that's harder to get to and everyone else ignores.

Simple tests are not so simple anymore

Not too many years ago a suspected fuel pump problem or a faulty starter motor could be quickly isolated with a couple of smacks of your trusty shop hammer. However, with today's brushless fuel pumps and their PWM operation, that trick isn't as effective or for that matter, recommended. The older brush-type motors had the habit of just conking out after a short trip to the store or just giving up going down the road. A quick rap on the tank could jar the motor brushes just enough to get it going long enough to drive into the service bay. These new brushless motors don't exactly conk out; they're more likely to slowly drop their fuel delivery volume until they just stop completely.

But there are similarities between the two types of fuel pump systems.



VOLTAGE LEVELS VARY DEPENDING on what system you are working on. High-voltage leads are orange (or blue) to indicate their potential energy levels.

They both have an electrical connection that needs to be checked for melted or expanded connectors. In both types of fuel pump systems (as the pump starts to fail), the current draw will increase. Now, of course, with the PWM type, they're pretty smart. They'll set codes to inform you of the situation before it gets out of hand, but that doesn't mean you should ignore checking the connector itself. Now, it's a much better idea to check the STFT and LTFT to see if the percentages are staying close to 0 or at least not above about 5 percent positive trim. But, for the most part, the current draw is the main factor that causes the service code to set, which informs you of the possible fuel pump efficiency dropping.

EVERY CUSTOMER HAS A STORY ABOUT THEIR CAR and its problems. Do yourself a favor and learn to listen not only to the story but to the incidental parts of the story that will help you in determining a course of action in the repair process.

Voltage drops

I can't remember ever using the term "voltage drop" 20 years ago. If somebody came in with a headlamp with the typical yellow glow, we just called it low voltage or blamed it on a loose connection. Now, that's commonly called a voltage drop. Today, the loss of one volt on a 5-volt circuit can be as detrimental as a completely open or grounded circuit. In fact, a loss of more than 50 milliamps on a grounded circuit is enough to cause all kinds of havoc. So the thought of a voltage drop is a dead serious issue these days.

I could shorten this whole thing down to a statement that a voltage drop is more or less a loose connection. That's true, but not always a correct answer. Take a look at some of the new fuel pump systems, for example. A lot of these new fuel pumps don't run at 100 percent voltage input but at a 50 percent duty cycle or even less. Running at a duty cycle means that the pump pressure and fuel volume can be controlled by varying on

and off time of the fuel pump. However, with some of these other new systems, it's not a duty cycle at all but a controlled voltage/current reduction from a PCM or fuel control module.

A voltage reduction basically makes the fuel pump run at a slower rpm when the fuel volume and pressure requests are low. Basically, it's a forced voltage drop (usually around 9 volts) by way of the FPCM (fuel pump control module). So now, (for all you voltage checkers out there), if you checked a fuel pump and saw only 9 volts, it may not necessarily mean you've got a voltage drop issue. It might actually be in perfect working order. Check the manufacturer's info for the method they're using for the fuel system you're checking before condemning it.

But, let's get back to voltage drops — the real ones. Yes, a voltage drop is usually found at a ground connection(s), but it's found just as easily on a positive connection, too — usually at a factory connection or spliced joint. I've found factory multi-crimped joints fail that produced a lower voltage on one wire and not on the other leads in the same multi-crimped joint or junction. Even though the term "voltage drop" is generally used to describe a lower-than-designed value on a circuit, the same thing can be said about a resistance value dropping — or more to the point, increasing its resistance than the designed value.

High and low CAN quick checks

This is very apparent when you're working on a high or low CAN lead. Many times the test procedure will say to disconnect the suspected component and recheck the signal. Even though the test is accurate, the results may not be, or as in some cases, it will leave you with an assumed correct answer, such as a CAN line that has an extremely high resistance value (60 ohms per terminating resistor – 2 terminating resistors in parallel – 120 ohms in total is the norm). But after disconnecting a component such as the IC or perhaps the PCM, your values are all over the place. You could make the assumption that the component must be at fault, only to find after replacing the module that nothing has changed.

It's another case of skipping over some of those boring steps in the middle of the diagnostic procedures and blindly going to the end of the diagnostic tree looking for a quick fix. Now you're jumping to conclusions without testing for any of the possible causes as closely as possible.

So you head back to that section of the diagnostic tree that said to ohm check each lead, wiggle test each lead,and verify continuity. That's when you notice any wiggle of the connector and the resistance value changed. The solution is to find the bad spot, which in this case was a faulty factory-crimped joint where several leads joined together.

Less than 5 ohms per line is considered good to go, but don't forget to wiggle the harnesses and connections to be sure you've covered all the possibilities. Any time you see a junction or wire connection in regards to a sensitive circuit, you should pay close attention to the procedures to avoid changing good parts for good parts. In other words, don't jump from one end to the other without checking the middle — do your ABCs. (Another quick tip is to use your thermal gun at these multi-connections. Look for a temperature rise at the connectors.)

How important are the tools of the trade?

Let's face it, not having the right tool always makes the job that much harder. There are the factory scanners that can cover every aspect of their manufactured models and several outstanding aftermarket scanners that can do some extraordinary and complex issues. A good multimeter (I prefer one with a min/max feature) and of course a good scope are excellent tools to have. A good two-channel is a great place to start, but it won't be long before you'll want a four- or six-channel.

THE ABCS OF ELECTRICAL DIAGNOSTICS are as simple as 1-2-3.

Having the right tool but not knowing how to use it can be just as disheartening. Too many times I've seen guys shy away from repairs because they are intimidated by a scanner. There are classes everywhere that can help you learn how to use your tools more efficiently. Car repair has evolved into literally a college-level job and has left the knuckle-busting socket jockeys down on the lube rack. Let's face it — it's more geek than grease these days.

You do have one advantage today that wasn't as available back in my younger years — the internet. With one search you can find out a lot about automotive repair and the tools of the trade. But, that's a whole other story.

SCOTT 'GONZO' WEAVER
After more than three decades as the owner of an automotive electrical repair shop in Tulsa, Oklahoma, ASE Master Tech Scott "Gonzo" Weaver now writes and teaches the latest automotive technology. As a storyteller, he has hundreds of published humorous and anecdotal stories that can be found on his website, www.gonzostoolbox.com. Gonzo is also the author of the book, 'Hey Look! I Found the Loose Nut'.
gonzosae@aol.com

DIAGNOSING CONTROLLER AREA NETWORK (CAN) SYSTEMS

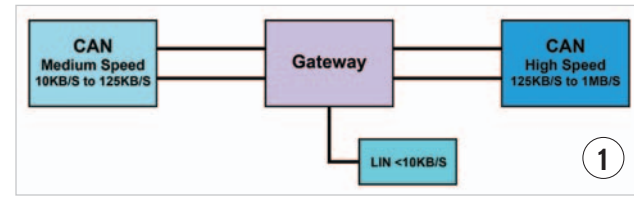
LOCATING FAULTS IN THE CAN NETWORK IS EASIER WHEN YOU APPLY THESE TIPS AND TECHNIQUES

BERNIE THOMPSON // Contributing Editor

The exchange of information and data has been key from the beginning of mankind. In order to make good decisions, one needs good information. Information exchange is imperative in order for the decision-making process to be carried out. The lack of information one has limits the decisions that can be made correctly. Just as you and I need information to make decisions confidently, so will the modern vehicle. In order for the modern vehicle to run and drive correctly, the information must be exchanged quickly with accuracy.

In order to exchange information, you must have a transmitter, a medium and a receiver. When we communicate with one another we use sound. When you speak, you become the transmitter, the air becomes the medium, and the person you are speaking to becomes the receiver. Since you can both speak and listen, you are a transceiver. In the modern vehicle, information exchange will occur using electricity. When a module speaks (transmits) it becomes the transmitter; the wiring becomes the mediumm, and the module that the message is sent to becomes the listener (receiver). Therefore, if the module can transmit and receive, it is a transceiver. Thus, using electrical on-off signals allows information to be transferred through the wiring between various vehicle modules.

This on-off digital information is sent at different speeds on different bus networks within the vehicle. Since each communication speed will use different rules on different networks, a means will be needed that allows communication between various vehicle networks. This will be accomplished by having a common module that connects each of these networks together. This common module is referred to as a gateway or bridge and is illustrated in **Figure 1**. The gateway has each of the different network communication transceivers within it. In this way, the gateway will isolate the different networks from one another, while bridging the communications between the different modules. In order to gather data from the vehicle, an interface is used. This interface or scan tool will allow a connection to the vehicle networks. Once a connection is established with the vehicle, data can be transmitted and received by the scan tool. If there are communication problems or no communications present, you will need to connect to the communications wiring with an oscilloscope in order to test the circuits.

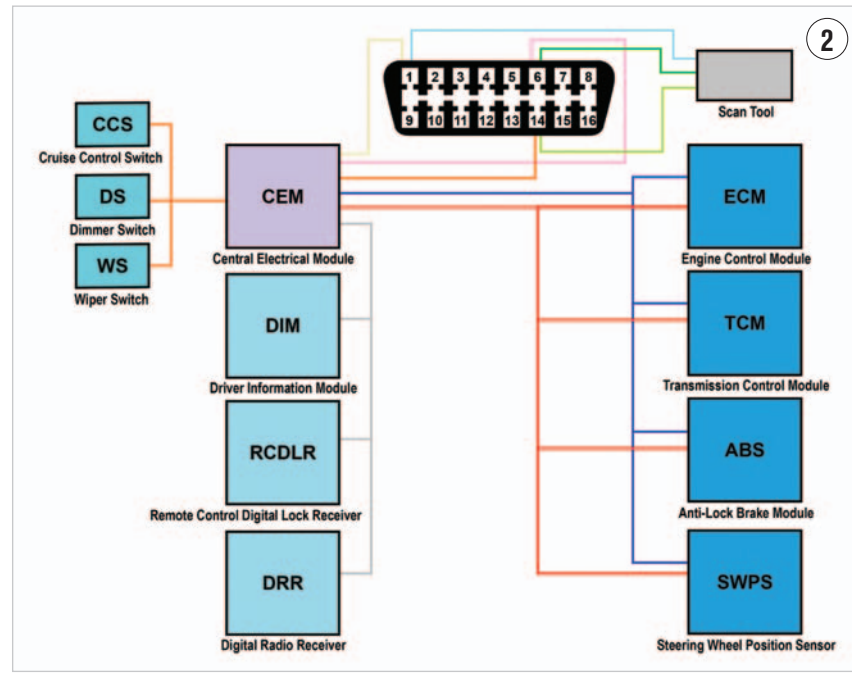


It is important to check a wiring diagram in order to understand how the scan tool will interface with the vehicle under test. In **Figure 2**, a block diagram of one method used to interface with the vehicle is illustrated. In this example, the scan tool is connected to the gateway module (CEM). It is important to understand that in this configuration the scan tool can be connected to the system by two different methods. In the first method, the scan tool interface is not connected directly to the vehicle network. If the engineering team that designs the vehicle network deems it is necessary to protect the network from the scan tool interference, the gateway will isolate the scan tool interface from the network. The gateway, when used in this method, will bridge the scan tool communications to the vehicle networks. This means the data that is exchanged from the Diagnostic Link Connector (DLC) to the scan tool is not on the vehicle network. So, if you were to check these signals with an oscilloscope, these signals are not the vehicle network communications, but the scan tool communications. In this case you will need to connect the oscilloscope directly to the vehicle network wiring under test.

PHOTOS: BERNIE THOMPSON

With the second method, the gateway will connect the scan tool interface to the vehicle network. This will allow the scan tool interface to directly access the vehicle communication network. If an oscilloscope is connected to the DLC, the data that is displayed on the oscilloscope is the data that is being exchanged on the actual vehicle network. When diagnosing the vehicle network, it is important to understand that these two methods are different. If one did not understand this you may connect to the gateway with the scan tool and see communications exchange on the oscilloscope and think the system is working. In actuality, the scan tool communications to the gateway is all that is being displayed. In order to know which system you are working on, connect the oscilloscope to the DLC and the wiring at one of the modules. If the oscilloscope display shows two different waveforms, then the gateway is isolating the scan tool from the network. If the oscilloscope displays the waveforms and they are overlaying one another, then the scan tool is directly connected to the network. If the DLC wiring is not connected to a gateway but connected directly to the network wiring, then the scan tool will be connected directly to the network.

If there are communications between the vehicle and the scan tool and there are communications codes set, get all codes from all of the modules. This will include the codes from the high-speed network, medium-speed network and low-speed network. Now that you have the codes, look over the codes to see if there are similarities between the modules of the same network and if there are similarities between the codes from different networks. Now you will need to become a detective and analyze the data at hand. For example, if the high-speed network (engine and transmission) has anti-lock brakes (ABS) module codes set, the medium-speed network (driver information module) has ABS codes set, and the low-speed network (windshield wiper system) has ABS codes set, then the ABS system is the most likely culprit. In this example, all of these systems need the vehicle speed in order to operate. In many of the communication problems on the vehicle there will be many different codes set. It will be important to relate each code that is produced and to try to find some commonality between them.



The low-speed network will most likely use the Local Interconnect Network (LIN). This network is a master/slave scheme. This means that the main control module (e.g. CEM) that the other modules connect to is the master and all the other modules are slaves. The LIN communication protocol is based on the SCI (UART) data format, which uses a single-master/multiple-slave concept, on a single-wire (plus ground) 12 V bus. The clock synchronization for nodes does not have a precise time base (e.g., without a crystal or resonator) but uses a capacitance-resistive timing circuit that lowers the cost of each module. Therefore, the codes will be stored in the master module. An example of an LIN waveform is shown in **Figure 3.**

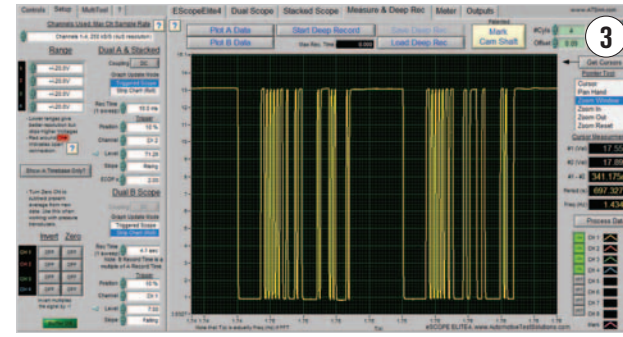
Once a module is suspected, the electrical circuit will need to be tested. This will need to be done with an oscilloscope. In order for a module to communicate, it will only need the powers, grounds and communication wires. The testing will need to be at the suspected module connector and will check the power source at the module, the ground source at the module and the communication wiring at the module. It is important to know what the communication network waveform you are working on should look like. When you are scoping a high-speed Controller Area Network (CAN) system, the waveform is recessive (idle) at 2.5 volts and dominant (active) at 3.4 volts CAN-H and 2.4 volts CAN-L. **Figure 4** shows the CAN high-speed waveform.

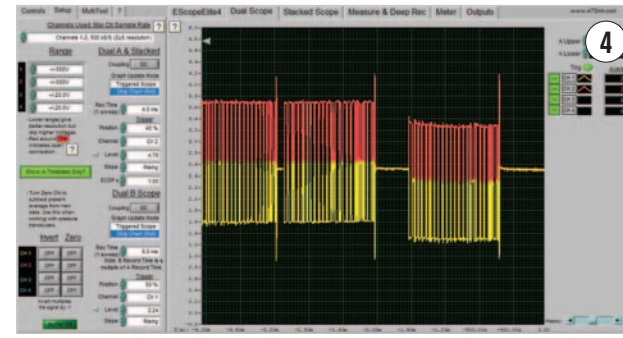
CAN high speed is a Carrier Sense Multiple Access with Collision Resolution (CSMA/CR) communication network system and uses two opposing voltages to reduce noise emissions. These voltages are carried on a two-wire

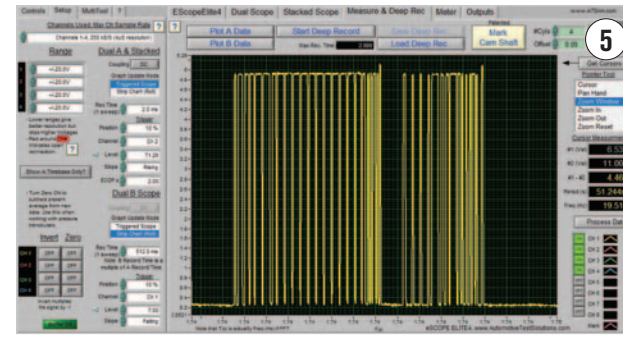
medium referred to as a balanced signal scheme. Each wire carries a voltage signal that occurs at the same time at two different voltage levels. By having one voltage level rise and the other voltage level fall, they will cancel each other's noise emissions. CAN high speed uses a twisted pair of wires: CAN high line (CAN-H) and CAN low line (CAN-L). These wires carry differential signal transmissions. The twisted wires reduce Radio Frequency (RF) both received and transmitted. RF is any of the electromagnetic wave frequencies that lie in the range extending from around 20 kHz to300 GHz — roughly the frequencies used in radio communication.

Another common CAN system used in vehicles is CAN medium-speed single wire. CAN Medium Speed uses voltage that is carried on a one-wire medium. The voltage is recessive (idle) at low voltage and dominant (active) at high voltage, as shown in **Figure 5**. The CAN medium-speed single wire system is a carrier Sense Multiple Access with Collision Resolution (CSMA/CR) communication network.

The most common communication network systems used in the modern vehicle are: CAN high speed, CAN medium speed and LIN low speed. (For more information on CAN read "Understanding Control Area Network," May 2016). All of these network systems use voltage changes over time to communicate their messages. Since the messages are based on voltage changes, it is important to use an oscilloscope to check the basic voltage patterns produced. When using the oscilloscope, it will not be necessary to check the message packets to the bitwise format. The bitwise format is the length of time each bit is recessive or dominant. These changes over time indicate the message to other modules on the network. These time intervals, for each bit, can be different for each system. Additionally, they can change from manufacturer to manufacturer due to the CAN transceiver being programmable for different bit times. Thus, each time interval indicates a bit can be changed from system to system. Therefore, these message packets are proprietary to the manufacturer and are not shared in the light-duty market. To follow the bits within a data frame and have any understanding of what the message packets are communicating would be impossible if you did not have the code that was being used. One such example would be if you were testing a telegraph system with an oscilloscope. You would be able to see the voltage changes over time, but without having the code (e.g. Morse) that's being transmitted, you would not understand the message that was produced. Therefore, it will not be necessary to read the message to the bitwise resolution, but to check the basic voltage patterns produced. The modules on the network are programed to understand the bitwise resolution of each data frame, so utilize the other modules to help diagnose the network under test.







Now that we have knowledge of what to expect when analyzing these network waveforms, let us analyze several other waveforms that you will encounter when working on CAN high-speed networks. These are the basic waveforms that you will need to know.

The first CAN high-speed network waveform, shown in **Figure 6**, is produced when the ignition switch is turned to the accessory position "Accessory Mode" (on some systems) or when the system did not fully wake up. This can also be caused by power or ground issues. In this example, the waveform does not move in opposite direction from 2.5 volts as shown in **Figure 4**, but instead moves from 1.8 volts to 3.6 volts. This accessory mode waveform is one where you may not be able to communicate with the high-speed bus using a scan tool. In this mode there is still data transmission contained in each frame. In some cases, you may be able to communicate with just one module on the bus, such as the transmission control unit.

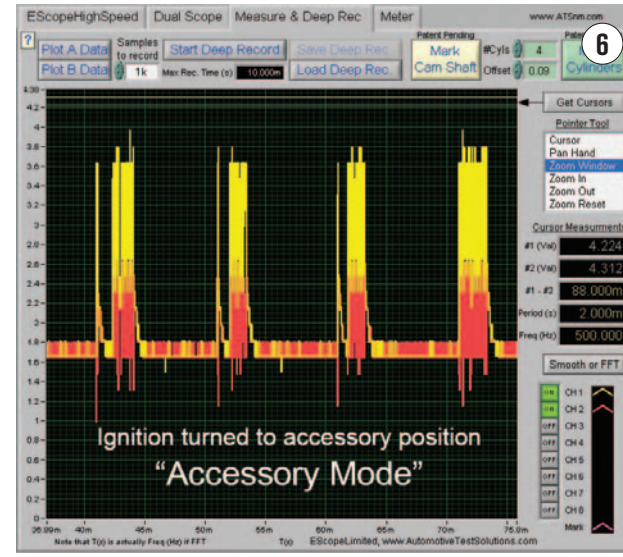
The second CAN high-speed network waveform is shown

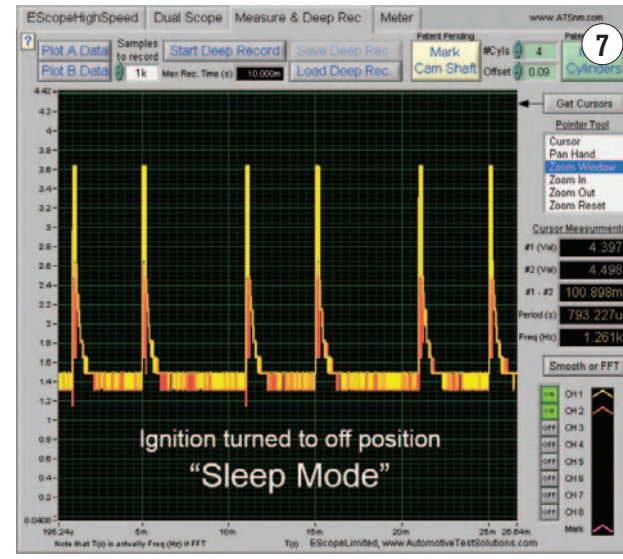
in **Figure 4** and is produced when the ignition is turned to the on position or "Active Mode." This is the normal CAN high-speed network waveform. The third CAN high-speed network waveform is shown in **Figure 7** and is produced when the Ignition is turned to the off position "Sleep Mode." In this example, the waveform does not move in opposite direction from 2.5 volts as shown in **Figure 4**, but instead moves from 1.4 volts to 3.6 volts with minimal data transmission.

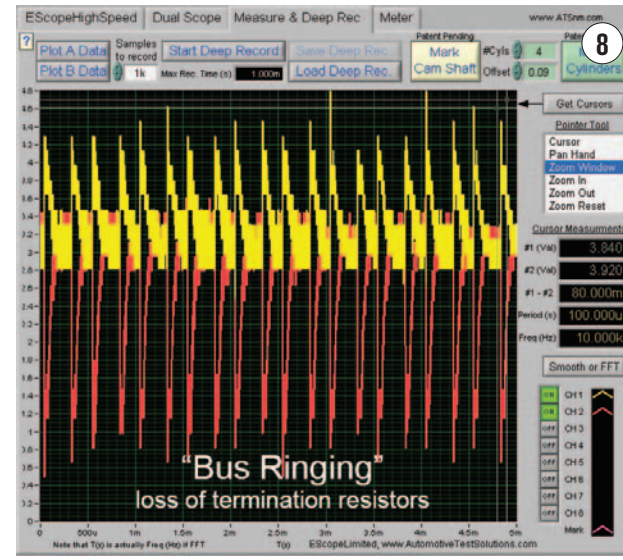
The third CAN high-speed network waveform is shown in **Figure 8** and is produced when the termination resistors are missing. The high-speed CAN Bus must have termination resistance in order to work properly. Without the proper termination resistance, the bits will not be formed correctly and will create a problem with the message bit timing. If no or low resistance is in place, the bus will have reflections. Reflection or ringing can create poor to no communication problems. This can be caused by missing resistors, broken wiring or when one disconnects the module connector and breaks the communication lines to the network. If you are unplugging modules while monitoring the oscilloscope display to locate the communication problem and the communication lines go into and out of the module, then you must bridge the CAN-H to CAN-H and CAN-L to CAN-L wiring at the connector. This will keep the communication wiring intact to the other modules in the system.

There are two 120 Ω termination resistors in the bus lines. These are placed between the CAN-H and CAN-L bus lines. The resistors can be in the modules, fuse panels or in the wiring so check a wiring schematic for their location. To test the resistance of the CAN termination resistors, there must be no power on the network (sleep mode). Ohm the DLC from pin 6 to pin 14 — the resistance should be approximately 62 ohms. If the communication lines connect to the gateway (e.g. CEM) and the gateway isolates the DLC from the CAN high-speed bus, and if you were to measure the bus resistance at the DLC, you are not measuring the actual CAN high-speed communication lines. In this case, back probe the communication lines at a module on the high-speed network.

The fourth CAN high-speed network waveform is shown in **Figure 9** and is produced when the In-Frame Response (IFR) or Acknowledgement (ACK) is missing. The ACK is a message that is embedded in the data frame by a module other than the original transmitter. This is to let the transmitter know that some other module on the network received the message. If the ACK is not received, a form error in the data frame is set. This means that the message is resent over and over until an ACK is read by the transmitting module. This is why the CAN message on the oscilloscope display is repeated over and over and usually caused by broken communication wiring. In this condition, the module is not on the network but is isolated from the network.

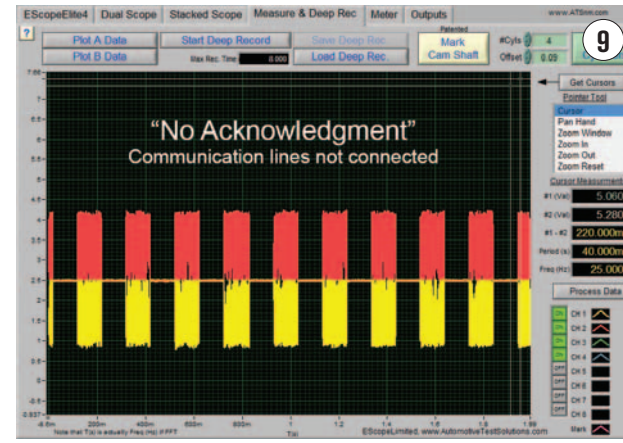


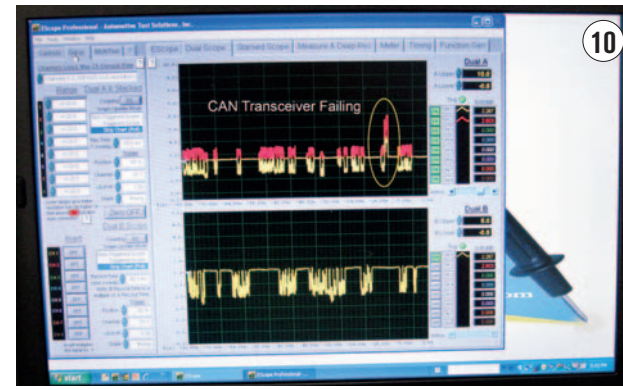




The fifth CAN high-speed network waveform is shown in **Figure 10**. This is produced by a common problem where a CAN transceiver is failing. This occurs when the voltage on the network is pulled high, as shown in **Figure 10**, or when the voltage on the network is pulled low (not shown). This can be an intermittent problem when the CAN transceiver first starts to fail or a hard failure in which each time the module takes control of the network the signal voltage fails. The faulty module is located by unplugging the modules from the network while monitoring the oscilloscope display. When setting your oscilloscope, always use strip chart roll mode at a speed where you can watch the bus messages stream across the oscilloscope display. If you use a trigger mode, it can hide the problem entirely. When the correct module is unplugged, the voltage failure will be gone. When the module is reconnected, the voltage failure will return. Be careful here — if the module is failing intermittently it can reset once it is unplugged and loses power and ground and can begin to work properly. Always be sure you can see the problem first, then disconnect the module from the network. If the problem is gone, this is the problematic module. Always test all of the powers and grounds before ever replacing any electronic device. When you remove the module electrical connector, check for contamination, such as oil in the connector. Check all of the connecting pins for any damage. If you question the connecting pins connection use Stabilant 22, this is a liquid that helps with poor electrical connections.

On CAN high-speed systems, the module can be isolated from the network due to faults exceeding 256 error counts. Each node maintains two error counters: 1) Transmit Error Counter 2) Receive Error Counter. A transmitter detecting a fault increments its Transmit Error Counter faster than the listening nodes will increment their Receive Error Counter. This is because it is assumed there is a better chance that the transmitter is at fault. From 0 to 126 error counts the module sets active errors where it can destroy messages on the bus. This is accomplished with 6 dominate bits at the end of frame, which violates the 5-bit stuff rule, and will destroy other bus traffic. When the Transmit Error Counter raises above 127 (e.g. after 16 attempts), module A goes Error Passive. The difference is that it will now transmit Passive Error Flags on the bus. A Passive Error Flag comprises 6 recessive bits (violates the 5-bit stuff rule), and will not destroy other bus traffic, so the other modules will not be affected by module A bus errors. However, module A continues to increase its Transmit Error Counter. When it raises above 255 error counts, module A takes itself off of the bus —"Bus Off State." A "Bus Off State" will require an extended bus idle period (not likely) or a battery reset to get the module back on the bus. So before replacing any module, first





reset the network and test to see if you can communicate with this module. If you can now communicate with this module, realize that this module could be bad or could be in "Bus Off State" not because it is bad, but due to another module's clock being bad. If one of the modules on the network has a clocking error it may not set any codes for itself but will destroy bus traffic, thus setting codes for other modules. If this module with a bad clock destroys another module's messages and the other module counts enough errors, this good module will take itself off of the network. Yet the module with the bad clock (bad module) will remain active on the bus. When a module with a bad clock is on the bus, there will be multiple codes in most of the other modules except for the module with the clock error. The Controller Area Network is a great system and, with an in-depth understanding of how these communication systems operate, will come an understanding of how to diagnose these advanced communication systems.

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

BATTERY DOS AND DON'TS

BATTERIES HAVE AN INCREASINGLY TOUGH JOB TO PERFORM. PROPER SERVICE AND INSPECTION IS THE KEY IN MAKING THEM LAST!

PETE MEIER // Technical Editor

The demand on the vehicle's battery is increasing as technology continues to move us toward an all-electric future. Start/stop systems place additional loads that add additional stress to the battery, and modern charging systems are designed to supply just enough to keep the battery alive. Add to that the fact that modern electronics are less tolerant of weakness in the battery than ever before and you can see that it is important for us, as professional technicians, to be able to properly service and test them.

But what are the common mistakes we are making when servicing and testing batteries? What are the proper methods we should be employing? To find out, I talked to several industry experts and asked their opinions.

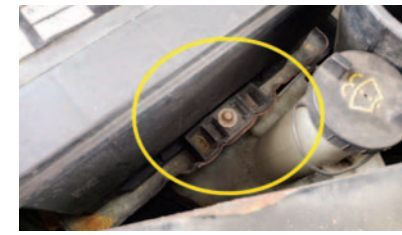
AGM or flooded?

According to Jim O'Hara of Clore Automotive, "The biggest issue we see when testing lead acid batteries...is being completely unable to identify the battery's construction or misidentifying the battery's construction. Digital testers rely on judgement maps for each of their testable batteries. Identifying an AGM battery as flooded or vice versa could yield inaccurate results." O'Hara adds, "If a battery is truly bad, it likely won't matter, but if a battery is marginal, it very much will. Also, many technicians have trouble with the terms AGM and Gel, thinking that AGM batteries are Gel batteries. They are not. Finally, many technicians do not properly identify spiral batteries as AGM construction. Our testers have an AGM Spiral setting vs AGM Flat Plate setting to try to distinguish between the different types and make it clear to users that Spiral batteries are typically AGM construction."

My contacts at EnerSys, the makers of ODYSSEY batteries, echoed O'Hara's comments. "Identifying the type of battery the technician is dealing with is probably the biggest hurdle. Sometimes it is not clear what type of battery is in the vehicle, or what type of battery is supposed to be in the vehicle. Some vehicles come from the factory with an AGM battery and must be replaced with an AGM battery. Gone are the days of buying the cheapest battery available that happens to fit. Always pay careful attention to the recommendation of the manufacturer. This not only applies to battery type, but also CCA rating. Never put in a battery rated for less than what was original equipment."

Properly identifying the battery design is also critical when it comes to maintaining the battery, whether it's the responsibility of the vehicle's charging system or your shop's battery charger. Patrick McLaughlin, Exide Technologies Product Manager-Transportation, offers, "AGM batteries do not have maintenance requirements; however, the charging profile is different than a conventional flooded battery. AGM batteries are more sensitive to overcharge due to the internal gas recombination cycle. Some battery chargers will have Flooded and AGM settings, which essentially toggle the maximum charge voltage up or down to match each technology." It's easy, then, to understand that misidentifying an AGM battery as a conventional flooded design and trying to correct a low State of Charge (SOC) with your old, high pow-

BE CAREFUL WHEN TAKING YOUR OCV MEASUREMENTS. If the reading is questionable, access the battery terminals/posts directly — especially on side post or remotely mounted batteries.



MAKE SURE THAT THE BATTERY MOUNTING IS SECURE to minimize the impact of vibration on the battery. If any form of deflector or heat shield was originally fitted, be sure to reinstall them as well.

PHOTOS: PETE MEIER

ered, shop charger will actually cause more harm than good.

Speaking of SOC

We all know that one of the very first measurements we need to take when assessing the condition of the battery is the Open Circuit Voltage (OCV). But is your OCV measurement accurate and what minimums are acceptable before proceeding with further tests?

Davis Knauer, Vice President Automotive Battery and Diversified Products Engineering for East Penn Manufacturing has this to say: "Accurate testing requires a minimum State of Charge level. A rested open-circuit voltage (that means it's been over 24 hours since the battery has been exposed to charging) of 12.4 minimum is required for load testing."

Where you test can also have an impact on your test results. If you just brought the car in and connected your meter or handheld battery tester to the battery's cable ends, your test results may be suspect. This is especially true if you're trying to test a remotely mounted battery using the jump points under the hood. According to the pros at Bosch, "[When a tester is hooked up to the battery cables, especially side terminals], corrosion on the underside of a terminal, unseen by techs, can prevent tester clamps from making good contact. Techs should always clean terminals and cables prior to testing or replacing a battery."

"Another issue can be with remote-mounted batteries, often found in vehicle trunks to save space under the hood. If techs test the battery using the underhood booster terminals, this may lead to falsely diagnosing a battery as bad. Additional resistance caused by the length of the cable can often result in inaccurate battery diagnosis. If a remote-mounted battery is tested and fails, techs should locate the battery and directly test it to confirm if it's an issue with the battery or if the issue is elsewhere."

"Testing failures in a vehicle must be confirmed after the battery is removed from the vehicle. Readings made while connected in the vehicle can be affected by poor connections, active loads and effects from recent operation," added Knauer.

On to performance testing

I was first taught to use a carbon pile load tester to test the vehicle's battery. Later in my career, I was introduced to the handheld conductance testers that are popular and required by many OEMs. Today, I personally prefer the use of a DSO (Digital Storage Oscilloscope) to test the battery. What do the experts have to say? Let's start with this great overview Knauer shared:

"Load Testing: The gold standard for serviceability of engine starting batteries is a load test conducted according to the Battery Service Manual published by BCI (Battery Council International). A load of half the CCA rating is applied for 15 seconds. The voltage must not fall below a limit that depends on the core battery temperature at the start of the test. The battery must initially be at least 75 percent charged, which correlates to a well-rested, open-circuit voltage of 12.4 or higher.

PHOTO: CLORE AUTOMOTIVE

CONDUCTANCE TESTING is one of two acceptable ways to performance test the battery. Just be sure to properly input the test parameters — battery rating, type, etc.

"Conductance Testing: Conductance testers that correlate to BCI standard load test results are useful tools. They may provide a quick decision or they may say CHARGE AND RETEST. You may trade some accuracy for speed, but it is generally worth the time saved. The user must connect it properly, avoid putting in incorrect data to the tester, charge the battery properly before retesting when requested by the tester, and reconfirm failed results obtained in a vehicle after the vehicle connections are removed from the battery terminals and the

terminals are cleaned. Proper connections to side or stud terminals REQUIRE that charging adapters be used properly.

"Diagnostic Fast Chargers: These can be effective, but their potential to streamline the warranty process too much and not do more extensive testing must be weighed against the possibility of increased warranty and added replacement costs. Following recommended safety procedures (shielding, etc.) is a must when using these testers.

"Battery Sensor Equipped Vehicle: A battery sensor equipped vehicle continuously monitoring the battery should be able to make a much more informed decision than any quick test by a technician, but some level of secondary confirmation may be required for warranty situations on a case-by-case basis."

Exide's McLaughlin agrees, adding, "We [also] recommend the methods as outlined in the BCI Service Manual. The first is the carbon pile test. At 15 seconds if the battery is (less than) 9.7 volts, it should either be replaced or recharged and re-tested. Batteries greater than 9.7 volts can be returned to service. The second is a conductance test with one of the various meters available on the market. We recommend following the meter's guidance on whether the battery is Good, Bad/Replace or Recharge and Retest. We do not advise making decisions solely on the estimated CCA rating output."

So I think what we've learned so far is that either testing method will provide us accurate results IF we ensure that we are connecting our tools directly to the battery. If you take a quick test in the vehicle and it passes, you'll probably be OK, but if the initial test is questionable, you'll need to remove the battery and test directly at the posts.

If the SOC measurement indicates a discharged battery, you'll need to identify the reason for the discharge. Today's charging systems are designed to maintain the battery properly and the only reasons for a battery to be discharged are age, faults in the vehicle's charging or electronic systems or extended periods of storage where the vehicle is not being used.

According to EnerSys, "When a vehicle sits for long periods of time, it can destroy the battery through repetitive deep discharges. Alternators are not deep-cycle chargers; their output is limited in operation. Elevated temperature can accelerate self-discharge and add to the total rate of storage discharge."

This high alternator demand can also cause damage to the alternator itself over time, and it should never be relied upon to replenish a discharged battery. If your customer stores his/her vehicle for extended periods of time, recommend the use of a home battery maintainer to protect the battery and alternator from harm and premature failure.

In addition to the effects of extended storage, EnerSys shares, "Many times issues with a vehicle's electrical system are automatically blamed on the battery. It is true that changing the battery is the easiest thing to do to start diagnosing an electrical problem, but that may not be the actual source of the problem. An example is when a parasitic load is causing battery and/or starting problems. Replacing the battery will only mask the problem temporarily. Taking the time to see why a vehicle may have trouble starting or why a battery is constantly failing is key."

Better yet, make sure the battery has indeed failed prior to replacement, especially if it's one that is not that old! This may require the battery to be charged and retested. Just remember what the experts have told us and let the battery acclimate to room temperature and "rest" for a minimum of 10-12 hours. If the "rested" OCV is still below 12.4, replace it with confidence.

Whether it's a young or old battery, be sure to test the vehicle's charging system to ensure the new battery has a shot at a long and happy life!

PHOTO: CLORE AUTOMOTIVE

STILL AN INDUSTRY STANDARD, the carbon pile load tester should be used to "load" the battery to half of its CCA rating for 15 seconds — then observe the OCV reading. It should remain above 9.7v.

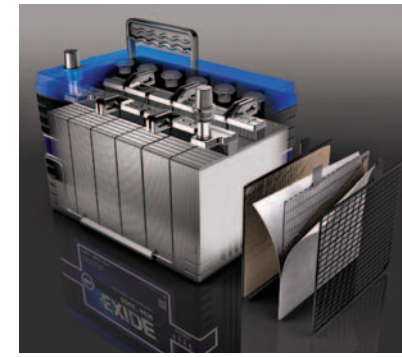


PHOTO: EXIDE TECHNOLOGIES

AGM STANDS FOR "ABSORBED GLASS MAT" and has several distinct differences in design from a conventional flooded lead acid battery. One is in how the battery must be charged and failure to follow the precautions will lead to internal damage.

PHOTO: ENERSYS

SIDE POST BATTERY DESIGNS can hid corrosion behind the battery cable connections and cause false test results. On both designs, make sure the connections are clean before reinstalling.

Don't forget the reset!

According to industry sources, there are more than 9 million vehicles in the U.S. fleet that currently require some

form of battery "reset" or "registration" when replacing the vehicle's battery.

"Not performing battery reset functions can cause some vehicles to go into a weak battery mode that will affect the operation of non-critical electrical loads. This mode can be manually reset after replacing the battery via a tool connected to the OBD II port. Not performing battery registration functions may result in short battery life. Some vehicles manage batteries differently as they age. They will also treat AGM and flooded batteries differently," says Knauer.

Bosch spells it out for us by offering these notes: "Most stop/start vehicles will require an ECM update when a battery is replaced to ensure the system works properly and the battery is being charged correctly. This includes newer vehicles from BMW, Mini and the Ford F-150, among others. The most important thing for techs to know or understand is that if they are replacing the battery on a start/stop vehicle, they should look for a battery reset procedure in their scan tool or invest in a separate battery reset tool that is updated for newer model year vehicles."

Other valuable tips

Our experts provided more information than I can fit in just one article. But there are still a few great tips and observations I think we need to squeeze in. All of our experts feel that parasitic drain is becoming increasingly common. "This causes batteries to live much of their life in a 'discharged' state, accelerating sulfation," shares O'Hara.

Sulfation is the formation of crystals on the surfaces of the plates and is also an issue for those of you who keep batteries in stock. Remember, they, too, are subject to normal discharge.

Another common point raised by our experts relates to the use of "memory saver" devices. East Penn's Knauer had this to say: "Vehicles and the people who drive them are relying more on the vehicle's settings than ever before. Protecting these settings is a simple precaution that doesn't get used enough. The loss of settings can be avoided with the use of a memory saver device. If the vehicle retains adequate voltage throughout a battery replacement, memory items such as radio presets and many other settings can often be preserved. However, it's important to note that since the memory saver keeps power in the system, the operator should be careful that the positive cable end doesn't contact something that could ground it out."

And that's a common problem, as Clore Automotive's O'Hara pointed out. "The biggest thing we stress when a battery is removed is properly securing the cable ends, especially when a memory saver is used. In those cases, as you know, the cable ends are live. I have seen on iATN where a user posted that he had specific non-conductive "bags" that he used and placed over the cable ends each time a battery was disconnected. This should be taught in the VoTech schools and be made standard practice in the industry. It is brilliant and much needed."

Today, even removing the battery may require a specific process, so read up on the procedure before you even open the hood. And learn a little from the experts. Make sure you follow the proper safety procedures when working around batteries, verify a failed battery with direct testing, and ensure that the replacement battery has a shot by testing the vehicle for issues in the charging system or electronics, especially parasitic drain. Use the right battery for the application when selecting your replacement and be sure you tell the ECM you updated it if required.

PETE MEIER is an ASE certified Master Technician with over 35 years of practical experience as a technician and educator, covering a wide variety of makes and models. He began writing for *Motor Age* as a contributor in 2006 and joined the magazine fulltime as Technical Editor in 2010. Pete believes in the mission of the magazine to "advance the automotive professional" and provides resources to working techs around the country through print, social media and YouTube.
pete.meier@ubm.com

FINISHING THE JOB

RELYING ON SOMEBODY ELSE'S DIAGNOSIS IS A BAD IDEA

RICHARD MCCUISTIAN //
Contributing Editor

When I was at the Ford place, I drew a work order for a charging system fault on an old F-150 and told the customer she needed a new alternator, and she went and bought one from a local parts store. Well, that one wound up being bad, so I yanked it off and she took it back, had it checked on their machine, and brought me another one. This happened four times. We finally got a good one, but she was kind of ill that she had to pay us to replace the alternator four times. Thinking she'd save money buying her own part, she made a series of bad choices. Had those bad alternators come from our parts room, the Ford Authorized Manufacturer would have paid all that labor.

On a slightly different note, I used to hang out when I was off work at Sambos drinking coffee back in the late '70s with some of the locals in Port Arthur, Texas. When I overheard one of the patrons asking a young waitress about her car, she told them she had a '63 Buick Special but that the "motor had burned up" and she couldn't drive it. I chimed in to ask if she had run it out of coolant or oil, and she told me it had caught fire under the hood while she was driving and had been sitting in her parents' driveway for months.

She went on to say that they had given her a coil, a distributor cap and some wires for her birthday, but nobody they knew wanted to attempt the fix, and they couldn't afford to hire a shop to do it. I asked if I could take a look, and she agreed, so I dropped by her parents' house and opened the hood on that little V6 to find that the engine fire had been wall to wall. The wire harness was little more than a bunch of bare wires, and the ignition components were, as expected, nothing but crust and ash. I wondered if I had bitten off more than I could chew; I couldn't even tell where the fire had started or why, but I dove in headfirst.

WITH THESE FUNKY BIG TIRES contacting the splash shields during turns of more than about 15 degrees, this one is no fun to drive, but it wasn't written up for that.

Retrieving some rolls of wire I carried in my truck toolbox, I carefully unplugged the mostly melted wire harness from its various connection points and using cheap butt connectors and electrical tape (I wasn't going to spend the time it'd take to solder and heat shrink everything), I rebuilt that underhood harness one wire at a time on the tailgate of my pickup, then plugged it all back in and installed her new distributor cap, wires and coil. I hooked up my jumper cables, we spun it over, and it fired right up and ran like a champ. The whole job only took a couple of hours, so I charged her $25, and she paid me with multiple rolls of coins from her tip money.

ANY SHOP THAT DOESN'T USE a refrigerant identifier does so at their own peril. Without one, this kind of contamination gets spread from the recycler to other vehicles like a disease.

The Commander

A friend of mine brought his son's 2006 Jeep Commander — 4.7L V8 with a 5-45RFE transmission and 187,854 miles on the odometer — telling me he believed water was making its way into the #8 cylinder, because the vehicle had overheated a few times and now it was misfiring on that one. We found his misfire on the cylinder he indicated, but a

PHOTOS: RICHARD MCCUISTIAN

Kia.com

If it's not in the right box, it's not genuine.

KIA

Genuine Parts

From starters to alternators, oil filters to spark plugs, there is no substitute for genuine. The only way to assure that you are getting Genuine Kia parts, backed by the Kia Warranty, is to order them from your local Authorized Kia Dealer. Contact your local Kia dealer for assistance and delivery of the parts you need.

*Genuine Kia replacement parts (except battery) sold by Authorized Kia Dealer under warranty are covered for the greater of (1) the duration of the New Vehicle Limited Warranty or (2) the first 12 months from the date of installation or 12,000 miles, whichever comes first. Labor charges not included when not installed by an Authorized Kia Dealer. Warranty is limited. See Kia's Replacement Parts and Accessories Limited Warranty for further details.

quick look at all the plugs didn't show any evidence of coolant ingestion at all, only a sooty plug on the dead hole. So, my man Charles tossed a set of plugs in there, and in the process of our testing we discovered the compression was low on that cylinder. Further, Charles said that with it idling he was hearing something under the valve cover he didn't like, and to get the valve cover off, he had to recover the refrigerant.

When we did the refrigerant I.D. with the Peter Coll Neutronics tester (a shop should always do that!), we got a big fat red FAIL light — five percent hydrocarbons in there, possibly from some fly-by-night canned stuff. We had to use our dedicated tank and machine to suck that garbage juice out. When Charles got the valve cover off (no fun), he found the rearmost roller rocker out of place and lying fallow on the head. How did this happen? Somebody else might know, but I don't. We removed and collapsed the lifter so we could get the rocker back in without too much trouble. That took care of the engine skip, but we weren't finished — not by a long shot. More about that one in a minute.

The Buick

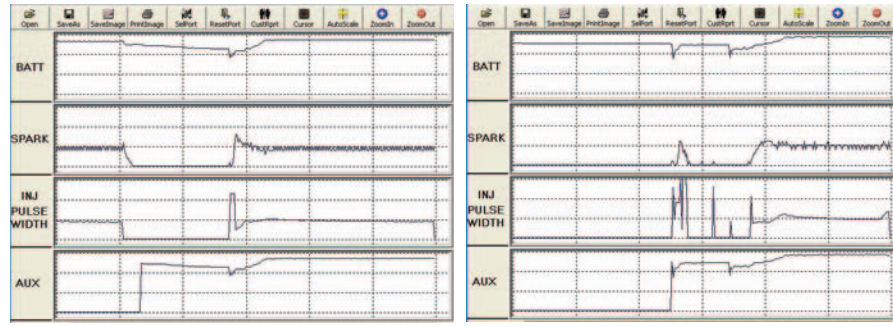
One of our staff drives a 2007 Buick Lucerne that was purchased from the local GM dealer as a very clean used vehicle, and it's outfitted with that tried-and-true 3.8L V6 GM used for so many years. It had been sporting an MIL light for a while along with a P0420 code, but the director in charge of our vehicles said the catalyst had already been replaced with an aftermarket unit before the car was purchased, and he wasn't concerned about that. What did turn out to be a concern after a few thousand miles was that the Buick died and came in on the hook with no fuel pressure.

It was interesting that at about this same time, the 2001 Tacoma driven by the director died from a lack of fuel pressure as well. We ordered a Delphi fuel pump from the local parts supplier for the Buick and initially ordered a fuel pump for the Tacoma, but after we got the Toyota pump out, we found somebody had already replaced it (just the pump, not the whole thing) and did a crappy job on the in-tank wiring patch. Thus, we got rid of the butt connectors, fixed the wiring the right way and sent the pump we had ordered back to the parts store to get the Tacoma done.

One of my people rolled into the trunk on that Buick with an air ratchet and a fan blowing the fumes away and replaced the pump module with a new Delphi unit. However, about six weeks later, the pump died again, and this time, since we were between terms and I was off work, the Buick wound up at

FIRST, WE NOTICED THE COOLANT DRAIN STAINS. Then, above that, we saw the clamp that somebody had never tightened, and finally, in a totally different hose, we found the cracked and lousy tee.

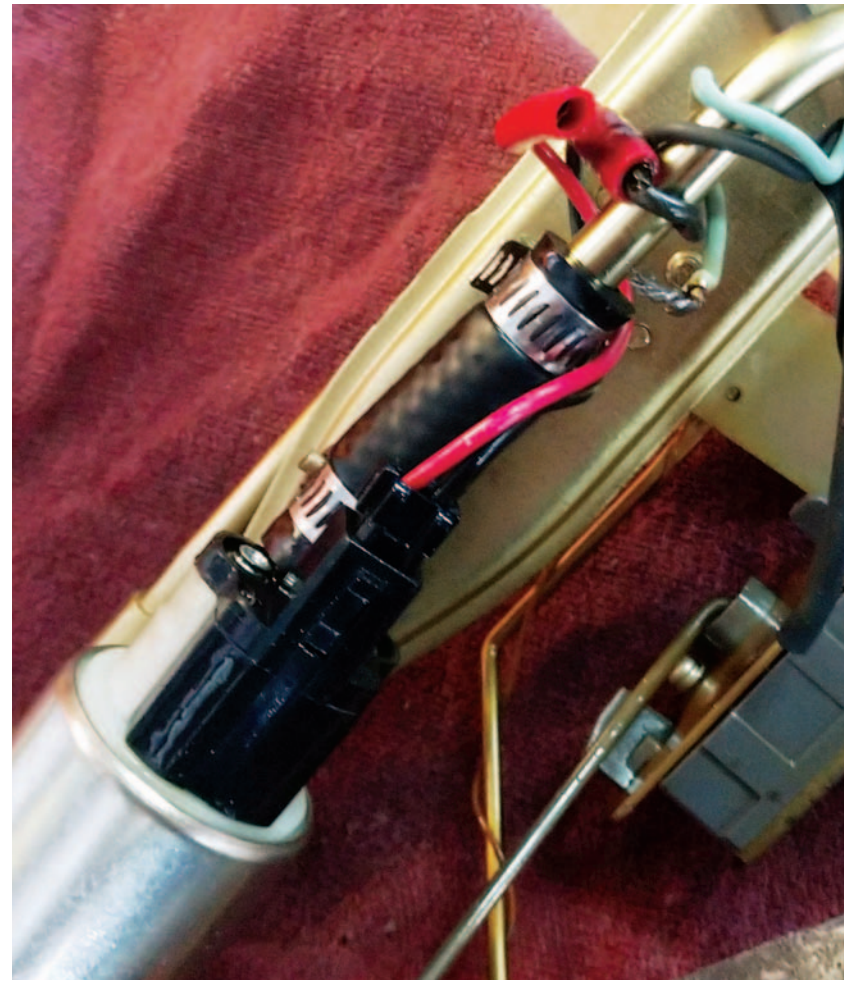
the GM dealer where it had originally been purchased — and the director called my cell phone to say that the dealer said the pump was bad. I called and explained to them that the pump was a Delphi pump, but they said since they didn't sell that one to us, they'd need us to get a replacement pump from the parts store, which I did, and they installed that one; it was back on the road.



THE GOOD TRACE (LEFT) shows when the Buick started and ran the way it was supposed to. The bad trace (note the down spikes at the top when the starter was operated) shows that spark and fuel pulse were initially absent on the long spin.

Well, the odd thing that happened next was that when the car was started after a hot soak it'd immediately die and would need to be re-started. We found the second new fuel pump failing to hold rail pressure after the vehicle was shut down. A third replacement Delphi pump held rail pressure at shutdown, but sometimes the car would still pull that odd start-and-die stunt. This was getting interesting. Further, there were a couple of times when the car would either lose power or just quit while driving and fail to re-start, but we could never duplicate this. We DID, however, get it to start, die and then spin about 10 seconds before starting, and we got it to repeat this somewhat regularly, if not every time. While it had nothing to do with this start-die problem, we obtained a Walker bolt-on replacement cat to get rid of that annoying P0420 once and for all. And it did.

For the other issue, I broke out the Waekon Industries Flight Recorder® (WAE-45364), which is kind of pricey but records ignition, fuel injector pulse, battery power and one auxiliary data plot of your choosing in an internal buffer when you tap the record button; the graphs can be retrieved on your PC with the dedicated software.



THE DIRECTOR'S 2001 TOYOTA TACOMA HUNTING TRUCK died when he was leaving his driveway that morning. We initially diagnosed a bad fuel pump and then found this. He hasn't owned the truck for very long — and this was done before he bought it.

We had successfully fixed a Chrysler Crossfire that had stumped the Chrysler dealer using this same tool (see "Methods, mysteries and frustration," May 2013), so we used the tool on the Buick and found that, when the concern was duplicated with the auxiliary measuring power to the injectors, there was indeed power to the injectors. However, the spark and pulse weren't consistent during the extended spin. After replacing the crank and cam sensors to no avail, we replaced the underhood fuse box because it has a gaggle of those integrated relays that can't be replaced

— one of them being the run/crank relay. If that relay doesn't deliver power (or not enough power) to the PCM, we reasoned that it might cause this concern. It was a Hail Mary pass, but at the time of this writing, about six weeks has gone by with no further complaints.

The 2007 Silverado and the Fusion lug

This truck came in for a routine service and an oil leak, and when we applied the dye and the black light, we found the oil oozing out around the oil filler cap, which was peculiar — but not unheard of — particularly on these GM V8 truck engines that have the PCV system integrated into the driver-side valve cover. The students who did the service also reported moisture in the crankcase — another indication of the PCV issue. We replaced the valve cover, and those concerns evaporated.

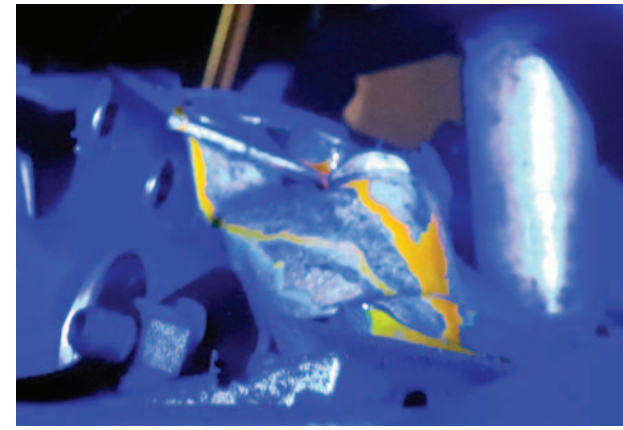
On a side note, we found a Camry leaking oil from around the oil filler cap, too, but it turned out that one just needed an oil filler cap.

We were doing a routine tire rotation on a 2012 Fusion when one of my people came to report that one of the lug nuts was spinning round and round on the left rear, and they couldn't get the tire off. That one was because of a nut that was initially cross-threaded and impact-forced right at its tip. This wasn't the first one of these I had seen; we had an Altima with the same issue a while back, and it was a bear. The folks who use an impact wrench with no torque stick tend to think that too tight is better than just right, and after a little of that, the threads begin to gall and sometimes the nut just won't move. If the splines on the stud are sufficiently strong, the stud will break off. If not, they spin in the hub, like this one did, which becomes something of a problem.

I used a two-pound hammer to drive an old MAC prybar in between the wheel and the hub with enough force so that we were able to foul the head of the lug stud and get the nut off, and then we replaced the stud and the nut. At my shop I teach them to spin the lugs on there with the impact on its lowest setting and then follow up with a torque wrench. Then I place the students in shops where all that careful torqueing (and even the practice of wearing safety glasses) goes out the window and they wonder why I even taught them that to begin with. Oh, well.

Back to the Commander – and a Dodge

In search of the overheating problem, we noticed that there were coolant stains on the exhaust back below the heater core area, and we initially thought there might have been a heater core issue, but then, there was no coolant in the passenger-side floor. Was this one of those with a secondary drain for a leaking heater core? No, there was a hose issue of some sort going on back there, and initially we found that one of the clamps was loose and dangling, but that wasn't our leak either. What we found was that somebody had replaced an original heater



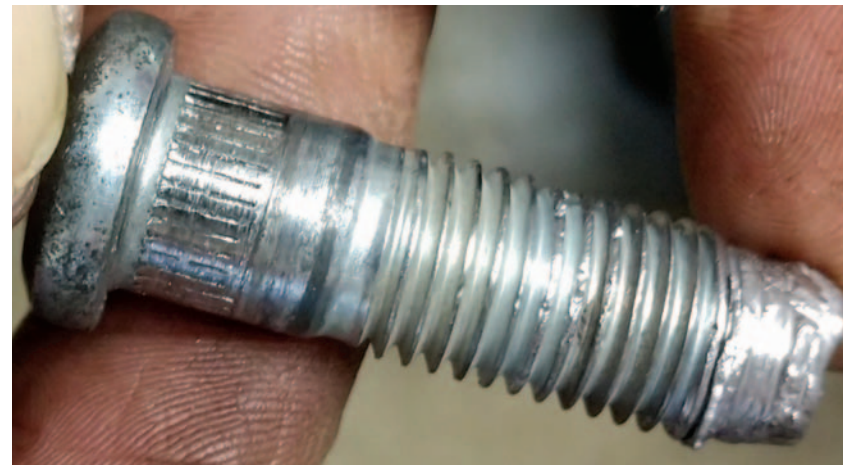
AT FIRST WE PUT DYE IN THE CRANKCASE, then we got under the truck and saw the trickles of oil, which we tracked to the filler cap. That, coupled with the moisture in the crankcase, fingered the valve cover, which has the integral PCV. This one got a replacement valve cover.

hose tee with a plastic one that looks like it came from a hardware store — it was a size too small, not made for coolant heat, and was cracked to boot, and the clamps had egg-shaped the plastic. It's a wonder it was holding coolant as well as it was.

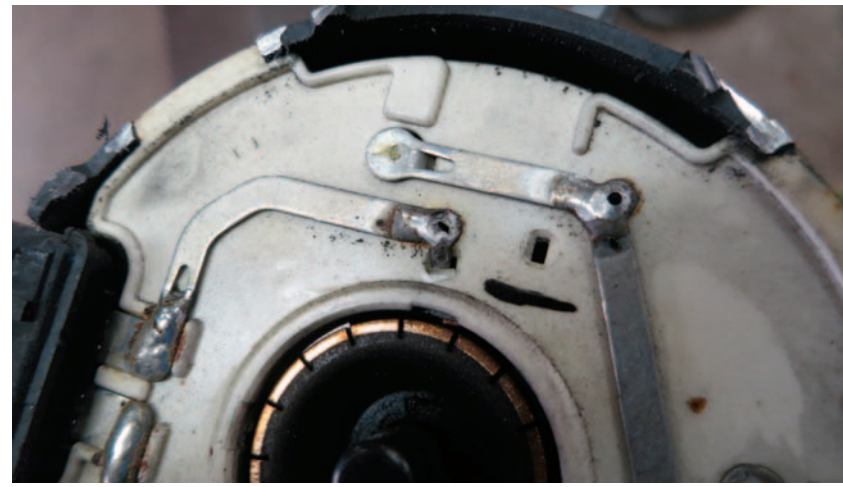
We replaced the tee, pressure tested the system, liked the results, and then drained the radiator, which didn't have much coolant in it. On this one, because the thermostat is in the bottom radiator hose, you drain almost nothing out of the engine block unless you yank the ¼ inch pipe plug out of the side of the block to let it gurgle out of there — we did that. Afterward, I wanted a full load of 50/50 in there, and I poured it in through the upper radiator hose with a funnel to fully purge the engine block water jacket of air before we did anything else. Remember, the thermostat is in the lower hose. Toyotas, old VW Rabbits, and some other platforms are built this way. Incidentally, Ford's 2.8L V6 was configured this way as far back as the '70s (think Mustang II).

Okay, so we fired up the Jeep and let it run for a while; there was a check engine light, and among some other codes, we got one for a cooling fan issue, and this had been an overheater — so we went back at it.

This is one of those Jeep vehicles that has a belt-driven fan AND an electric fan, and we noticed that somebody had pocketknife-shaved the cooling fan wires in spots, probably trying to see if there was power to the fan. We checked the fan electrically with a test light wired in series but found no open segments. Pulling both fan relays, we found no power at their common terminals, and that's when we noticed that blown 50-amp fuse that probably happened when somebody was fiddling around with the fan wiring. With the fuse replaced and a smooth re-test, the fan came online and everything was dandy.



I'VE SEEN THIS MORE THAN ONCE — this lug nut was crossed up by somebody on the starting threads, and then they tried to force it with an impact wrench, which effectively welded the lug nut to the stud. In other cases, the impact wrench distorts and galls the threads all the way down due to overtorqueing. Oil drain plugs are prone to a similar kind of failure.



I LIKE TO DISSECT THE FANS THAT FAIL. Usually, the brushes are worn out, but this one (from the Charger) died because of a cold solder joint.

Speaking of Chrysler V8 overheating problems and customer-bought parts, we had a 2006 Charger that came to us with a new radiator in the back seat that the owner had purchased online, along with specific instructions that we were to replace the radiator first. In true form, they had had a friend of a friend do the troubleshooting and he told them that was what they needed. We followed those instructions (replaced the radiator) but we also did a pressure test, which revealed the actual problem — it had a leaking water pump, so we did that, too. But once again, we weren't done yet. In sewing that job up, we noticed the fan (a dual unit) wouldn't run, and our test light test of the driver-side fan motor revealed an open motor. With a new dual fan, a new water pump and a new radiator, that '06 charger was cool to go.

RICHARD MCCUISTIAN is an ASE-certified Master Auto Technician and was a professional mechanic for more than 25 years. Richard is now an auto mechanics instructor at LBW Community College/ MacArthur Campus in Opp, Ala.
rwm19@mail.com

2019 — AN EXCITING YEAR AHEAD!

CHECK THE FRONT COVER AND BELOW THE *MOTOR AGE* HEADLINE YOU'LL SEE "ADVANCING THE AUTOMOTIVE SERVICE PROFESSIONAL SINCE 1899" — A MISSION WE'RE TAKING TO THE NEXT LEVEL IN 2019!

PETE MEIER // Technical Editor

Motor Age is the nation's oldest automotive trade publication and the mission of "advancing the automotive service professional" is one that I've tried to keep foremost in mind as I perform the role of technical editor. In the last eight years, I've been fortunate enough to recruit some of the best trainers and technicians in the nation as contributors, and I'm proud to announce the addition of yet one more — Scott "Gonzo" Weaver.

Many of you may already know Gonzo. He's an ASE Master Technician and owned his own repair shop, Superior Auto Electric, for over 30 years before selling and semi-retiring in 2017. He has written articles for other industry publications and is the author of "Hey Look, I Found The Loose Nut!" — a humorous collection of stories based on his experiences as a tech and shop owner. We hope you'll enjoy his debut feature, "The ABCs of electrical diagnostics," in this month's issue!

Bringing you training opportunities like never before!

Eight years ago, I started the *Motor Age* YouTube channel and began producing monthly technical features you may know as "The Trainer" video series. To date, there are more than 80 videos in that playlist alone. As of this writing, the channel itself has more than 300 titles and nearly 30,000 of you have subscribed, so you'll be the first to know when new content is added. (If you haven't subscribed yet, do that now by logging on to our channel at www.youtube.com/MotorAgeMagazine.)

The main reason I became involved with YouTube, Facebook and other social media platforms was simple. I wanted to reach out to the nearly 3/4 million technicians this country employs in a way that would complement the print issue and make those same resources available to as many of you as I could. Having wrenched for more than 35 years, I understand how tough our business can be and how hard it can be to get the training and technical information you need to deal with the latest systems and technologies.

A natural outgrowth of that effort was the partnership we formed with Technicians Service Training, better known simply as TST and their president G. Jerry Truglia. G. has been active in aftermarket training since the early days of OBD and OBD II and is still

PHOTO: PETE MEIER

THE IGNITION SPECIALIST™

NGK's OE legacy, unsurpassed quality and leading vehicle coverage reinforces NGK as The Ignition Specialist.™ NGK's premium ignition products are manufactured to the highest durability and operational performance to meet OE standards. Each individual product line covers ***over 95%*** of domestic and import applications.

Visit **ngksparkplugs.com/ignition-products** to learn more.

NGK SPARK PLUGS

THE IGNITION SPECIALIST™

among the top trainers in the country. Together, we've been hosting "live" webinars four times a year, bringing you technical training in a format that is still unique in the industry. We'll be hosting our first for this year about the same time you're reading this column with three more on the schedule for 2019.

MOTOR AGE IS PROUD TO WELCOME SCOTT "GONZO" WEAVER as its newest contributor. Look for Gonzo's debut article in this month's issue.

And we both appreciate the support you've shown for these efforts. You've shared with us how useful these webinars have been for you at events we've attended all across the country. Many of you asked us for more such opportunities and, together, we've found a way to do just that!

For 2019, *Motor Age* has expanded on its relationship with TST. You may already know that TST hosts an annual training every year called the "TST Big Event" — an event that has grown substantially over the last few years and will be hosted again next month, March 30, at the Westchester Marriott in Tarrytown, New York. The Saturday event will feature back-to-back presentations by Kris Lewis, John Anello and John Thornton. It may be sold out by the time you read this, but you can always check for open slots by logging on to www.tstseminars.org.

What you may not know is that TST is also known for the live training events it hosts for its area members in Massachusetts, Connecticut, New Jersey and New York. About six times a year, TST brings in nationally recognized trainers to present to their local membership. The fourth and final stop is in New York and is also simulcast online for those members who are unable to attend in person. Keep in mind that

PHOTO: SCOTT BROWN

AMONG THE FIRST GUESTS OF "SHOP TALK LIVE" was the founder and president of the Diagnostic Network, Scott Brown.

DON'T MISS THE 16TH ANNUAL TST TECH TRAINING BIG EVENT

The 16th Annual TST Big Event will be held on Saturday, March 30, at the Westchester Marriott in Tarrytown, N.Y.

The event includes three training seminars, breakfast and lunch, and a free Android tablet, as well as a chance to win tools.

The cost of the event is $110 for TST members and $160 for non-members. Registration is open until March 18, so be sure to register soon.

Vin Waterhouse of The Waterhouse Group will be presenting the keynote speech. The three training sessions include the following:

Topic 1: "Direct Injection & Systems Diagnostics" — presented by Kris Lewis, Automotive Training Group (ATG)

Gasoline Direct Injection (GDI) is simple in design but difficult to diagnose. This is why ATG has adapted a "High Level Indicator" approach for ruling out possible causes before parts come off. This seminar was built by analyzing actual diagnostic struggles and documenting the shortest diagnostic paths for these systems. Because of this practical approach, you won't be buried in useless engineering detail — only useful facts that you can measure and that will help guide your diagnostic path.

Topic 2: "Advanced Driver-Assistance Systems (ADAS)" — presented by John Anello, Auto Tech on Wheels

This seminar will familiarize you with information on current and future vehicles. This high-energy presentation will include system information and a detailed case study.

Topic 3: "In Cylinder Pressure Transducer Diagnostics" — presented by John Thornton, Autotrain, Inc.

Today, in-cylinder pressure transducers are changing how technicians evaluate the mechanical condition of an engine. John will discuss how to interpret cranking and running compression patterns captured by an in-cylinder pressure transducer. Both good and bad will analyzed. John will cover exhaust path restrictions, intake path restrictions, cam timing issues, leaking valves, broken valve springs and much more.

For more information and to register, go to www.TSTseminars.org.

these are not scaled down versions of the classes these instructors present at the major events! It's the same material with the same ability to interact and ask questions. It's the next best thing to being there!

And now, with the support of TST, *Motor Age* is able to offer these same simulcasts on MotorAge.com! In fact, you may have already taken advantage of this new addition to our training offerings and participated in the first one we co-hosted, featuring our very own Brandon Steckler. Brandon led a great class on the use of pressure sensors and transducers as aids in troubleshooting drivability concerns this past January. Want to see the recorded version? You can still access it at MotorAge.com/pressureanalysis.

Wait, there's more!

In addition to expanding our range of technical training, I'm proud to announce that we are also hosting quarterly webinars with a management focus. I am proud to partner with Jeremy O'Neal, founder of AdvisorFix (https://www.advisorfix.com), in a series aimed at helping service advisors, shop managers and owners get paid for their services by teaching them sales techniques that work. Jeremy is especially well known for his sessions teaching attendees how to sell diagnostic time, and as a former tech, I only wish my service advisor had received his training! We'll be hosting Jeremy's first webinar this month, so be sure to catch it when it's available!

Another new effort I've taken on is called "Shop Talk LIVE," which is a live webcast hosted on the *Motor Age* Magazine Facebook page twice a month. By the time this issue hits your mailbox, I'll have completed six episodes, featuring industry influencers like Jorge Menchu and Scott Brown, and bringing you information and resources you can use to further your career as a technician or shop owner. I invite you to join me for our next episode and keep up on my efforts by following our Facebook page! It's all about keeping our conversation going and "advancing the automotive service professional!"

PETE MEIER is an ASE certified Master Technician with over 35 years of practical experience as a technician and educator, covering a wide variety of makes and models. He began writing for *Motor Age* as a contributor in 2006 and joined the magazine fulltime as Technical Editor in 2010. Pete believes in the mission of the magazine to "advance the automotive professional" and provides resources to working techs around the country through print, social media and YouTube.
pete.meier@ubm.com

FUEL PUMPS

Carquest Fuel Pumps, available exclusively from Advance Professional and Carquest, are performance-tested premium fuel pumps that ensure long life through quiet and precise operation. Designed with upgrades to meet or exceed OE specifications, Carquest Fuel Pumps use a superior carbon commutator and turbine technology to improve durability, enhance performance and reduce vibration noise. For more information on quality Carquest parts, call your local Advance Auto Parts or Carquest delivery location.

WWW.CARQUEST.COM

BRAKE DISCS

Textar engineers have utilized the know-how that comes from decades of producing premium OE brake pads to develop a perfectly matched brake disc that ensures the ultimate braking performance of your vehicle. The Textar range of brake discs is manufactured to precise German specification and are application engineered for cars driven in North America. Textar brake discs, Textar brake fluids (DOT 3, 4, 5.1), Textar anti-squeal pastes and Textar brake tools are available exclusively at WORLDPAC, as well as a full range of premier Textar brake pads, e-pads and brake shoes.

WWW.TEXTAR-WORLDPAC.COM

TECHNICAL TRAINING

WTI WORLDPAC Training Institute

WORLDPAC Training Institute (WTI) offers carline-specific advanced technical training, business management solutions and exclusive Smart Groups designed explicitly for independent repair shop professionals. Always developed and taught by experienced instructors, WTI training keeps you ahead of the learning curve to ensure your business remains competitive and profitable. View the complete class listing at the below website.

WWW.WORLDPAC.COM/TRAINING

GENUINE VOLKSWAGEN MECHANICAL PARTS

Parts Volkswagen

Unlike aftermarket alternatives, Genuine VW Mechanical Parts offer factory original fit and finish. Not only will this OEM quality help save time and avoid the hassle of potential setbacks, it can also help you keep up with customer demands quickly and efficiently. Order today via a nationwide network for easy ordering, speedy delivery, and reliable support.

VWWHOLESALEDEALERS.COM

AD INDEX

AD INDEX

PRODUCTS

TRAINING

WHEN A BELT NOISE ISN'T A BELT NOISE

WATCH THIS MONTH'S EDITION OF THE TRAINER BEFORE YOU ATTEMPT TO SOLVE A CUSTOMER'S NOISE CONCERN WITH A NEW BELT.

PETE MEIER // Technical Editor

You can hear the "squeal" or "chirp" even before your customer pulls into the service drive. And it's one that is often associated with a failed belt. It may very well be, but how many times have you replaced a belt only to have the noise remain?

In this edition of The Trainer, with the help from the experts at DAYCO, I will show you how to diagnose and isolate the cause of that annoying noise. I'll explain the two fundamental types of noise and how to determine which is which, and I'll also show you how to perform an accurate visual inspection of the accessory drive system.

And, as a special offer for *Motor Age* readers, DAYCO will send everyone who completes a short registration form a free aWEARness Gauge. Using this specialty gauge is the ONLY way to accurately inspect modern serpentine belts for wear and is demonstrated in this month's video. But that's not all!

Three lucky registrants will be selected at random to win a complete DAYCO Belt Diagnostic Kit (DAYCO p/n 93874) containing a laser alignment tool, a belt tension gauge and an aWEARness Gauge. This is the same kit I demonstrate in the video and is a valued addition to any toolbox!

SPONSORED BY

DAYCO®

ENTER THE DAYCO CONTEST TO WIN TODAY AT MOTORAGE.COM/FEB19TRAINER